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International Journal of Population Studies

REVIEW ARTICLE

Human behaviors during the COVID-19 pandemic and their consequences

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Abstract

COVID-19 accounted for about 1.1 million deaths in the United States, 365,000 in 2020 alone, and about 7 million worldwide. Due to underreporting, the actual global COVID-19-related deaths were likely between 15 and 30 million, with around 4 million in 2020. As devastating as these numbers were, without any behavioral changes—whether voluntary or mandated—deaths in the United States would have been about 8 million, and global deaths about 115 million, all within 2020. Behavioral measures included border closure, air filtration, surface disinfection, handwashing, wearing glasses/goggles, testing, contact tracing, and politically mandated nonpharmaceutical interventions such as mask-wearing, social distancing, school closures, and lockdowns. These measures significantly reduced mortality rates. Depending on the specific behaviors adopted and the extent of vaccination coverage, countries worldwide experienced widely varying outcomes—ranging from essentially no increase in deaths to overwhelming surges. Each country's COVID-19 response was shaped by its leadership, making political decision-making a decisive factor in pandemic outcomes. Furthermore, recommended behaviors became heavily politicized and were implemented and adhered to unevenly. Each mandated behavior had significant negative consequences, such as reduced learning, diminished socialization, and increased incidences of measles and polio. In addition, maintaining safety required sacrificing quality of life. The most impactful measure was isolation, which contributed to increased stress, mental health problems, and delays in medical treatment—factors that led to higher mortality rates and deaths of despair. Moreover, a range of unusual human behaviors emerged. Misinformation spread rapidly, resulting in lower vaccination rates and reduced adherence to safe practices. Interestingly, even animal behaviors changed. Hence, this paper discusses behaviors during the COVID-19 pandemic and their far-reaching consequences.

Keywords: COVID-19; Nonpharmaceutical interventions; Lockdowns; Social distancing; School closures

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1. Introduction

Human behavior, to put it mildly, is complex, unpredictable, and frustratingly irrational. Our COVID-related behaviors disrupted fragile equilibria and impacted our health, socialization, education, and economy. Since the beginning of the pandemic, a comprehensive document titled *The Mouse that Roared* has been compiled to summarize COVID research. The title reflects the fact that, in historical context, severe acute

respiratory syndrome coronavirus 2 (SARS-CoV-2) is a relatively mild virus that has caused huge societal impacts. The 23,000-page document contains approximately 22,000 paper summaries drawn from 2,250 sources. Most of these papers originate from journals and platforms such as *Nature*, *Cell*, *Science*, *Frontiers*, MDPI, Sage, *Cureus*, *JAMA*, the American Health Association, *The British Medical Journal*, *New England Journal of Medicine*, *PLOS*, *BMC*, Wiley, *Proceedings of the National Academy of Sciences*, bioRxiv, medRxiv, preprints.org, SSRN, Research Square, and the Centers for Disease Control and Prevention (CDC). The six chapters—"How People Behaved," "Avoiding COVID," "Politics and National COVID Responses," "Herd Immunity," "Superspreaders and Superspreading Events," and "Pandemic Medical Impacts"—along with the 4,500 paper summaries, form the foundation of this review.

2. The significance of behavior during a pandemic

Let us consider a Gedanken thought experiment to see what would have happened if no one had changed their behavior during the pandemic. An April 2021 CDC *Mortality and Morbidity Weekly Report* paper presented data on COVID-19 in the United States (US) in 2020, as shown in Figure 1.

This 4.9% rate is consistent with Our World of Data's world case fatality rates, which were 5.2% for the same interval. Case fatality rates are calculated as confirmed deaths divided by confirmed cases. Confirmed cases typically represent symptomatic cases, which accounted for only 60% of the cases. In addition, many mild cases would have been interpreted as the flu or a mild cold. Thus, it is reasonable to assume that the actual number of cases was twice as high, resulting in an estimated case fatality rate of 2.5% for all infections. Assuming no changes in behavior and applying these death rates, Table 1 shows the projected number of deaths by age in the US, corresponding to an overall 2.5% death rate.

The global COVID-19 death rate would have been lower than that of the US due to its lower overall age rate. Globally, if there had been no behavioral changes, there would have been about 115 million deaths or a 1.5% case fatality rate.

With the Wuhan variant of COVID-19, which had a viral reproduction number (R_0) of 2.5, cases would have grown exponentially—as observed in the first few weeks in the US outbreak (later in the pandemic, SARS-CoV-2's R_0 reached double digits). Under this scenario, everyone in the US would have been infected by mid-summer, rendering vaccines ineffective, and hospitals would have been extremely overloaded. This scenario epitomizes the remark by Boris Johnson, then Prime Minister of the United Kingdom, that "COVID is just nature's way of dealing with old people."

The October 2020 Great Barrington Declaration, which was endorsed by the US President at the time, Donald Trump, suggested that elderly individuals stay home, while allowing others to become infected, thereby achieving herd immunity and avoiding school closures. Assuming this approach had been implemented early in the pandemic, herd immunity might have been attainable if people aged 50 and older stayed home; however, the number of deaths would be equal to the actual pandemic toll. If the threshold had been raised to isolate the 60+ age group instead, deaths would have doubled. To complicate matters further, new variants would have required subsequent Great Barrington Declarations.

2.1. Differences between countries

COVID-19 deaths and excess deaths dramatically reflected the impacts of different countries' pandemic behavioral responses. Had the US matched the average performance

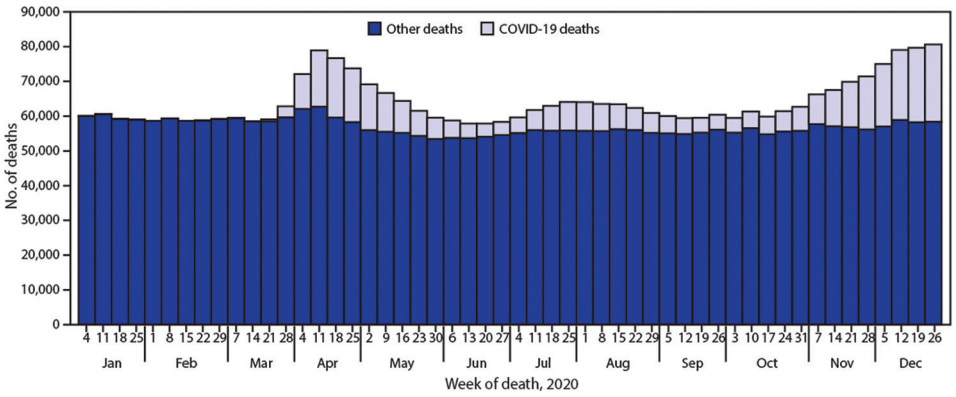

Figure 1. United States COVID deaths. Image obtained from Ahmad *et al.*, 2021.

Table 1. Projected deaths in the United States, if there were no behavioral changes

Age	Men	Women	Total
<29	96,964	97,459	194,422
30–39	56,067	54,418	110,486
40–49	110,651	112,465	223,116
50–59	306,722	321,563	628,286
60–69	877,291	955,621	1,832,912
70–79	1,353,535	1,579,124	2,932,659
>80	1,220,292	1,171,481	2,391,773
Total	4,021,522	4,292,131	8,313,653

of countries such as Japan, South Korea, Taiwan, Singapore, Australia, and New Zealand, there would have been 700,000 fewer deaths in the US. In other words, roughly seven out of the 10 COVID-related deaths in the US would have been prevented through rational behavior. This raises the critical question: Why did the US have such terrible outcomes?

3. The role of the leader

All countries' pandemic responses were shaped by their respective leaders. No country delegated that responsibility to its public health agencies. A country's leader established practices and acted as a role model, thus influencing public behavior and determining COVID-19 outcomes.

The significance of leadership was starkly demonstrated by the 1991 Milgram experiment at Yale (Blass, 1991). The experiment demonstrated the overwhelming power of authority and provided the psychological evidence that people will blindly and obediently follow leaders. Remarkably, two-thirds of the participants in the experiment administered a potentially lethal shock to another participant after s/he was allegedly unconscious simply because someone in a White coat told them to do so.

Adding to people's inbred, lemming-like behaviors, the threat, uncertainty, and urgency associated with a crisis like the pandemic magnify a leader's power. This dynamic helps explain why 4% of adult respondents said they drank or gargled diluted bleach after Trump's ill-advised suggestion to drink bleach.

4. People's behavior

4.1. COVID-19 infection

SARS-CoV-2 infects the host by entering the body through the mouth, nose, or eyes. The virus cannot enter the body through the skin, open sores, or ingestion of contaminated food. Thus, transmission primarily occurs through airborne exposure and contact with the mucous membranes of the face.

Although not officially recognized by the World Health Organization until December 2022, SARS-CoV-2 spreads mainly through small droplets in aerosol, rather than large droplets. Infection typically requires exposure to about 100 viral particles. However, transmission could occur with as few as three viral particles. Compounding this risk, Bleicker *et al.* (2021) found that infected individuals can release up to hundreds of millions of viral particles.

Airborne transmission occurs through several means:

(i) Breathing releases 50–5,000 droplets. Most of these droplets are low velocity and fall to the ground quickly. Fewer droplets are released through breathing through the nose.

(ii) Sneezing produces approximately 30,000 droplets, with droplets traveling at speeds up to 200 miles per hour. Infected individuals may release up to 200 million viral particles in a single cough or sneeze.

(iii) A toilet flush generates about 8,000 droplets if the seat is left open. Infections have resulted from toilet flushes.

SARS-CoV-2 viral particles can also be transmitted through surfaces. A study by Chatterjee *et al.* (2021) reported the persistence of the SARS-CoV-2 virus particles on hard surfaces, as shown in Table 2.

With the emergence of variants, SARS-CoV-2's infectiousness grew. The original Wuhan strain had an R_0 of 2.5, followed by Alpha at 3.0, Delta at 5.0, and the original Omicron variant at 8.2. Since then, the transmissibility has continued to rise.

5. Common settings for SARS-CoV-2 transmission

Having established how infection happens, the next question is where. According to Grabowski *et al.* (2020), the primary settings for SARS-CoV-2 spread include households, within the community, which is fueled by superspreaders, and interregional transmission networks.

A meta-analysis by Dean *et al.* (2020), which reviewed 54 relevant studies with 77,758 participants regarding household secondary transmission, reported that the estimated household secondary attack rate was 16.6% (95% confidence interval [CI]: 14.0–19.3%), which was higher than the secondary attack rates for SARS-CoV-1 (7.5%; 95% CI: 4.8–10.7%) and Middle East respiratory syndrome (MERS) coronavirus (4.7%; 95% CI: 0.9–10.7%). Household secondary attack rates from symptomatic index cases (18.0%; 95% CI, 14.2–22.1%) were higher than from asymptomatic index cases (0.7%; 95% CI: 0–4.9%). Adult

Table 2. Virus survival time

Material	Average survival time
Plastic	Up to 7 days
Stainless steel	Up to 7 days
Metal	Up to 5 days
Glass	Up to 4 days
Ceramic	Up to 4 days
Paper money	Up to 2 days
Unvarnished wood	Up to 1 day
Cloth	Up to 1 day
Cardboard	Up to 1 day
Paper	Up to 30 min
Tissue paper	Up to 30 min

contacts (28.3%; 95% CI: 20.2–37.1%) had more infections than child contacts (16.8%; 95% CI: 12.3–21.7%), with spouses (37.8%; 95% CI: 25.8–50.5%) experiencing more infections than other family contacts (17.8%; 95% CI: 11.7–24.8%).

5.1. Community spread

Three major factors are implicated in community spread: the activities of other people, the location, and the presence of a nearby superspreader.

Alsved *et al.* (2020) reported that there are huge ranges in viral spread depending on a person's activity, as shown in Figure 2. Notably, the impact of wearing a face mask is shown by the rightmost bar in Figure 2.

Alsved *et al.*, (2020) reported that the type of wind instrument used in orchestras significantly affects viral spread. Instruments that are larger and oriented more directly toward the audience—rather than toward the ceiling or floor—tend to disperse greater quantities of viral particles.

Location also plays a crucial role, as venues vary in crowd density and ventilation quality. Viral infection rates associated with the reopening of various US venues and activities.

Another primary factor influencing COVID-19 spread is the presence of superspreaders and superspreading events. Not all people emit the same number of viral particles; rather, the distribution follows a negative binomial distribution, where a small percentage of people account for the majority of viral emissions. Yang *et al.* (2021) reported that just 2% of individuals carry 90% of the population's viral load, as shown in Figure 3.

Meagher and Friel (2022) estimated that 20% of index cases, those with the high viral load, accounted

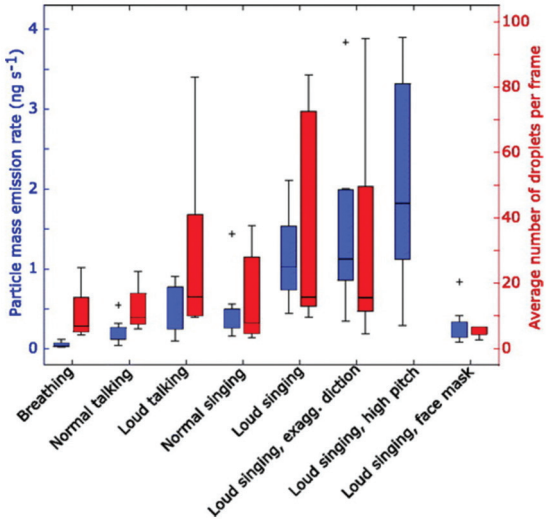

Figure 2. Severe acute respiratory syndrome coronavirus 2 aerosol spray rates. Image obtained from Alsved *et al.*, 2020.

for approximately 75–98% of the expected secondary infections. The index case or patient zero is the first documented patient in a disease epidemic within a population, or the first documented patient included in an epidemiological study. A superspreader event happens when an event is crowded and/or is indoors and exhibits uninhibited social behavior. Superspreading occurred in restaurants, bars, nightclubs, churches, nursing homes, prisons, cruise ships, airplanes (particularly boarding), homeless shelters, colleges, sporting events, and the Sturgis motorcycle rally.

In May 2020, the CDC erroneously recommended maintaining a six-foot distance as a sufficient preventive measure; however, infections happened in unexpected ways. Wong *et al.* (2022) documented a case in which a vaccinated individual contracted COVID-19 from another vaccinated, infected person staying in a hotel room across the hallway, likely due to viral particles travelling under the doors.

6. Prevention of COVID-19 infection

As discussions on non-pharmaceutical interventions (NPIs) unfold, it will become clear that it was possible to avoid SARS-CoV-2 infection. However, beyond ignorance, a major reason that so many people got infected was the challenging tradeoff between safety and quality of life. Not being able to go to restaurants, movies, and sporting events greatly impacted many people's enjoyment of life. Face masks were uncomfortable, and taking a rapid antigen test before seeing friends was onerous. Consequently, many chose quality of life over safety. For younger people, particularly later in the pandemic, this was a rational choice.

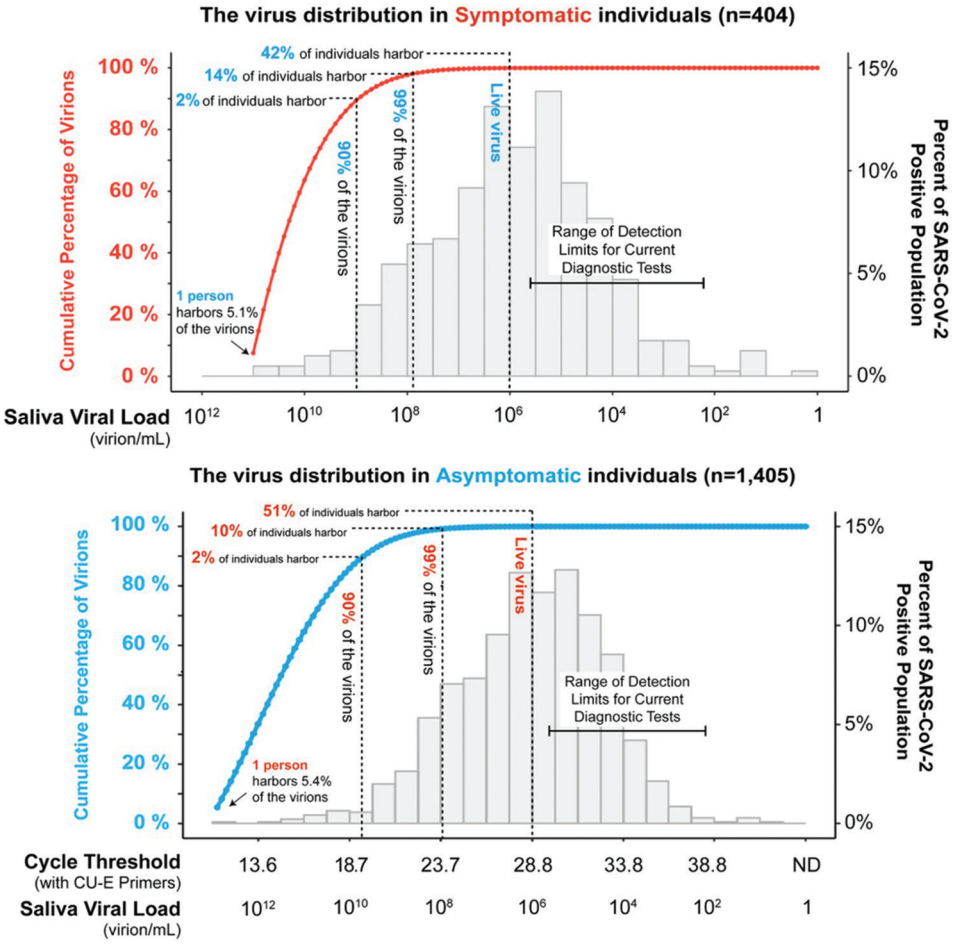

Figure 3. Percentage of viral load in symptomatic and asymptomatic individuals. Image obtained from Yang *et al.*, 2021.

6.1. Pharmaceutical interventions

Even though SARS-CoV-2 is highly infectious, the infection can be prevented primarily through vaccinations and/or therapeutics. When the initial messenger RNA vaccine trial results were published in December 2020, the prospect of achieving herd immunity and ending the pandemic seemed within reach. Moderna's vaccine showed 94.1% efficiency (95% CI: 89.3–96.8%) (Baden *et al.*, 2020) and Pfizer's demonstrated 94.8% efficacy (95% CI: 89.8–97.6%) (Polack *et al.*, 2020) against the infection. These spectacular results took many by surprise.

The proportion of the population that must be immune from infection to achieve herd immunity is greatly influenced by R_0, which reflects how many people an average person will infect in a new environment. With ~95% vaccine effectiveness against infection and the Wuhan strains' R_0 of 2.5, roughly 65% of the population needed to be vaccinated or previously infected to achieve herd immunity. However, with Delta's higher R_0 of 5 and the low vaccination rates in the US, achieving herd immunity through vaccination alone became unattainable.

Furthermore, as the variants evolved, SARS-CoV-2 evaded vaccine protection. By the end of 2023, protection against infection from the XBB.1.5 Pfizer booster was 35% (95% CI: 10–52%) among 18–59 year olds and 55% (95% CI: 48–61%) among 60–85 year olds (Huiberts *et al.*, 2024). Furthermore, for unknown reasons, COVID-19 vaccine protection quickly waned with time. While some vaccines, for example, measles and polio, confer lifetime immunity, COVID vaccines require annual updates and boosters every 6 months. Other than vaccinations, there are two other therapeutic approaches to avoid infection: monoclonal antibodies and 5% iodine nasal spray and/or gargle.

6.1.1. Monoclonal antibodies

The two that were approved for use to prevent COVID-19 infection in the US were Evusheld (tixagevimab and cilgavimab) and Pemgarda.

Levin *et al.* (2022) reported that at a median of 6 months after use, Evusheld reduced infection risk by 82.8% (95% CI: 65.8–91.4%). A meta-analysis by Glhoom *et al.* (2024) similarly found that Evusheld reduced COVID-19 symptomatic infection by 77%. Although it was effective against Omicron BA.1 and BA.2, later Omicron subvariants rendered it ineffective.

In August 2024, Invivyd, the manufacturer of Pemgarda, reported its phase III trial results. Through the first 6 months, there was an 84% infection risk reduction. Between months 7–12, there was a 64% risk reduction of symptomatic COVID in immunocompetent adults. However, variants KP.3.1.1 and XEC significantly impacted Pemgarda neutralization rates. Subsequent studies reported the same reduced effectiveness.

6.1.2. Povidone iodine nasal spray or gargle

Several pre-pandemic studies reported that 0.5–1% povidone iodine nasal spray or gargle killed all viruses in the nose or mouth. Fujii *et al.* (2006) reported that treatment of SARS-CoV-1 with povidone iodine products for 2 min reduced viral infectivity from 1.17 $\times 10^6$ tissue culture infectious dose to below detectable levels. Pelletier *et al.* (2020) reported that all evaluated concentrations of nasal antiseptics and oral rinse antiseptics completely inactivated SARS-CoV-2 after 60 s. Moreover, povidone iodine nasal spray resulted in an 8.57 times reduction of COVID-19 hospitalization and death rates (Baxter *et al.*, 2024).

6.2. NPIs

NPIs are techniques to avoid SARS-CoV-2 infection that are not based on vaccines or therapeutics. They are particularly important for immunocompromised individuals. Furthermore, diabetic individuals utilized them more than the population average.

There are two types of NPIs that keep viral particles from entering the body. First, elimination of SARS-CoV-2 before human contact by killing the virus on surfaces, on the skin, in liquids, or in the air. Second, avoid COVID-19 infection by staying away from infected people or animals and/or their viral particles.

6.2.1. Elimination of SARS-CoV-2 before human contact

There are several aspects to consider when eliminating the virus before it comes into contact with humans. This eradication encompasses the skin, hard surfaces, liquids, and air.

Killing the virus on the skin is relatively easy. Wash it with a good soap for 20 s or use an alcohol-containing disinfectant like Purell. However, these practices can induce irritant contact dermatitis, particularly in healthcare professionals, who often seek out skin-friendly cleansers to minimize irritation. In regard to hard surfaces, cleaning with a disinfectant such as bleach or Virusend not only kills the virus on the surface but also provides lasting protection for the surface.

Viral infection does not occur through the drinking of water, as one cannot get infected by ingesting solid foods or liquids. However, swimming pools can be the source of an infection. Brown *et al.* (2021) reported that to meet the United Kingdom's swimming pool regulations, infectious SARS-CoV-2 levels must be reduced by at least three orders of magnitude. A pH of no more than 7.4 and free chlorine above 1.5 parts per million achieved that goal.

COVID-19 primarily spreads through small, respiratory droplets. Hence, removing them from the air would serve as another method of eliminating the virus before it comes into contact with humans. There are several ways to achieve this. One way is using ultraviolet light. Liu and Shan (2023) reported that ultraviolet light kills viruses by disrupting their RNA. Hence, inexpensive ultraviolet systems can be installed in heating, ventilation, and air conditioning heating/cooling systems to inactivate viral RNA using human-safe, electromagnetic waves. However, ionization does not appear to be effective at killing SARS-CoV-2.

Installing high-efficiency particulate air (HEPA)-14 filters is another method which is eliminating the virus from the air. The SARS-CoV-2 virus is about 0.1 μm in diameter. HEPA-14 filters can remove at least 99.97% of airborne particles that are 0.3 microns (μm) or larger in size. Fortunately, if the air is passed multiple times through a HEPA-14 filter, it will remove the 0.1 μm SARS-CoV-2 particles from the air. Ueki *et al.* (2022) reported that an air cleaner with the HEPA filter removed SARS-CoV-2 from the air at virus capture ratios of 85.38%, 96.03%, and >99.97% at 1, 2, and 7.1 ventilation volumes, respectively.

Another important factor to consider is ventilation. During the pandemic, there have been more than 2,000 documented "superspreading" events, in which a single, infected person quickly infected many others. Almost all involved large groups in poorly ventilated indoor spaces. Morawska *et al.* (2024) reported key lessons learned from the COVID pandemic on ventilation's role as an effective means against airborne pathogen transmission. The authors highlighted the longstanding historical connection between air quality and infectious diseases. Moreover, Busato and Cavallini (2023) demonstrated the power of ventilation systems in school rooms. Interestingly, they only required 1/3 the energy to keep the Italian classrooms heated compared to open windows (Figure 4).

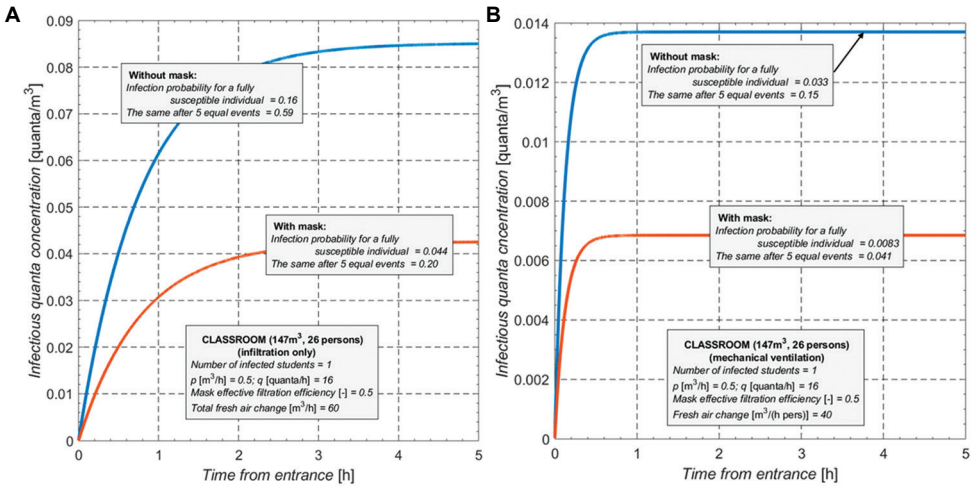

Figure 4. The power of air ventilation systems. (A) Open window and (B) mechanical ventilation infection rates. Image obtained from Busato and Cavallini (2023).

6.2.2. Protection from COVID-positive individuals

At the peak of the early 2022 Omicron surge, including asymptomatic cases, roughly 4% of the US population was infected. If you walked passed people on a street or were with a group of people, the likelihood of at least one of them being infected is shown in Table 3.

The risk of infection in an air-conditioned space was demonstrated by Lu *et al.* (2020) in a restaurant in Guangzhou, China, as shown in Figure 5. Among the 83 individuals in the restaurant, 10 were infected with COVID-19. The attack rate to those seated near the index case was ~23%. Small droplet aerosol transmission was implicated as viral spread occurred beyond six feet.

Given how easily it is to be infected through aerosol spray, it is evident why so many people got infected. There are actions one can take to reduce the chances of infection, but unfortunately, each has negative consequences. Table 4 summarizes the NPIs that were employed to avoid infection.

Other, less impactful forms of reducing the chance of infection were smart elevators, improved refuse shoots, spittoons, and virus-blocking textiles and fibers.

6.2.2.1. Border closures

During 2020–2021, nearly every country in the world imposed border restrictions to curb the spread of SARS-CoV-2. More than 1,000 new international border closures were introduced in 2020 and 2021. As shown in Figure 6 (African Center for Strategy Studies, 2020), it took the Spanish Flu 18 months to infect the world, mainly through World War I troop ships.

Even with the border closures, COVID-19 spread globally within 3 months—highlighting the speed of modern air travel compared to historical troop ship movements. Shiraef *et al.* (2022) found no evidence in favor of international border closures except in a few highly isolated countries, for example, New Zealand, Australia, and South Korea. Typically, attempting to close the borders only delayed the COVID-19 spread by a few days. Sometimes, partial closures had little effect. For example, when Trump closed the borders to China, he let infected Americans return home.

Airplanes were quickly recognized as high-risk environments for COVID-19 transmission, leading to a sharp decline in air travel. According to TSA passenger data, and after adjusting for population increases since 2019, US air travel per capita did not return to pre-pandemic (2019) levels until 2024. The 2023 population level adjusted traffic levels would have exceeded 2019 levels if people had followed the traditional Thanksgiving and Christmas heavy traffic patterns. However, the winter surge kept them home.

6.2.2.2. Testing and contact testing

Given that 60% of COVID-19 spread happens from asymptomatic infected people, the only way to be sure that someone does not have COVID-19 is to test them. While many next-generation tests are under development, the two personal pandemic testing workhorses were the polymerase chain reaction (PCR) and the rapid antigen tests. The third type of test, antibody, is used to see if someone was previously infected with COVID-19. Notably, only slightly more than 40% of the people who tested positive for prior infection were aware that they had been infected.

PCR is a laboratory technique that detects and amplifies specific genetic sequences, such as those in viruses and

Table 3. Infection probabilities

Number of people	Probability of at least one person having COVID (%)
10	33
20	56
30	71
40	80
50	87

Table 4. Techniques to avoid infection

Technique	Negative consequences
Border closures	Impeded worker movement and people returning home
Testing and contact tracing	Before rapid antigen tests, polymerase chain reaction tests were difficult to get and often took too long to provide an actionable result
Glasses or goggles	Goggles are uncomfortable, and some can fog up
Face masks	Masks are uncomfortable, interfere with recognition, and increase the chance of bacterial infection due to the warm, moist environment created by the face masks
Social distancing	It interfered with all aspects of daily life, for example, socialization, shopping, eating out, and working
School closures	They reduced learning, caused isolation, increased myopia, and increased body mass index
Lockdowns	They significantly interfered with all aspects of daily life and led to extreme isolation

bacteria. PCR testing is highly sensitive and can detect small amounts of genetic material. In PCR testing, a nose or throat sample is sent to a lab. One receives the test result as early as 24 h after the test, but it took several days when case rates were high and testing capacity was low. While PCR tests provided insights into case rates, their delayed results often precluded their use for behavior modification. South Korea, with its excellent, widely deployed camera face recognition technology, excellent test availability, and a compliant population, used PCR testing in its world-class contact tracing system to control viral spread.

In contrast, the rapid antigen test is an at-home, personally administered test with results returned in about 20 min. It detects the presence of the N protein, is quite accurate, and has yet to be affected by variants. It is used for determining if it was safe to visit friends or relatives, whether people could board an airplane or enter a country, if people should take an antiviral, and who should be isolated in a nursing home, prison, college, or passenger ship. Their widespread use reduced COVID cases, and the introduction of community testing was associated with a 43% (95% CI: 29–57%) reduction in COVID-related hospital admissions in Liverpool during the United Kingdom national lockdown from November 06 to December 03, 2020 (Zhang *et al*., 2022).

Contact tracing was only effective when case rates were low, testing was high, and the population was compliant, for example, South Korea. Due to the terribly botched CDC test development effort, the US did not have effective testing until mid-March 2020, and some states did not have enough tests until June 2020. Low test availability, high case rates, and the difficulty of getting some people to take tests made contact tracing useless in the US. Due to the high US case rates, the George Washington University Fitzhugh Mullan Institute for Health Workforce Equity contact tracing estimator estimated the US would have needed 1,250,000 people in the contact tracing workforce in September 2020 to be effective. A very clever use of testing was the US's Test to Treat program. If one tested positive, one could find a pharmacy from a website where s/he could get a free COVID antiviral such as Paxlovid.

Other forms of testing were used for special purposes. Pooled testing, when the samples of many people are mixed together, could, for example, determine if someone in a college dorm was infected. If so, individual testing could determine the infected individual. Wastewater testing was used to provide some indication of COVID case rates when home testing replaced lab testing. It started as a pandemic novelty and is now widely used around the world, for example, in Zambia and Ethiopia. Van Beusekon (2023) reported that more than 70 countries and 3,500 sites report COVID wastewater data to a global dashboard.

There were other forms of less frequently used tests, for example, dog sniffing. As the pandemic progressed, many next-generation tests were developed, enhancing existing tests or analyzing different properties such as lipid levels, sweat, or breath. These innovations used different measurement technologies such as magnetic nanoparticles, smart toilets, and smartphones. Some were wearable, such as face masks capable of performing on-the-go testing.

6.2.2.3. Glasses or goggles

There is a wide range of results on the impact of wearing glasses and goggles. Li *et al.* (2020) reported a much lower COVID-19 rate for those who wore glasses for 8 h a day. They speculated that the glasses reduced the hand-to-face touching and thus reduced the chance of infection. The study included 276 patients hospitalized with COVID-19 in Suizhou, China. The proportion of daily eyeglasses wearers who were infected with COVID-19 was much lower than that of the local population (5.8% vs. 31.5%).

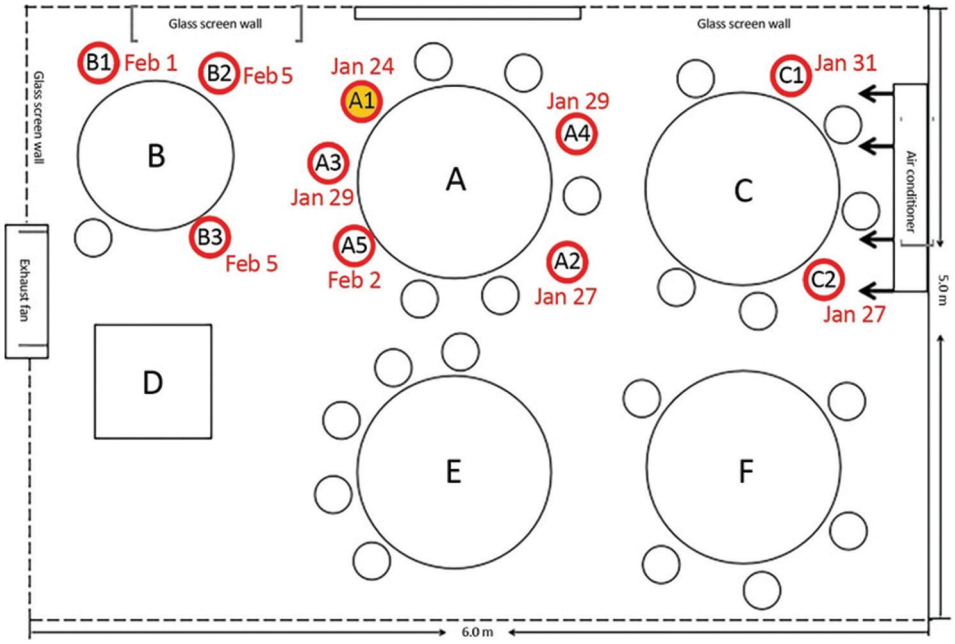

Figure 5. Guangzhou restaurant infections and positive testing dates. A1 refers to the index case. Image obtained from Lu *et al.* (2020).

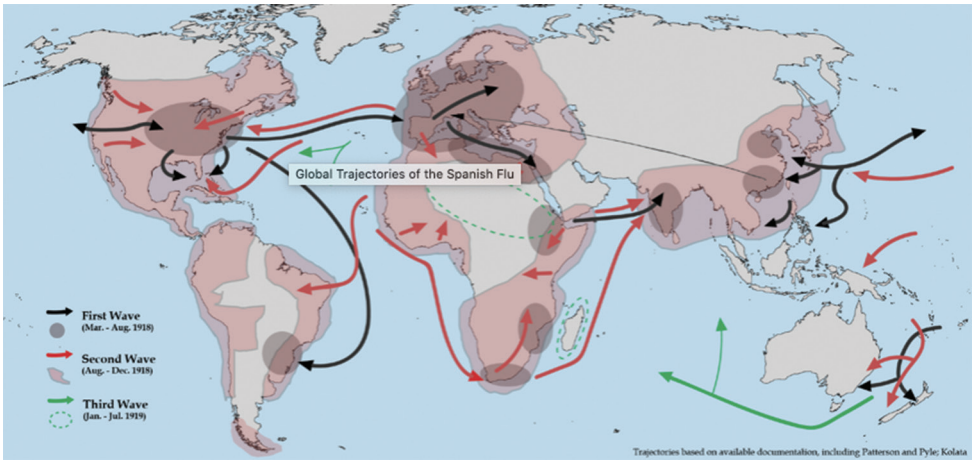

Figure 6. The spanish flu global spread. Image obtained from the African Center for Strategy Studies (2020). Source: https://africacenter.org/spotlight/lessons-1918-1919-spanish-flu-africa.

However, the paper did not discuss mask-wearing among the study participants.

All healthcare professionals should consider tears to be potentially infectious. They should ask patients about ocular symptoms consistent with COVID-19 and use eye protection such as goggles or face shields as part of the standard personal protective equipment.

6.2.3. Primary NPI measures

The primary NPI measures against COVID were face masks, lockdowns, school closures, and social distancing. Most US states mandated them, but over different timeframes and with different rules. Their duration and implementation by the Democratic and Republican states are summarized in Figure 7.

Akhmetzhanov *et al.* (2022) reported a significant reduction in the number of cases in Taiwan after the implementation of control measures. Figure 8 demonstrates the importance of acting early during the pandemic.

Krieger *et al.* (2022) reported that in models mutually adjusted for congressional district political and social metrics and vaccination rates, Republican and conservative voter political lean was associated with 11–26% higher COVID-19 mortality rate, as shown in Figure 9. The

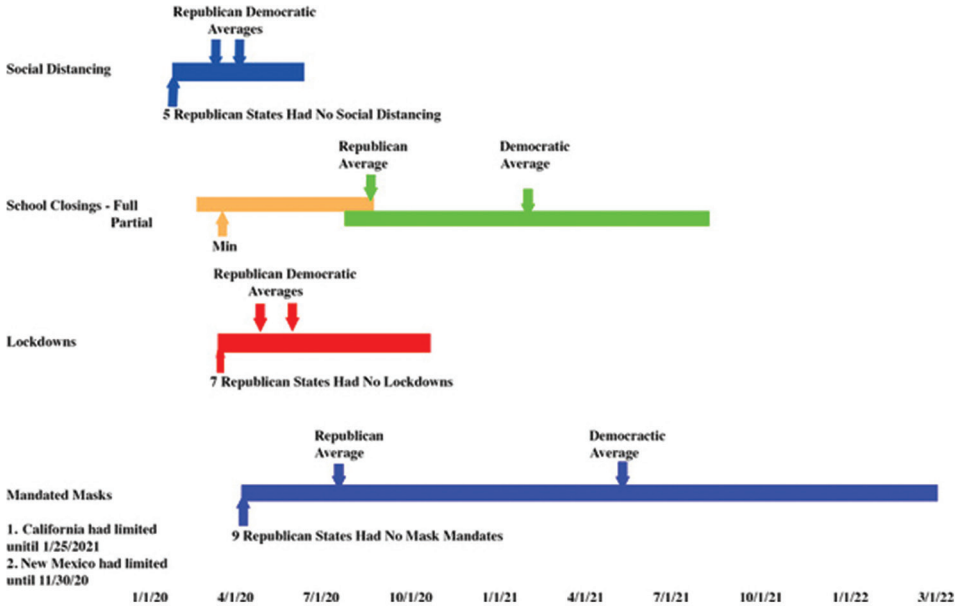

Figure 7. Primary COVID-19 nonpharmaceutical interventions timeframes

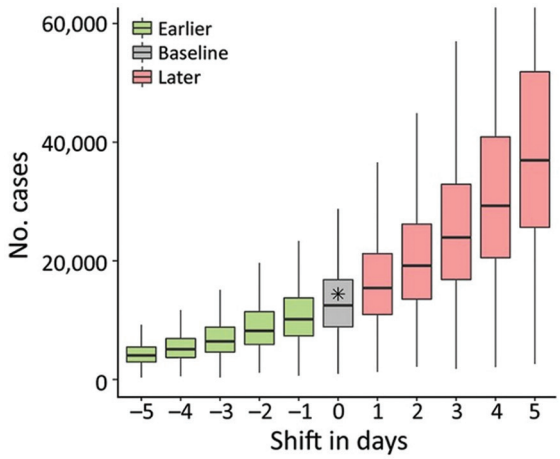

Figure 8. Impact of speed on COVID-19 case rate growth. Image obtained from Akhmetzhanov *et al.* (2022).

X-axis is the Democratic/Republican leaning based on the congressional representative's voting record.

If the death rates for the political parties had been the same, Trump would have won Arizona and Georgia in the 2020 Presidential election; however, he would have still lost the election to Biden. These differences were the result of the lack of mandates in some states, but also the lower Republican compliance with mandates. As shown in Figure 10, Republicans and Democrats behaved quite differently.

6.2.3.1. Face masks

Face masks have been around a long time. In the 1500s, European women wore them to be fashionable and to hide their identities. Pale skin was a sign of high status; sun-kissed skin suggested poor health, and the drudgery of working outside. To achieve the lightest complexion, untouched by freckles and sunburn, upper-class women wore face coverings to shield their faces from sun, wind, and dust. Wearing face masks was controversial during the 1918 Spanish pandemic.

Face masks were very effective during the Spanish flu. US cities that were strictly compliant in face mask wearing did not have a second Spanish Flu wave. The masks worked for severe acute respiratory syndrome and MERS, so why were they not strongly recommended in the US during the COVID-19 pandemic onset? Part of the reason was that the Strategic National Stockpile had only 12 million N95 masks. It had once held more than a hundred million masks, but many were used during the 2009 H1N1 flu pandemic, and the supply was not replenished. Dr. Fauci commented that he intentionally underplayed face masks early in the pandemic due to their short supply and medical personnel's urgent need. In April 2020, he told the American public that face masks would help stifle the pandemic.

In February 2022, *The New York Times* reported that the number of weddings in the US dropped in 2020, from

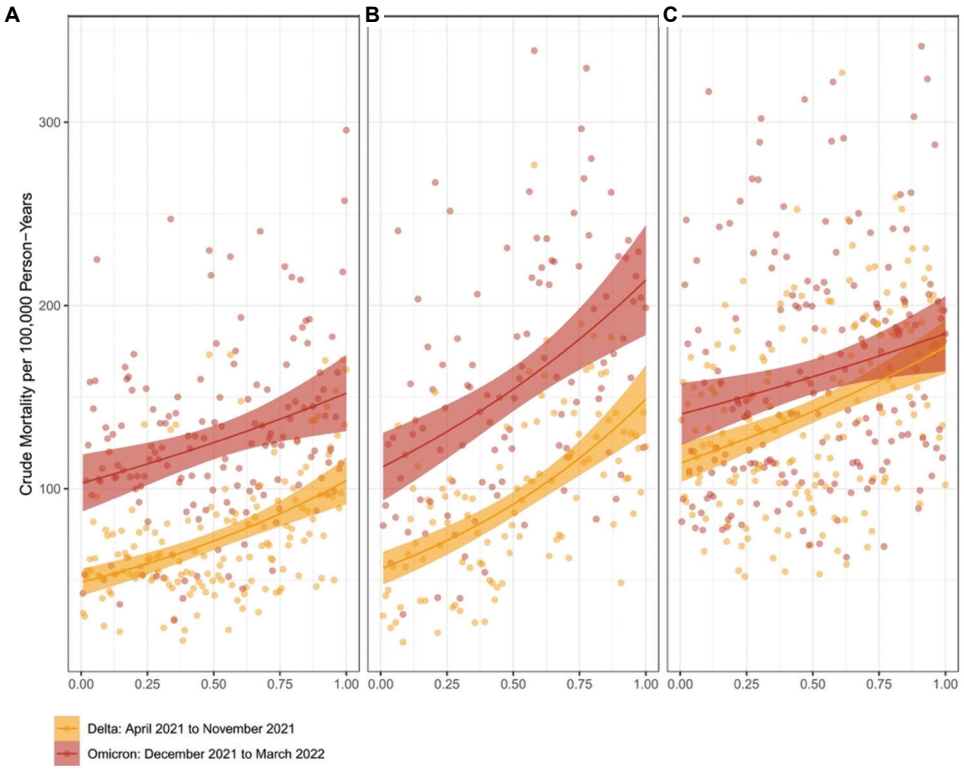

Figure 9. Impact of political bias on united states COVID-19 death rates. (A) Democratic: 14 states, with 151 congressional districts, (B) divided: 13 states, with 107 congressional districts, and (C) republican: 23 states, with 177 congressional districts. Image obtained from Krieger *et al.* (2022).

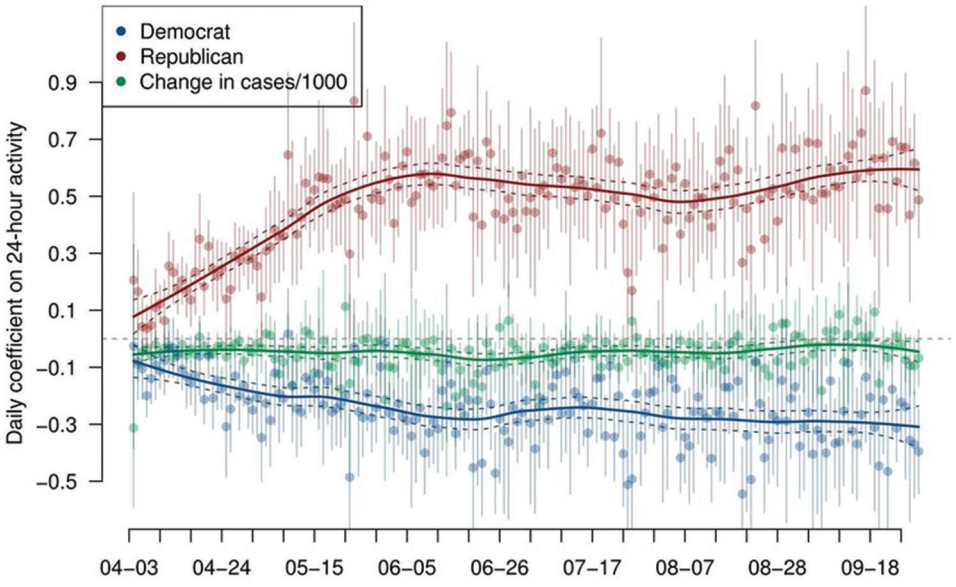

Figure 10. Mobility reduction rates based on politics. Image obtained from Clinton *et al.* (2021).

about 2.4 million per year to 1.4 million. While some ceremonies took place with masks, the drop in the number of weddings may have also contributed to the 4.39% drop in the birthrate observed in 2020 compared to 2019.

There are many types of face masks, with cloth, surgical, KN-95, and N-95 being the most common. Face masks reduced the spread of disease from people with COVID-19 and protected people from the infection. As

shown in Figure 11, there are huge differences in the ability of different masks to block aerosol droplets (Fischer *et al.*, 2020). For Omicron variants, surgical and cloth masks did not offer protection against infection, but still provided some protection against its spread.

Bagheri *et al.* (2021) reported mask effectiveness based on respiratory particle size, exhalation flow physics, leakage based on types and fits of face masks, ambient particle shrinkage due to evaporation, rehydration, inhalability, and deposition in susceptible airways. In Figure 12, "FFP2 w/o adjustment" is the same as a KN-95 mask, and "FFP2 with adjustment" is the same as an N-95 mask. There are two messages from Figure 12. First, surgical masks, even with adjusted straps, are not very effective. N-95 masks provide more protection than KN-95 masks because their straps facilitate a tight face fit. Second, when an infected person wears a mask, it provides slightly more protection than when an uninfected person wears a mask.

There were many studies on the effectiveness of wearing masks in reducing COVID-19 cases. The IHME

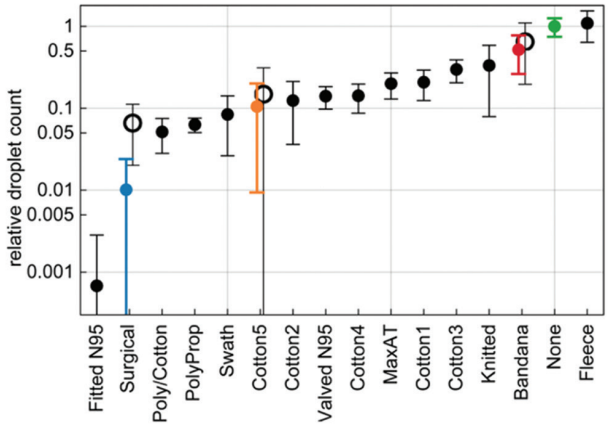

Figure 11. Mask relative effectiveness at blocking aerosol droplets. Image obtained from Fischer *et al.*, 2020.

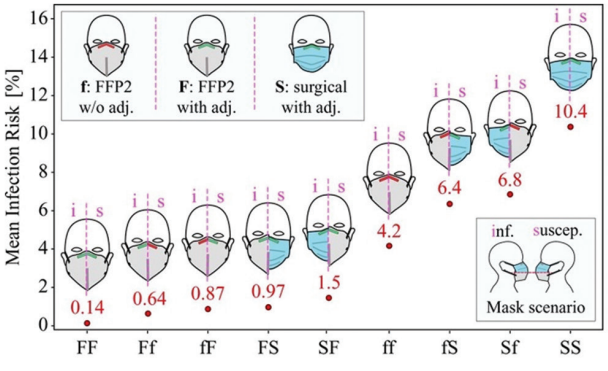

Figure 12. Infection risk from talking for 20 min while standing 1.5 m apart. Image obtained from Bagheri *et al.* (2021).

COVID-19 Forecasting Team (2020) reported a study that simulated the effect of mask wearing in the US. They reported that 470,000–580,000 people would die from COVID-19 by February 28, 2021, if states continued their present behavior of 49% of the population wearing masks. Significant lives would be saved from increased mask usage; 95% mask usage enabled 85,000–171,000 additional lives to be saved, while 85% mask usage enabled 61,000–133,000 additional lives to be saved. From Our World In Data, 520,000 died from COVID-19 in the US by January 28, 2021.

People of color wore masks more than White people. Nonetheless, due to poorer medical care and different jobs that had higher COVID-19 exposure rates, they had higher death rates. Budzyn *et al.* (2021) reported the mean county-level change in daily COVID-19 cases per 100,000 children and adolescents aged <18 years in counties with (198) and without (322) school mask requirements before and after the start of the 2021–2022 school year, as shown in Figure 13.

The most effective NPI after lockdowns was masks. Nonetheless, as discussed earlier, many people did not wear masks, particularly Republicans and the ultra-orthodox from many religions. An August 2020 PEW survey reported mask usage rates by political party, as shown in Table 5.

As noted earlier, Republican states had higher COVID-19 case rates and deaths than Democratic states. Part of this was due to the difference in mask mandates, which is illustrated in Figure 14.

However, masks also have negative consequences. They are uncomfortable, slightly hinder breathing (though they do not impede exercise), impair facial recognition, and reduce speech recognition due to the lack of visual cues. In addition, they can cause some skin problems, particularly in health professionals who use them often. Mohanty *et al.* (2024) noted that worldwide face mask usage reached 129 billion per month early during the pandemic. When discarded, they impacted the environment in many ways and complicated waste disposal.

6.2.3.2. Social distancing

Social distancing limits physical closeness and contact with other people to avoid catching or transmitting an infectious disease. The question, of course, is what is close? An 1896 droplet emission study (Flugge, 1896) of speech, coughing, or sneezing proposed a 1–2-m safe distance. It was based on the distance over which sampled, visible droplets containing pathogens stayed in the air. In the 1940s, close-up, still images of sneezing, coughing, or talking were added to the data. A 1948 study on hemolytic streptococci by Howard

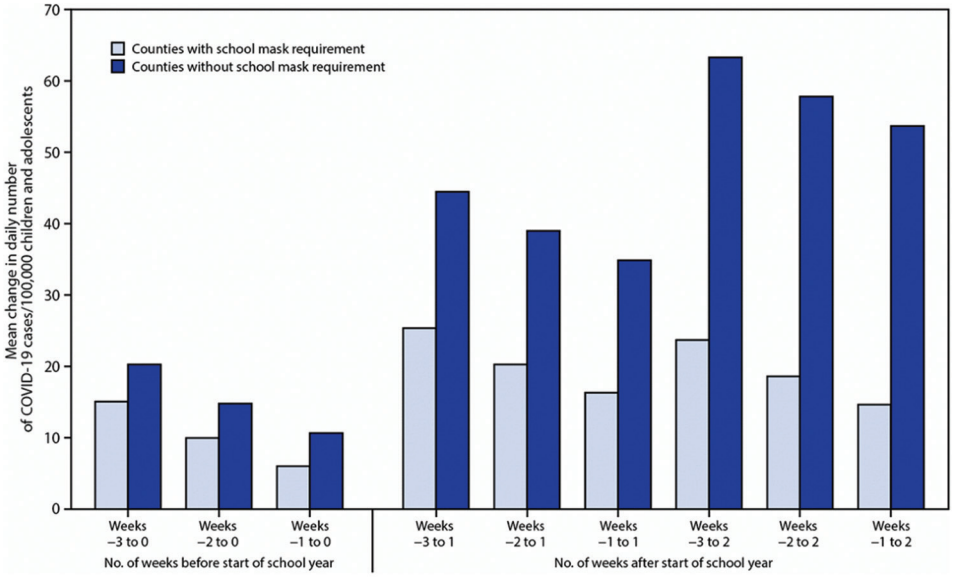

Figure 13. COVID case rates in the united states counties with and without mask mandates. Image obtained from Budzyn *et al*., 2021.

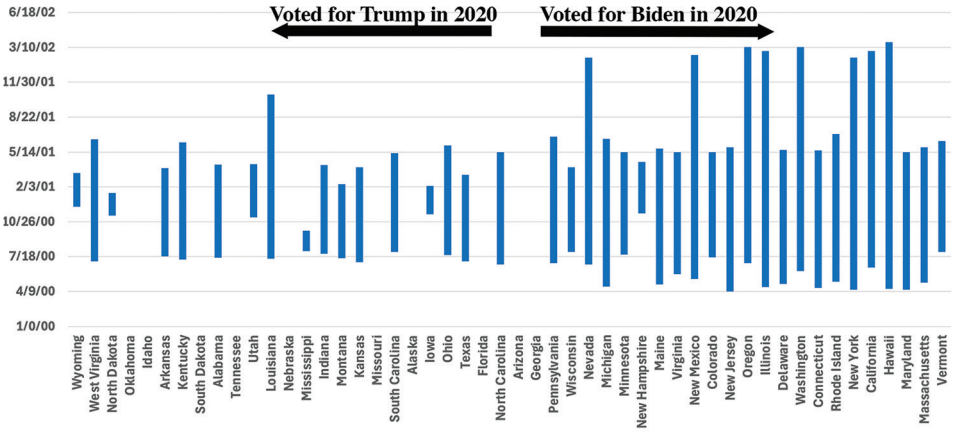

Figure 14. COVID-19 mask mandates. Data is ordered by increasing vote for biden in 2020.

Table 5. Percentage of people who wore face masks in 2020

Survey date	Democratic or Democratic leaning (%)	Republican or republican leaning (%)
June 2020	76	53
August 2020	92	76

et al. found that 65% of 48 participants produced only large droplets, with fewer than 10% of droplets traveling as far as 5.5 feet. However, 10% of droplets traveled 9.5 feet. Despite the limitations of these early studies—especially regarding long-range transmission—the consistent observation that large droplets tend to fall close to the host reinforced and entrenched the scientific basis for the six-foot distancing rule.

Thus, six feet appeared to be a reasonable minimum, but it must be modified based on factors such as whether one was indoors or outdoors, the nature of activities, crowd density, and whether someone without a mask was sneezing. The six-foot rule became obsolete when it was determined that aerosol droplets, which can linger and travel through the air, were the primary mode of COVID-19 transmission.

Fisher *et al*. (2020) provided additional insights into why social distancing was considered effective, as shown in Figure 15. Note the significant effect of being in crowded, active indoor spaces on transmission risk.

Each state had its own unique set of social distancing rules with varying strictness levels and exceptions. Typical

rules were closing non-essential businesses such as restaurants, bars, gyms, and churches. In certain instances, presenting a vaccination card—authentic or counterfeit—was sufficient to gain entry to restaurants, resulting in widespread use of counterfeit vaccine cards.

Price and van Holm (2020) reported that if the typical American individual were to spend 8 h away from crowds, there would be approximately 480,000 fewer COVID-19 cases. Courtemanche *et al.* (2020) reported that adoption of government-imposed social distancing measures reduced the daily growth rate of confirmed US COVID-19 cases by 5.4% after 1–5 days, 6.8% after 6–10 days, 8.2% after 11–15 days, and 9.1% after 16–20 days.

Social distancing compliance was influenced by political party and socioeconomic status. Regarding socioeconomic factors, Garnier *et al.* (2021) found that social distancing is less intense in counties with higher proportions of people below the poverty level and higher numbers of essential workers. In contrast, social distancing is intensely adopted in counties with higher population densities and larger Black populations, as shown in Figure 16.

Allcott *et al.* (2020) reported that researchers used location data from smartphones to show that areas with more Republicans engaged in less social distancing. The study controlled for other factors, including public policies, population density, and local COVID-19 cases and deaths. The paper also presented survey evidence of the significant gaps at the individual level between Republicans and Democrats in self-reported social distancing, beliefs about personal COVID-19 risk, and beliefs about the future severity of the pandemic. Figure 17 shows the social distancing by state.

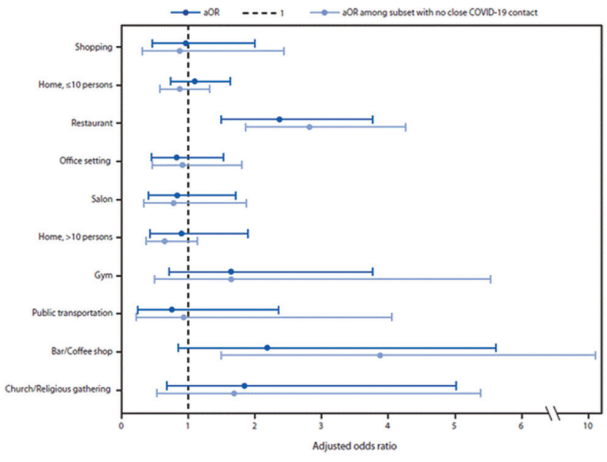

Figure 15. Relative odds of contracting COVID. Image obtained from Fisher *et al.*, 2020.
Abbreviation: aOR: Adjusted odds ratio.

6.2.3.3. School closures

School closures were and have remained the most controversial actions taken to reduce COVID-19 spread. The logic of its implementation is direct; schools are often crowded and poorly ventilated. They are a near-perfect COVID-19 spreading setting, particularly when singing the national anthem. Not only would the virus spread amongst the kids but it would also infect the teachers, the teachers' family members, and the children's family members. Figure 18 shows the rate of school closures by state.

The impact of school closures on COVID-19 case rates was difficult to analyze was schools could have taken many actions to reduce viral spread, for example, open the windows, install HEPA-14 filters, move desks six feet apart, mandate vaccination, initiate contact tracing, offer/or require diagnostic testing, and ensure everyone wore face masks.

Castillo *et al.* (2021) reported that daily COVID-19 infection rates were examined before and after statewide school closure orders. In the 15 states where data were available for 11 or more days after school closure, the average case rate drop was 25%; however, there was great variation in the case rate drop.

When the schools reopened, actions could be taken to reduce transmission risk. Weng *et al.* (2023) analyzed eight school operating scenarios. When masks were worn at school, work, and in the community, cumulative infections would have increased only 1% from increasing in-person education from 50% to 100%. As shown in Figure 19 and Table 6, when there were neither masks nor contact tracing when schools were conducted 100% in-person,

Table 6. Scenarios used to assess the impact of school reopenings

Scenario	In-person (%)	Remote (%)	Mingled with another class	Masks	Contact tracing[a]
1	50 alternating		No	Everywhere	Yes
2	50[a]	50	No	Everywhere	Yes
3	80[a]	20	No	Everywhere	Yes
4	100		No	Everywhere	Yes
5	100		Yes	Everywhere	Yes
6	100		Yes	Not at School	Yes
7	100		Yes	None	Yes
8	100		Yes	None	No

Note: [a]Contact tracing was difficult in the United States due to its high case rates. That said, focused contact tracing, perhaps, was implemented.

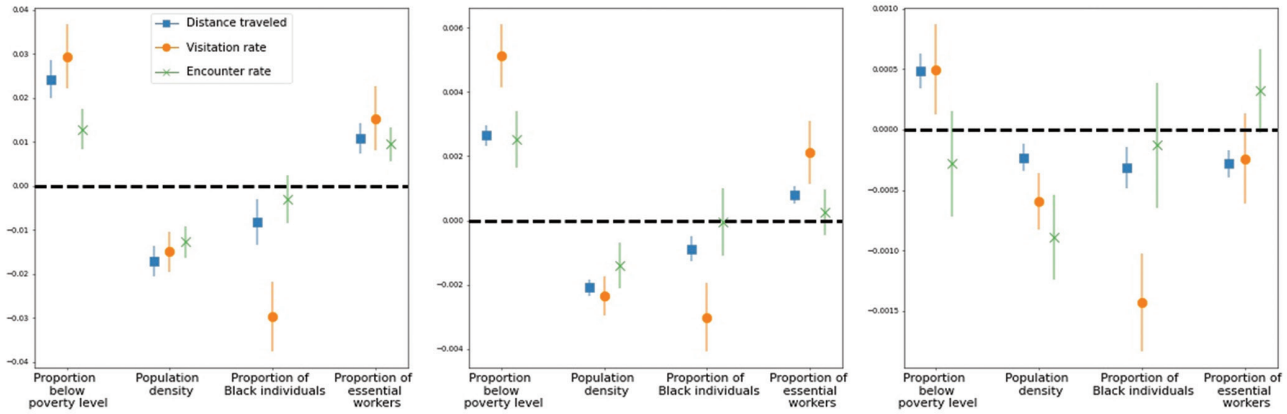

Figure 16. Impact of socioeconomic factors on the impacts of social distancing. Image obtained from Garnier *et al.* (2021).

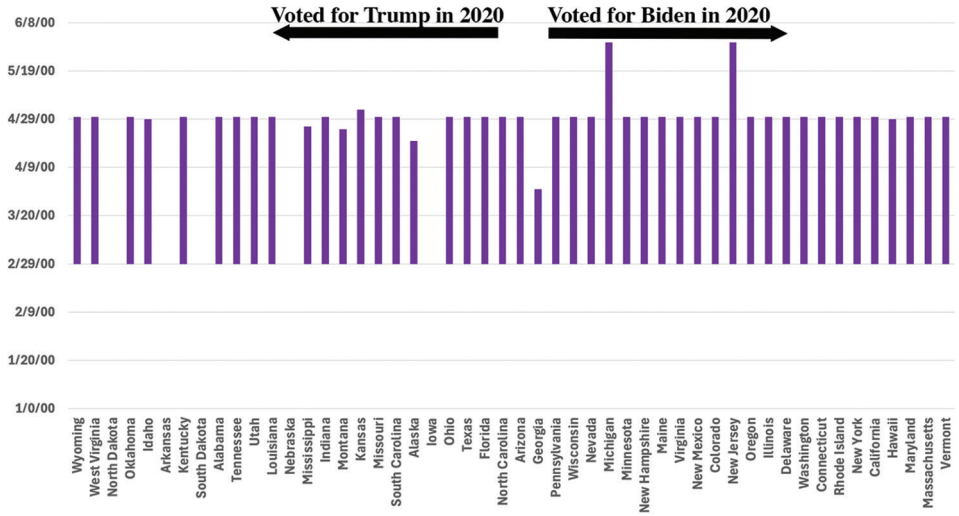

Figure 17. Social distancing practices by state. Data are ordered by increasing biden's vote in the 2020 election.

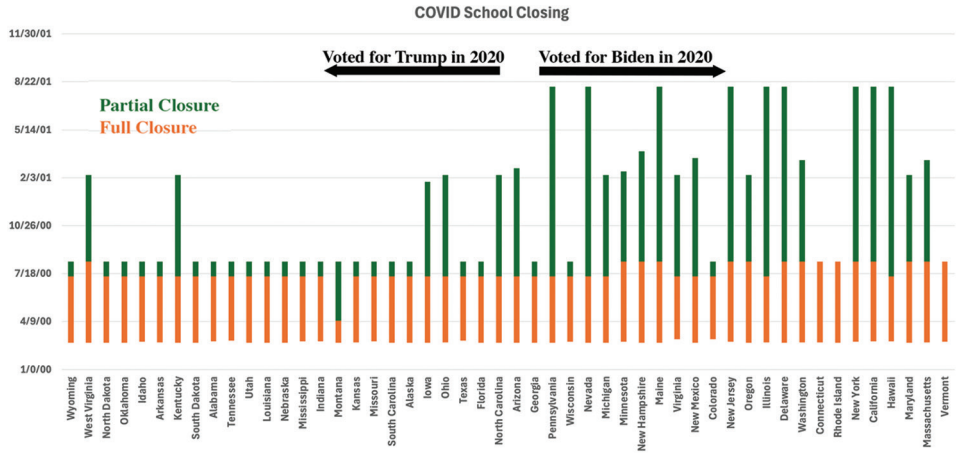

Figure 18. COVID school closures by state. (Ordered by increasing biden vote in the 2020 election). Image created by the author.

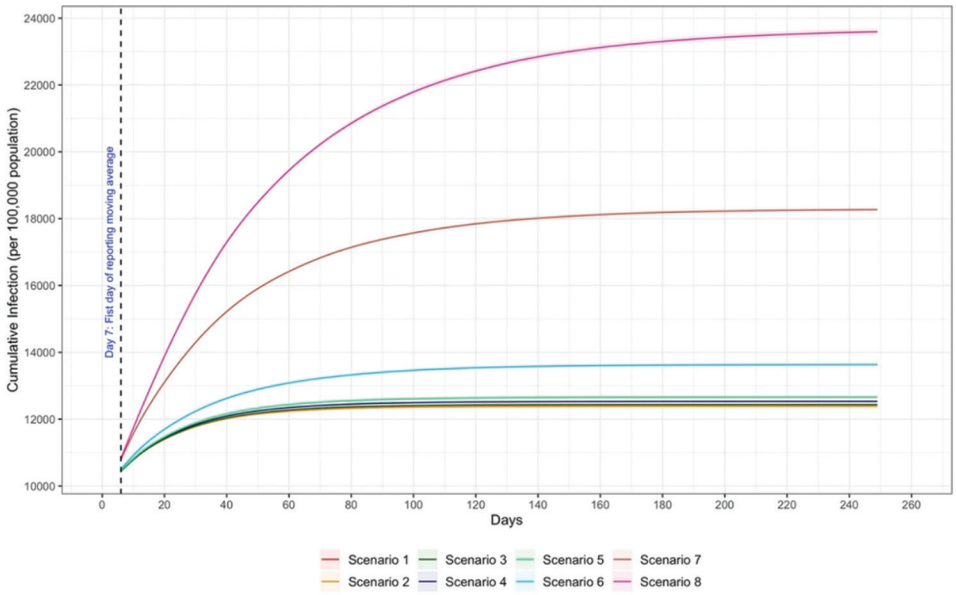

Figure 19. Impact of school reopenings under different scenarios. Image obtained from Weng *et al.* (2023).

the cumulative infection rate increased by 86%. Due to the existing vaccine hesitancy, the model assumed the maximum vaccination coverage of 70% for adults and 40% for children.

Rauscher and Burns (2021) reported that within nearest neighboring pairs in different states with different school closure timing, each additional day from a county's first case until state-ordered school closure was related to 1.5–2.4% higher cumulative COVID-19 deaths per capita. This was 1,227–1,972 additional deaths for a county with a median population and deaths/capita. A similar impact on death rates was reported by Viner *et al.* (2020), which addressed the COVID-19 outbreak in Hong Kong and China. They also reported that modeling studies of SARS-CoV-1 produced conflicting results. Auger *et al.* (2020) reported that closing schools when the cumulative incidence of COVID-19 was in the lowest quartile compared with the highest quartile was associated with 128.7 fewer cases per 100,000 population over 26 days and 1.5 fewer deaths per 100,000 population over 16 days.

Van den Berg *et al.* (2021) conducted a study on 251 school districts, 537,336 masked students and teachers, and found similar infection rates for three feet or six feet distancing, as shown in Figure 20. The CDC changed its school social distancing guidance on March 20, 2021, from six feet to three feet.

School closures, particularly when combined with lockdowns and social distancing, led to increased rates of mental illnesses in children. Moreover, they significantly impacted reading and math skills. Sadly, little to no progress

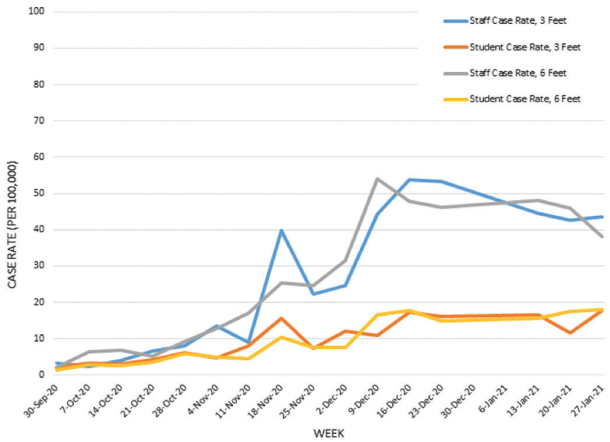

Figure 20. Three feet versus six feet social distancing in schools. Image obtained from van den Berg *et al.* (2021).

was made in 2024 to close the learning gap, as shown in Figure 21 from the National Assessment of Educational Progress (NAEP, 2023).

Global mathematics scores declined by an average of 14% of a standard deviation, roughly equal to 7 months of learning. Losses are greater for students in schools that faced relatively longer closures, for boys, immigrants, and disadvantaged students. Given the different school closure rates in Republican and Democratic states, one might expect that the Republican states had fewer educational drops. The simple correlation shown in Figure 22 supports this expectation.

Alarmingly, the school closures also affected the children's IQ according to a large German study

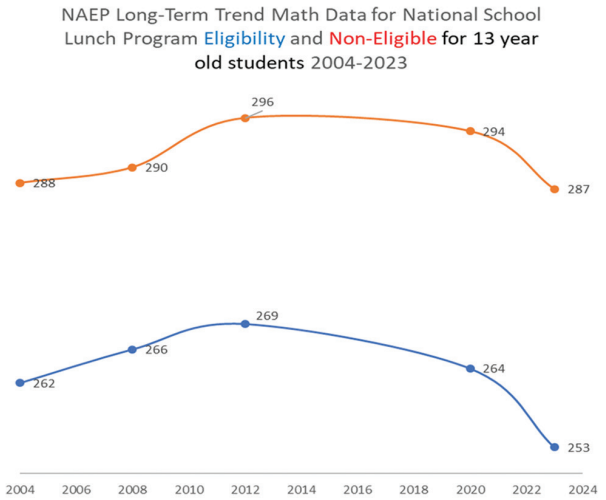

Figure 21. Drop in 13 year olds' math and reading scores. Image obtained from national assessment of educational progress (NAEP, 2023).

(Breit *et al.*, 2023). Similarly, the National Center for Education Statistics, May 2022 School Pulse Panel survey of US public K-12 schools showed that the COVID-19 pandemic, continued to significantly impair student socioemotional and behavioral development. During the most recent school year, over half reported that chronic absenteeism was worse than the year before, as shown in Figure 23.

There were other impacts from school closures, such as increased body mass index, increased myopia from more video games, reduced fitness, and higher rates of cyberbullying and teenage pregnancies.

6.2.3.4. Lockdowns

The most severe NPIs were lockdowns/stay-at-home orders, where individuals were supposed to stay at home except for obtaining essential services such as food shopping and medical care. As shown in Figure 24, five Republican states did not have lockdowns. The average length of their implementation in Democratic states was 57 days. In the Republican states that implemented lockdowns, it was 35 days.

Altoè *et al.* (2020) reported the impact on lives saved by advancing or delaying lockdowns in Belgium, Hubei, China, Denmark, Germany, Italy, Korea, New Zealand, the United Kingdom, and the US by ±3 days. Notice the lives saved represent more than twice the lives lost to COVID-19 in the US through 2024, as shown by Table 7.

There were some positive impacts from lockdowns. Zheng *et al.* (2025) reported that global pollution dropped, as shown in Figure 25. The drop in air pollution was accompanied by dropping disease rates, particularly diseases related to the ears, throat, and lungs (Altoè *et al.*, 2020).

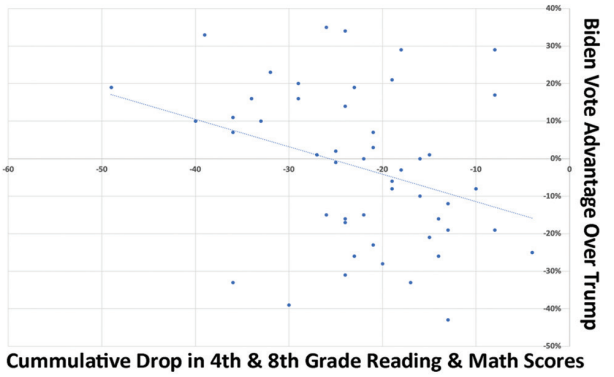

Figure 22. Cumulative drop in fourth- and eighth-grade reading scores by Biden's vote advantage over Trump

Table 7. Number of lives saved through lockdowns

Country	Saved by lockdown (*n*)	Three days earlier		Three days later	
		Number	Percentage	Number	Percentage
Belgium	71,000	4,600	6.5	7,700	10.8
China (Hubei)	67,000	2,200	3.3	4,000	6.0
Denmark	35,000	300	0.9	500	1.4
Germany	539,000	4,000	0.7	7,900	1.5
Italy	378,000	18,100	4.8	29,100	7.7
Korea	276,000	105	0.0	182	0.1
New Zealand	30,000	37	0.1	72	0.2
United Kingdom	424,000	20,000	4.7	32,000	7.5
United States	2,283,000	51,100	2.2	90,000	3.9
Cumulative	4,103,000	100,442	2.4	171,454	4.2

Trajtenberg *et al.* (2024) reported that cities that implemented strict lockdowns experienced large declines in robbery, burglary, and vehicle theft, but assault, theft, or homicide increased, as shown in Figure 26.

Businesses such as restaurants, bars, gyms, and even churches in some states were shut down. Salpini (2021) noted that witnessing the pandemic's impact on retail was equivalent to watching a series of waves wash over the industry. When the pandemic began, retailers were not sure exactly how long-lasting the crisis would be. Retail Dive kept a tracker that evolved into a living journal of how retailers were responding to 2020's unique events. In addition, even babies were affected. With reduced socialization, their speech development lagged, as shown in Figure 27 (Bartelt *et al.*, 2025).

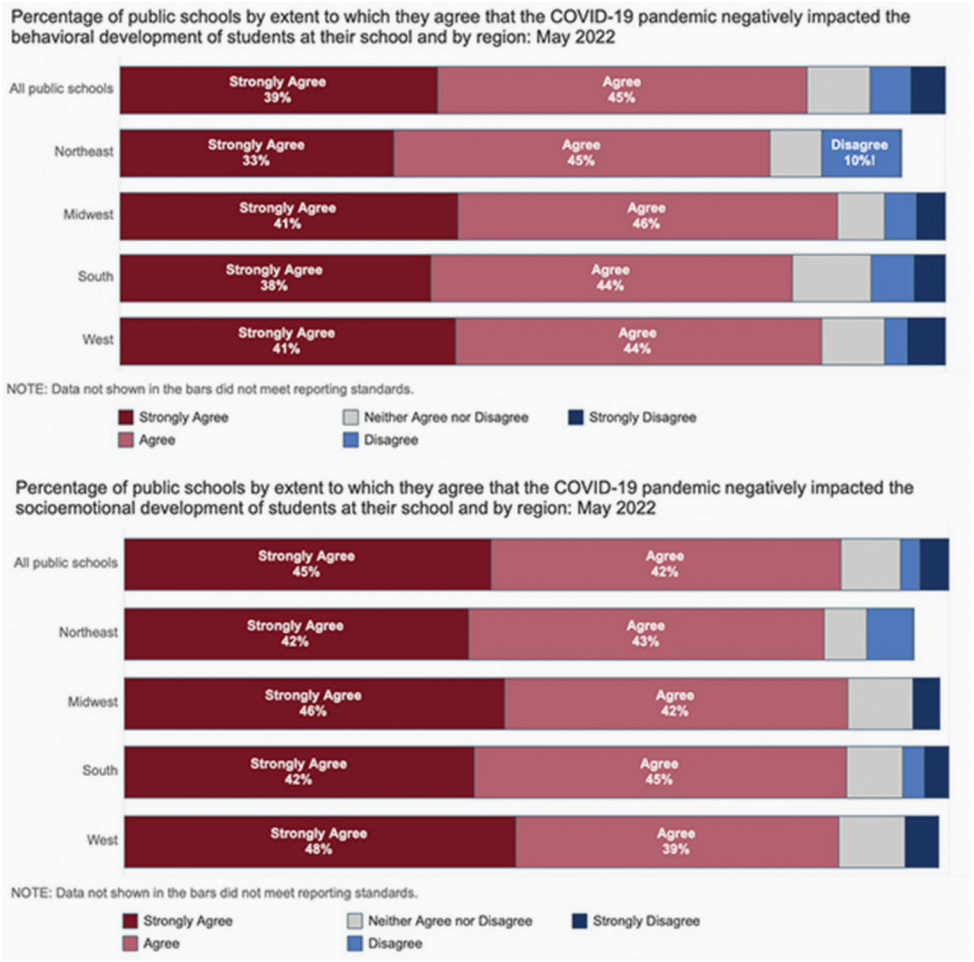

Figure 23. Public schools that agreed that COVID-19 impacted emotional development. Image obtained from Malkus (2024).

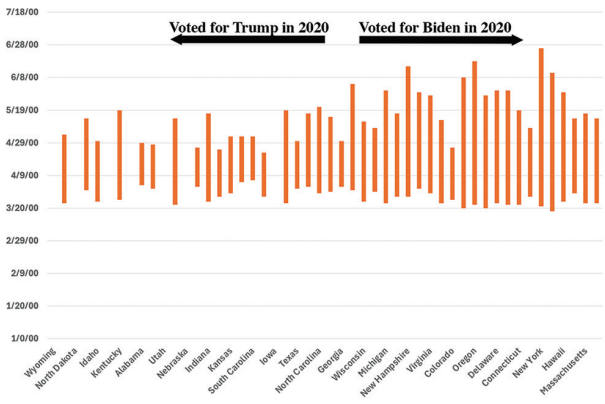

Figure 24. COVID-19 lockdowns. Data are ordered by increasing Biden's vote in the 2020 election.

Virtual meetings were used for work, education, medical services, shopping, socialization, and entertainment. In each of these domains, the impacts were diverse. For example, in education, beyond the drop in test scores, cheating, youth arrests, and absenteeism increased. There were socioeconomic differences in all of these impacts. With virtual work, people fled the cities.

Some businesses thrived during the pandemic. A notable example is Instacart, where one places an order online, which is filled by an "Instacart Shopper," who would deliver your food. Amazon, DoorDash, Fresh Direct, Uber Eats, and many others provided similar services. Instacart has about a 73% market share of the door delivery services market. Perhaps unexpectedly, the pandemic permanently changed food home delivery and virtual communication rates.

While lockdowns saved lives during the pandemic, Bianchi *et al.* (2023) modeled the impact of COVID and estimated that lockdowns would lead to 800,000 future lives from the children of those saved during the pandemic. Lockdowns also had an economic impact as people could not work and often lost their jobs. Overall, the Republican-led states had a better economic recovery than the Democratic-led states, as shown in Table 8. This was, perhaps, a ripple effect of fewer and shorter lockdowns.

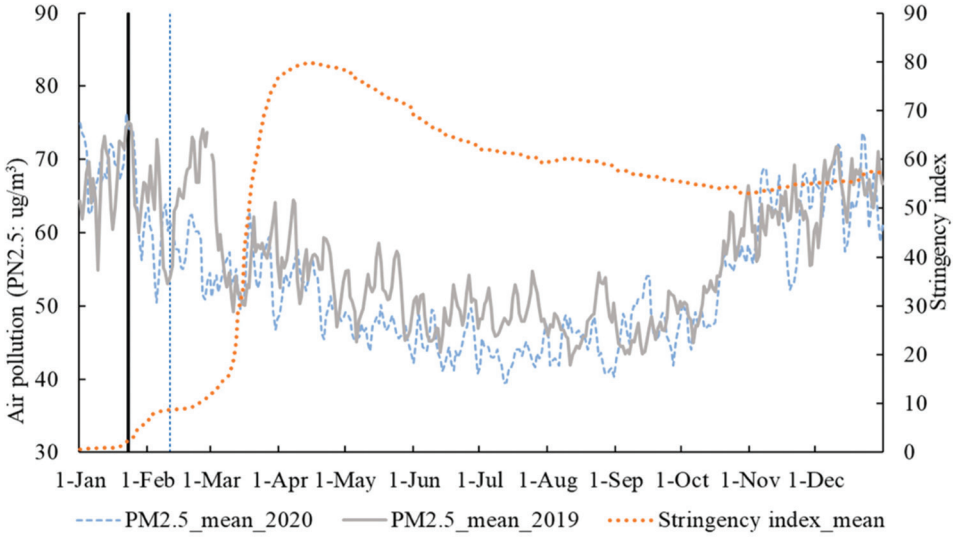

Figure 25. Global pollution and the stringency index. Image obtained from Zheng *et al.* (2025).

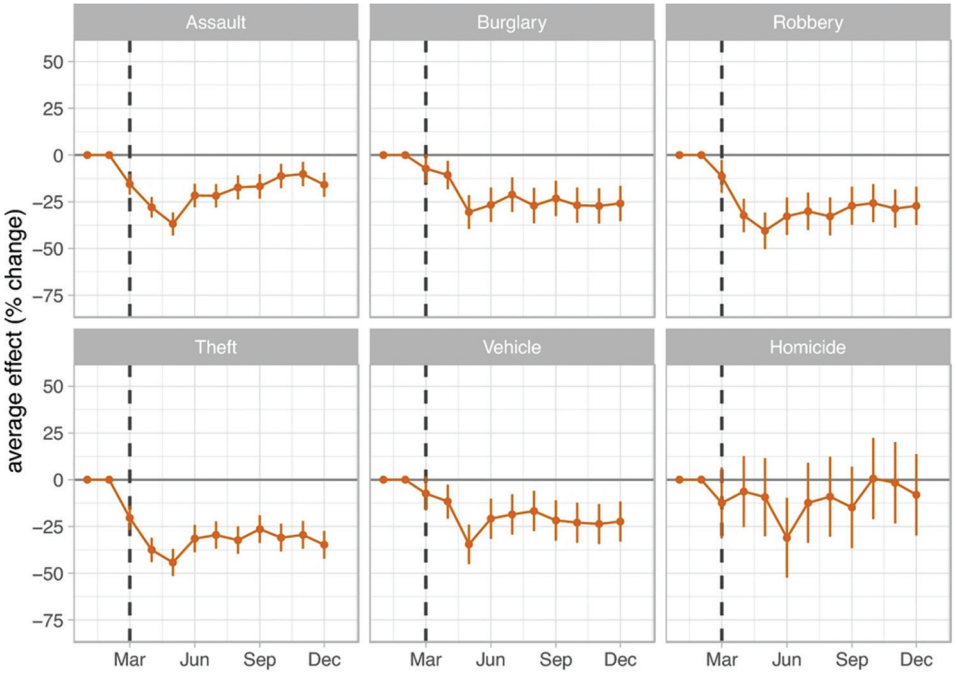

Figure 26. 2020 crime rate changes. Image obtained from Trajtenberg *et al.* (2024).

Table 8. Summary of state job recoveries

Parameters	Republican-led states	Democratic-led states
States with >100% job recovery	12	3
Average jobs recovered (% of jobs lost)	143%	118%
Average unemployment rate	3.4%	3.9%
States with record-low unemployment rates	3	0

Some states had yet to recover lost jobs as of April 2025, including California, Hawaii, Illinois, Maryland, Massachusetts, and New York, which are all Democratic-led states.

7. Pandemic medical impacts

Excess deaths that resulted from the COVID-19 NPIs have been discussed. Other COVID pandemic medical impacts were surprisingly broad-based and intense.

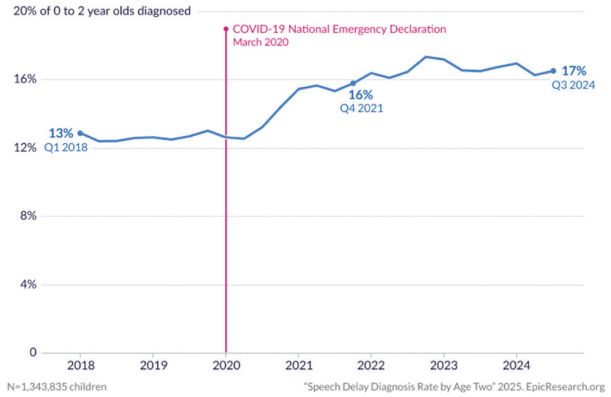

Figure 27. Speech delay in 2-year olds. Image obtained from Bartelt *et al.* (2025).

7.1. Stress

Fear of COVID for oneself, family members, and friends, unemployment, economic uncertainty, and the suppressive NPIs contributed to an increase in stress levels. An American Psychological Association report (2020) stated that despite several months of acclimating to COVID's societal upheaval, Americans were struggling to cope with its disruptions. A total of 78% said that the pandemic was a significant source of stress in their lives, and 67% said that they had experienced increased stress over the pandemic's course, as shown in Figure 28. The report stated that stress was greater in socioeconomically disadvantaged groups. Other reports noted that there were disproportionate effects on healthcare workers and chaplains.

7.2. Isolation and loneliness

Humans are inherently social animals. Preventing COVID-19 infection largely meant avoiding other people. Cudjoe and Kotwal (2020 [p.27]) noted that, "Decades of observational studies have demonstrated the long-term negative health outcomes of social isolation and loneliness. The COVID-19 crisis has exacerbated these challenges, with worsening social isolation and loneliness among those who live alone or are frail and even declines in the well-being of older adults with previously active or healthy social lives. Community centers for older adults have closed, nursing homes have terminated visitation, and grandparents are unable to visit their grandchildren."

The book, *Loneliness*, notes that loneliness impairs executive function and that there are genetic predispositions to loneliness (Cacioppo & Patrick, 2008). It also stated that it modulates some of the same neurochemicals involved in depression, such as serotonin, oxytocin, and vasopressin. Likewise, inflammation, which is one of COVID's dangerous outcomes, can be triggered by loneliness and

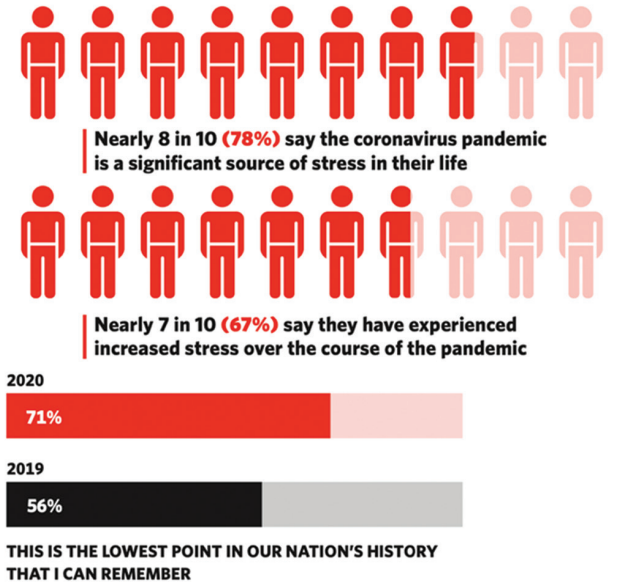

Figure 28. Pandemic and stress. Reprinted with permission from American Psychological Association (2020). Copyright © 2025, American Psychological Association.

isolation, physical inactivity, chronic stress, poor sleep, and negative thought patterns.

While loneliness affected everyone during the pandemic, those with dementia were particularly severely affected. Chen *et al.* (2023) reported excess deaths attributable to dementia, as shown in Figure 29.

Lockdowns, of course, were key contributors to loneliness, particularly among seniors who did not have access to the internet or regular companionship from children, grandchildren, or pets. Caring for grandchildren or pets helped in coping with loneliness; however, if one could no longer care for them, loneliness increased. Internet usage was more nuanced. If it was obsessively used to check on the pandemic, interestingly, loneliness increased. Loneliness also contributed to low physical activity, which, by itself, impacts health.

Moreover, loneliness triggered the "pandemic puppy" epidemic during which 20% of American households adopted a pet, which is equivalent to 55 million. Interestingly, most studies reported that they did not help with loneliness. The return rate for them was about the same as the return rate for prepandemic adoptions.

Isolation was not always bad. During his isolation from the Black Plague, Newton discovered differential and integral calculus, formulated a theory of universal gravitation, explored optics, experimented with prisms, and investigated light. He wrote the most important book in the history of science, Principia.

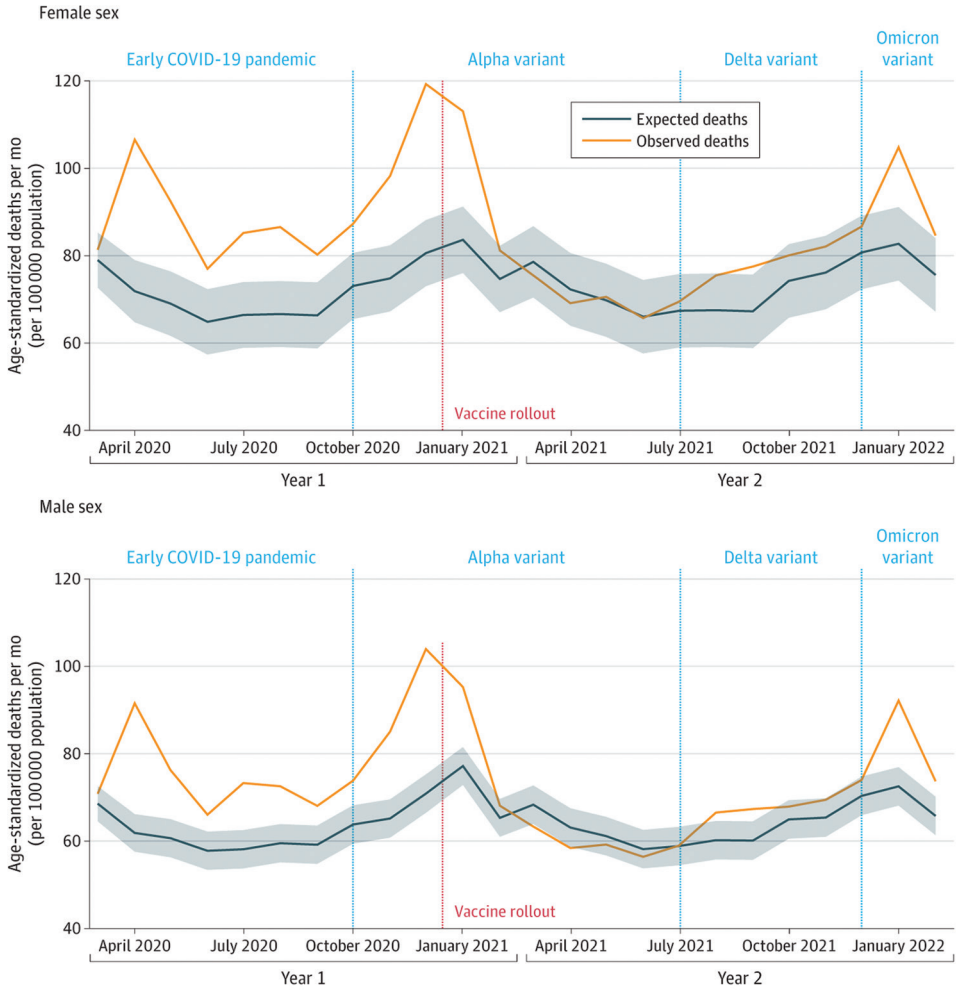

Figure 29. Excess dementia deaths. Image obtained from Chen *et al.* (2023).

7.3. Deaths of despair (DoD)

With increased stress and loneliness, DoD significantly increased in 2020. Entrup *et al.* (2023) reported that in 2020, COVID-19 caused 350,831 deaths and 4,405,699 years of life lost (YLL). By contrast, DoD contributed to 6,045,819 YLL. There were more YLLs in DoD because COVID-19 mainly killed the old, and DoD happened across all ages. Men had more deaths and YLL than women due to COVID-19 and DoD. Among White Americans and those with more than one race identification, both had a greater burden of DoD YLL than COVID-19 YLL. However, for all other racial categories (Native American/Alaskan Native, Asian, Black/African American, Native Hawaiian/Pacific Islander), COVID-19 caused more YLL than DoD. Surprisingly, as in Australia and New Zealand, the number of suicides in the US did not increase. They, however, did so in Japan, South Korea, India, Mexico, and Thailand.

The total number of US DoD in 2020 was 377,000, about 20,000 higher than the number of 2020 US COVID-19 deaths. Moreover, as COVID deaths were more prevalent among the elderly, the YLL from DoD in 2020 were greater than those lost to COVID-19, as shown in Figure 30.

7.4. Mental health

It is important to remember that there is a bias risk in survey questions, particularly about maladies that do not have definitive medical tests. It is hard to imagine someone replying negatively in October 2020 to a question like: "Are you more anxious and/or depressed than you were a year ago?" That said, many studies reported increased rates of anxiety and depression during the pandemic. Santomauro *et al.* (2021) reported a meta-analysis of 48 studies published between January 01, 2020, and January 29, 2021, as summarized in Figure 31. The increases in rates during the pandemic for various mental health problems are shown by pink relative to purple.

Not surprisingly, the mental health of those with severe comorbidities such as Parkinson's, lupus, inflammatory bowel syndrome, kidney diseases, eating disorders, or acquired immune deficiency syndrome was more significantly impacted. Those who exercised, were vaccinated, were religious, had positive lifestyles, for example, no smoking, low alcohol, and low body mass index, were less impacted. Misinformation increased mental health problems, as well.

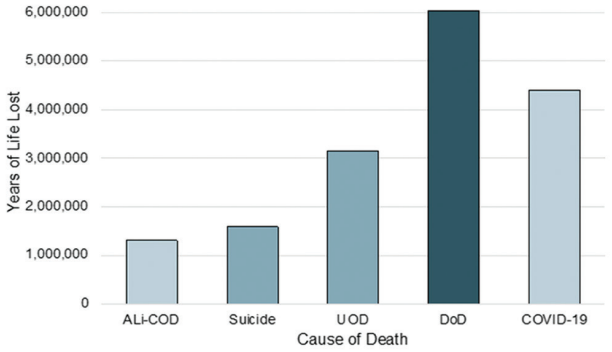

Figure 30. Years of life lost due to COVID-19 and deaths of despair, including alcohol-induced causes of death, suicide, and unintentional drug overdose in the US in 2020. Image obtained from Entrup *et al.* (2023).

7.5. Postponed treatments

Widespread delays in medical treatments during the pandemic have created serious long-term health risks. People were hesitant to go to crowded medical facilities. Furthermore, there were fewer doctors and nurses. Lack of medical insurance also impacted the socioeconomically disadvantaged. Figure 32 summarizes elective surgery rates in the US as reported by Butler *et al.* (2021).

7.5.1. Cancer

Although there were increased death rates for many diseases, for example, diabetes, cardiovascular diseases, and kidney disease, cancer had some of the largest increases. Thus, cancer will be used as an illustrative case for the impact of postponed health care during the pandemic.

Butler *et al.* (2021) reported that cancer screening rates were reduced by 70–80% in May 2020. This left a long-term impact on future cancer rates. They recovered to prepandemic rates only in February 2023. Angelini *et al.* (2022) observed that the risk of death from colon cancer from delayed treatment increased 6% for every 4 weeks that surgery was delayed, and that similar delays in adjuvant chemotherapy for colorectal cancer elevated the

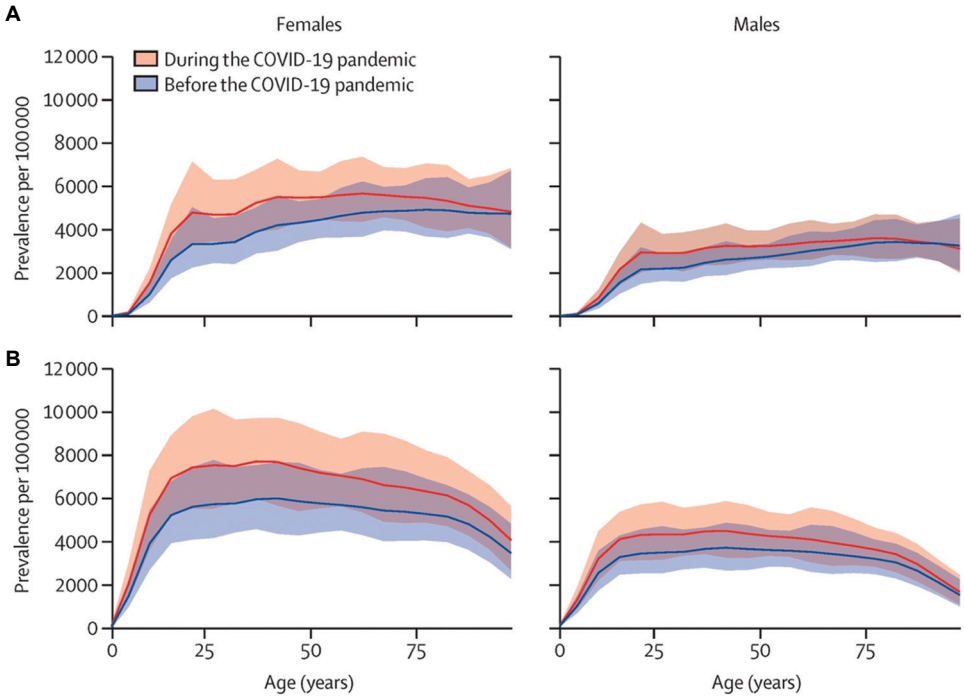

Figure 31. Global prevalence of major depressive disorder (A) and anxiety disorders (B) before and after adjustment for (i.e., during) the COVID-19 pandemic, 2020, by age and sex. Image obtained from Santomauro *et al.* (2021).

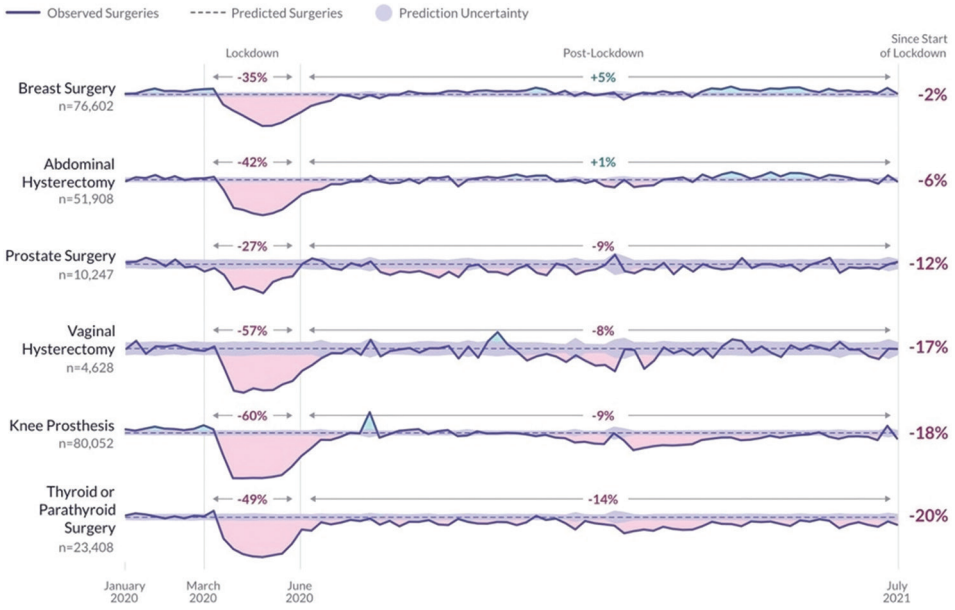

Figure 32. United states elective surgery rates. Image obtained from Butler *et al.* (2021).

mortality risk by 13%. Furthermore, the lack of screening and postponed treatments will lead to increased cancer deaths over the next decade, as shown in Figure 33 (Miller *et al.*, 2021).

7.5.2. Vaccination rates

An alarming case of postponed health care was the drop in non-COVID vaccines. They dropped early in the pandemic but have largely started to recover. Measles and polio vaccination rates are discussed to illustrate the impacts of delayed vaccination.

Measles is thought to have killed 150 million people over the past 150 years. It is highly contagious and is particularly dangerous to young children, who often die from pneumonia. The death rate in developed countries is 0.1–0.2%, while, in underdeveloped countries, it is 10%. Before widespread vaccination from the 1963 measles vaccine, there were an estimated 2.6 million annual measles deaths, mainly in underdeveloped countries, indicating that almost everyone had childhood measles.

A Johns Hopkins Public Health report (2024) stated that as of March 21, 2024, 64 measles cases were reported in the US, more than the 58 cases reported in all of 2023. More than 300,000 cases were reported globally in 2023, which is an increase of more than 79% from the previous year. More than 61 million doses of measles-containing vaccine were postponed or missed between 2020–2022 due to COVID-related disruptions. The World Health Organization stated that more than half the world's

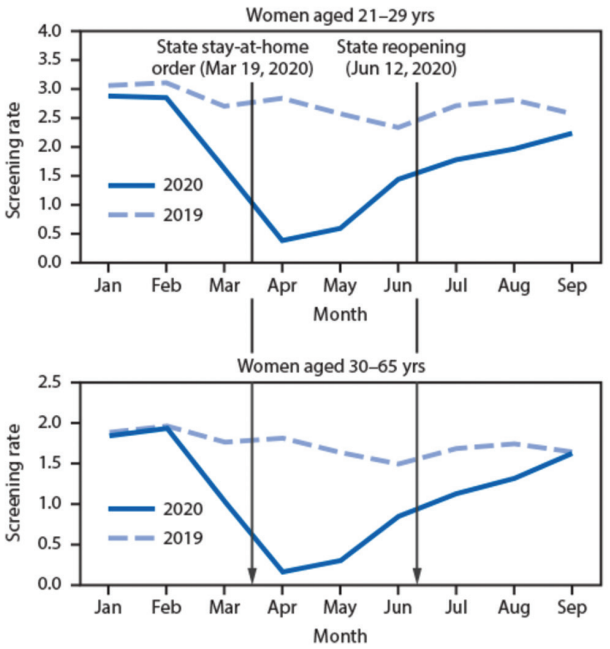

Figure 33. Delayed cervical screening rates in Southern California. Image obtained from Miller *et al.* (2021).

countries will be at high or very high risk of measles outbreaks by the end of 2023 unless urgent preventative measures are taken.

Polio was almost eradicated. In the early 1950s, polio was paralyzing or killing over half a million people worldwide annually. As a disease carried only by humans,

it became highly controllable with the introduction of the effective oral vaccine in 1961, though it can infrequently result in polio in a person who was recently vaccinated. It is called vaccine-associated paralytic poliomyelitis; however, this is very rare. For every million doses of oral poliovirus vaccines, there have been between 0.09 and 25 cases of vaccine-associated paralytic poliomyelitis. Hence, it is no longer used in any country. Instead, the inactivated version given through a needle and syringe is used. Figure 34 shows vaccine-induced polio cases.

Polio was eliminated from the US in 1979 and from the Western Hemisphere in 1991. However, the pandemic caused a reduction in vaccination and the growth of endemic cases in a few countries. Similarly, tuberculosis treatments have been set back at least a decade, cholera was on the rise, particularly in Pakistan and Bangladesh, malaria cases and deaths grew in 2020, and human immunodeficiency virus preventative programs and prescriptions decreased.

7.6. Disease prevalence changes

Not surprisingly, as reported by Cohen *et al.* (2022), NPIs reduced the rate of many pediatric viral infections in France. Lockdown strictness impacted the rate of decline. CDC reported (2023) that the rate of sexually transmitted diseases in the US went down significantly early in 2020, only to sharply rebound as restrictions were lifted and casual sex resumed.

Fortunately, the rate of many of the seasonal respiratory infections dramatically dropped, mainly from isolation, but also partially due to COVID-generated antibody and T-cell protection. The most significant reduction in disease prevalence is that of the seasonal flu. Chen *et al.* (2024) reported that the pandemic reshaped global flu patterns. For example, the US had only 624 flu cases in 2020. Furthermore, one strain, B/Yamagata, disappeared and is no longer included in flu vaccinations.

Other disease prevalence changes include respiratory syncytial virus, pneumococcus, noroviruses, scabies, conjunctivitis, Graves' disease, and hand, foot, and mouth disease. Similarly, human immunodeficiency virus treatment was reduced.

8. Weird behaviors

The pandemic triggered unfortunate and weird human behaviors.

8.1. Guns

Chen *et al.* (2023) reported firearm sales and gunshot emergency room visits before and during the 1st year of the pandemic. Although we were under lockdown during part of 2020 and encouraged to follow social distancing throughout 2020, both measures showed increments.

8.2. Wildfires

Chen *et al.* (2023) reported that the 2020 US western wildfires were at an all-time high, mainly due to increased recreation during a dry season.

8.3. Conspiracy theory and misinformation

Misinformation and conspiracy theories, often from the ultra-right, addressed, with hurricane force, COVID's source, NPIs, therapeutics, and vaccines. Many had deadly consequences, such as lower vaccination rates and improper therapeutic use, for example, hydroxychloroquine and ivermectin, used to treat COVID. Some examples of misinformation include:

(i) A PEW Research Center June 2020 survey reported 25% of Americans believed that the COVID-19 pandemic was definitely or probably "intentionally planned by powerful people"

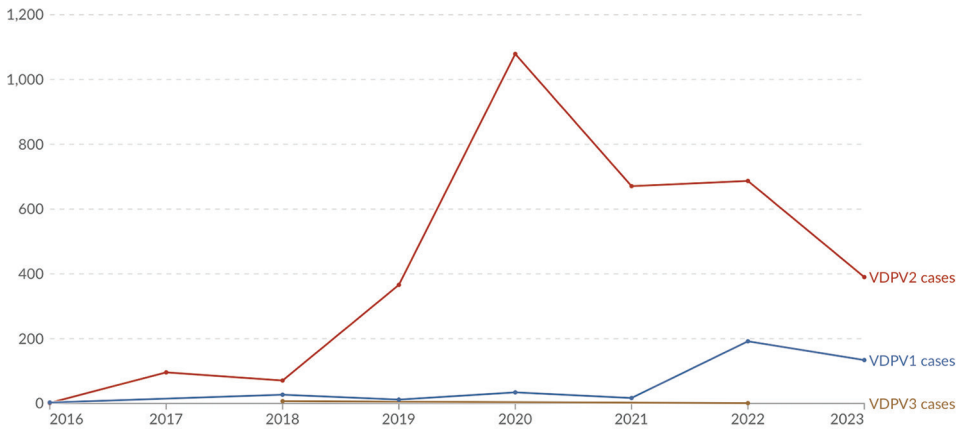

Figure 34. Vaccine-induced polio cases. Image obtained from Our World in Data.
Source: https://ourworldindata.org/grapher/cases-of-paralytic-polio-from-vaccine-derived-viruses-by-strain.

(ii) A "deep state" of America's elite is plotting to undermine the president, and Dr. Anthony Fauci, the face of the US coronavirus pandemic response, is a secret member working with Hillary Clinton
(iii) Greta Thunberg created the virus to help with climate change
(iv) Hand sanitizer companies created it
(v) Disney + released COVID for its launch
(vi) Netflix released it to increase viewers for its new series
(vii) According to 2020 PEW research, 23% of Americans believed that it was developed intentionally, with only 6% believing it was an accident
(viii) A United Kingdom astrobiologist claimed it piggybacked across the universe on a meteorite
(ix) Genetically modified crops caused genetic pollution that allowed viruses to proliferate due to the environmental "imbalance"
(x) Food from US Chinese restaurants caused the virus to spread
(xi) The Pope said that it is a punishment for mishandling climate change
(xii) President Donald Trump is waging a secret war against an elite of devil-worshipping pedophiles
(xiii) Bill Gates created the virus, patented it, and would use vaccines to force vaccinating everyone to control them through an injected microchip or quantum-dot spy software. 5G networks were burned down in response. 25% of Americans and 44% of Republicans in a May 2020 YouGov poll believed this.

Some of the misinformation addressed how to avoid or treat COVID-19.

(i) Turkmenistan banned the word coronavirus, hoping that would keep it away
(ii) You do not have to avoid or treat it because it is a hoax, no worse than the flu
(iii) Vodka will cure COVID-19, according to the Belarusian President
(iv) Eat garlic
(v) Consume bleach, which led to COVID-19 humor
(vi) Avoid spicy foods
(vii) Take cocaine
(viii) Russia released lions to enforce social distancing
(ix) Wearing masks can cause carbon dioxide poisoning
(x) The Philippines' President said to use clean masks with gasoline or diesel fuel.
(xi) Hydroxychloroquine is great. A total of 26% of Americans supported President Trump's medically dangerous claims
(xii) Drink cow urine
(xiii) Spread the body with cow dung as shown, which appeared in many publications. This sadly led to a fatal bacterial infection.

8.4. Charming consequences

There were also some charming consequences from the pandemic. A COVID Park opened in Vietnam's Tuyen Lam Lake National Tourist Complex. Figure 35 is a view of part of the park that appears on many websites.

Other examples include hoarding of toilet paper, changes in referees' behaviors without crowd pressure, causing the home team advantage to drop, and a measurable cooling of the moon due to decreased pollution. In addition, there were studies on changes in many parts of our lives, such as the yak economy in Sikkim, India, the mango economy in Ghana, and the livelihood of female waste pickers.

Researchers documented shifts in tourism patterns in Kyoto, increased households, and changes in US home gardening and sportfishing. Other findings highlighted the impact of fishing in Moorea, French Polynesia, recreational hunting in Europe, German cross-country skiing, the seafood supply in the Galapagos, wildlife diversity, and wildlife behavioral changes, such as those in mountain lions, squirrels, and bowing deer. The pandemic also influenced bird song loudness, fish biodiversity, whale migration, and even the resurgence of bloodsucking sea lampreys. Changes were also observed in the operation of sex workers (poke for a stroke), performance of soccer

Figure 35. Vietnam's COVID Park
Source: COVID Park (https://www.msn.com/en-us/travel/article/traveler-stumbles-on-bizarre-covid-19-theme-park-it-all-feels-pretty-dystopian/ar-AA1vFPqo).

players and referees, the Paris and Tokyo Olympics, and patterns of piracy.

9. Conclusion

Once it was confirmed that the primary infection transmission route is through aerosol spray, it was clear that eradicating COVID-19 would require drastic changes in behavior, or 8 million Americans and 115 million of the world's population would have died from COVID-19 in 2020. All countries' COVID-19 responses were led by their leaders, not their health departments. Leaders have great powers of persuasion, particularly in a crisis. Thus, each country's leader largely determined his/her country's fate.

The only 2020 measures against COVID were the mandated NPIs, which were face masks, social distancing, school closures, and lockdowns/stay-in-place orders. Others included border closures, hand washing, disinfection, wearing glasses/goggles, clean air, testing, and contact tracing. All of them reduced COVID-19 cases and deaths. In fact, just face masks, avoiding crowded places, the use of the iodine-based nasal spray, washing one's hands or using Purell, and rapid antigen tests can keep one safe. Hence, why were so many people in the US affected by COVID-19? Part of the reason was that Republican states implemented fewer of the mandated NPIs and were less compliant with them. Furthermore, the tradeoff between safety and quality of life often tilted in favor of quality of life, such as eating at indoor restaurants.

Unfortunately, all of these measures had negative consequences. Isolation was perhaps the most pernicious and contributed to increased mental illnesses, DoD, increased deaths from postponed medical procedures, and reduced children's math and reading skills. All are frightening long-term effects for our future health.

When considering how to prepare for the next pandemic, we must recognize that there are no easy answers. As H. L. Mencken said, "For every complex problem there is an answer that is clear, simple and wrong." Each of our choices, such as whether to close the schools or not, is an ethical dilemma. Since 1980, Michael Sandel has taught Harvard's most popular course, "Justice." Competing student teams address justice's ethical dilemmas such as affirmative action, income distribution, same-sex marriage, and the role of markets in a classroom debate. In all cases, it is clear that there are no simple answers to complex problems, which is also the case for COVID NPIs.

Without NPIs, deaths in the US would have risen from 1 million to 8 million. The ethical dilemma is how many lives would a nation be willing to sacrifice to avoid the negative consequences of lockdowns and school closures? In the US, is it none, 50,000, 100,000, or 1,000,000? What if one of the deaths were a family member? One's political leanings likely influence one's answer.

The right question, of course, is not what the balance should be but rather how to avoid the need for it. There is an initiative called the 100-day vaccine development. While achieving 1rapid vaccine development and deployment within 100 days is complex, as reported in a separate paper (Martin, 2024), its success could defeat the virus and reduce the need for oppressive NPIs. Without the 100-day vaccine or new breakthroughs, these stringent, mandated measures will once again be necessary in the next inevitable pandemic.

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Consent for publication

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ACCSCIENCE PUBLISHING

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PERSPECTIVE ARTICLE

Addressing the psychological impact of infertility risk arising from breast cancer treatment: Education and self-compassion interventions

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Abstract

Breast cancer incidence is increasing globally, including populations of childbearing age. Infertility risk from cancer treatment can negatively impact mental health in breast cancer patients and survivors, in part due to a lack of understanding of the risk and mitigation options ahead of treatment. In this commentary, recent literature on understanding of breast cancer treatment risk to infertility is reviewed, and recommendations are made for improving knowledge for at-risk populations. In addition, we propose a novel integration of self-compassion interventions be applied within breast cancer clinical care, building on groundwork from both breast cancer and primary infertility research areas that indicate the psychological benefits of self-compassion. Considerations for the application of self-compassion interventions to address fertility concerns within breast cancer patient and survivor populations are discussed.

Keywords: Breast cancer; Breast cancer understanding; Infertility; Reproductive health; Self-compassion; Mental health

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1. Introduction

It is the purpose of this perspective article to offer a commentary of prevailing knowledge regarding understanding of infertility risk following breast cancer treatment and suggest potential interventions to help breast cancer patients and survivors cope with the psychological impacts of this risk. These include improving access to fertility preservation information ahead of treatment and offering a self-compassion intervention as adjunct to cancer treatment.

Breast cancer is the leading cause of cancer-related death in females across the lifespan (Cardoso *et al.*, 2019). Incidence is increasing in many phases of women's lives. Between 25% and 55% of total breast cancer diagnoses occur in pre-menopausal females, depending on the geographical regions (Paluch-Shimon *et al.*, 2022). In recent reviews of breast cancer understanding amongst the general population (Wang *et al.*, 2022) and university students internationally (Colman *et al.*, 2023), a marked lack of

awareness and knowledge of breast cancer prevalence, its symptoms, screening, and treatments have been found. Within this commentary, we suggest that information on the impact of breast cancer treatment be incorporated in breast cancer educational interventions, delivered to the general population, students, or those diagnosed with breast cancer. The inclusion of this information will ensure those at risk of developing breast cancer or undergoing treatment can make informed choices of how best to safeguard their quality of life and mental well-being. In particular, infertility risk is greatly heightened for those receiving cancer treatment (Silvestris *et al.*, 2020). Though mitigations can be implemented, these approaches are clinical and require medical advice to inform choice.

Infertility is a strong risk factor for psychopathologies such as depression (Kiani *et al.*, 2021) and anxiety (Yusuf, 2016). Pre-menopausal breast cancer survivors are at particular risk of depression due to reproduction-related concerns (Gorman *et al.*, 2015). Since self-compassion interventions have been found to promote mental health for breast cancer patients (Haj Sadeghi *et al.*, 2018; Pinto-Gouveia *et al.*, 2014) and those experiencing primary infertility (Hajihasani & Ekhtiari Amiri, 2023; Hoyle *et al.*, 2022), we suggest incorporating it as a promising intervention for protecting the mental health of those diagnosed with breast cancer who are family-planning.

2. Breast cancer treatment, infertility risk, educational intervention, and psychological impact

2.1. Breast cancer treatment as a risk for infertility

Breast cancer treatment options include administration of gonadotoxic drugs, that is, those which can damage reproductive organs, and radiation; each of which carry a high risk of impairing ovarian function (Paluch-Shimon *et al.*, 2022). Silvestris *et al.* (2020) reported that cancer treatment results in permanent infertility for over one-third of breast cancer patients. Although approximately half of young breast cancer patients report wishing to pursue pregnancy post-treatment, their chance is reduced by between 40% and 60% in comparison to the general population (Marklund *et al.*, 2021). This heightened risk can be mitigated through a number of strategies, such as egg (oocyte) and embryo preservation (Gullo *et al.*, 2022), though all must be implemented ahead of cancer treatment and are complicated in some cases by exacerbation of the cancer risk itself (Silvestris *et al.*, 2020).

Developments in preventative treatment for breast cancer, using myo-inositol-based supplements, have shown clinical benefit (Pasta *et al.*, 2015). Since myo-inositol supplement has also been shown to improve reproductive outcomes (Mohammadi *et al.*, 2021), such a treatment holds significant promise for young breast cancer patients but may not be commonly available. Assisted reproductive technologies have been found not to be associated with neurodevelopmental diseases (Gullo *et al.*, 2022), and non-invasive screening for pathology during gestation is commonly applied (Gullo *et al.*, 2023), improving fertility outcomes.

Recent understanding of the role of microRNAs in breast cancer etiology will lead to improvements in diagnosis, with potential for elevated rates of early diagnosis and survival (Piergentili *et al.*, 2024). With the advent of artificial intelligence-assisted fertility assessment, improvements in fertility rates are expected in this population despite the impact of cancer treatment (Medenica *et al.*, 2022). Taken together, this evidence indicates a complex and changing informational environment for the clinician and patient to navigate when considering fertility preservation.

2.2. Improving education regarding the fertility impact of breast cancer treatment

Despite fertility preservation techniques being accessible in industrialized nations, Schover *et al.* (2014) identified that these were underutilized, and many cancer patients were not informed of their availability. Roberts *et al.* (2015) cite the lack of clinician knowledge, inadequate resources, and misperceptions regarding intervention costs and efficacy as barriers to accessing fertility preservation techniques. Furthermore, highlighted by Roberts *et al.* (2015) are the challenges posed by the psychological impact of receiving a cancer diagnosis on a patient's ability to make informed fertility decisions, and the complex ethical implications of the various preservation options. A study by Zaami *et al.* (2022a) showed a decline in fertility counseling rates for cancer patients since the COVID-19 pandemic. Reviews of extant literature on breast cancer patients' information needs, particularly relating to fertility, reveal that, in the last 15 years, little has improved. Peate *et al.* (2009) concluded that patients' needs and concerns regarding fertility and menopause were often not adequately addressed or discussed before commencing breast cancer treatment. This finding was echoed more recently by Martino *et al.* (2021), who highlighted that as many as 25% of women were not aware of disease or treatment impacts on fertility at the time of diagnosis.

The European Society of Human Reproduction and Embryology Guideline Group on Female Fertility Preservation (ESHRE) (2020) strongly recommended the crucial provision of fertility information by clinicians and fertility counselors to young women diagnosed

with cancer. Fertility counseling must align to available resources and legislation per setting to ensure information on procedures is relevant (Zaami *et al*., 2022b). In line with the latest guidance of the European School of Oncology (ESO) and the European Society of Medical Oncology (ESMO) (Paluch-Shimon *et al*., 2022), enhancing clinician, patient, and general population knowledge of cancer treatment fertility impact and mitigation options is therefore recommended. General breast cancer educational interventions and targeted clinical work with patients are each indicated to achieve these aims.

2.3. Psychological impacts of breast cancer and infertility

2.3.1. Psychological impact of breast cancer and treatment

The effects of cancer and cancer treatments are well-documented as having a serious negative impact on psychological well-being (Niedzwiedz *et al*., 2019). Depression, in particular, is seen to have interactive effects with cancer that can inhibit treatment adherence and worsen outcomes (Pinto-Gouveia *et al*., 2014). Reviewing the breast cancer-specific literature, Dinapoli *et al.* (2021) identify anxiety, distress, post-traumatic stress disorder, and depression as highly prevalent in breast cancer patients. Since findings indicate that psychopathology can, in addition, independently impact on fertility owing to deleterious influence on the endocrine and nervous system (Szkodziak *et al*., 2020), the psychological impact of breast cancer exacerbates reproductive health problems.

2.3.2. Psychological impact of infertility

Infertility's impact on psychological well-being itself has understandably received much research attention. Kiani *et al.* (2021) have recently systematically reviewed the literature and determined that infertile women were significantly more depressed than the general population of a given country. This effect was particularly pronounced in low- to middle-income countries. In addition to depression, anxiety and stress have been found to be higher in infertile females than in the general population (Yusuf, 2016).

2.3.3. Psychological impact of infertility on breast cancer survivors

By exploring empirical work on the specific psychological impact of fertility concerns among breast cancer survivors, we found that treatment-related fertility risk evokes the same level of emotional distress and arousal in young non-cancer infertile females, though accompanied by worse perceived health-related quality of life (Bártolo *et al*., 2020). After investigating the reproduction concerns of 200 young breast cancer survivors (18 – 35 years of age), Gorman *et al.* (2015) identified strong associations between reproduction concerns and depression risk, corroborating the findings of Howard-Anderson *et al.*'s (2012) systematic review, which found that depression risk was heightened in breast cancer survivors due to reproduction concerns and that these concerns were common. Synthesized qualitative findings also support this link, and shed light on the lived experience of breast cancer survivors' fertility concerns, with reports that loss of fertility is viewed as the biggest post-treatment regret (Campbell-Enns & Woodgate, 2017). Grief over fertility loss in breast cancer patients is identified as a common theme (Ussher & Perz, 2019). Such grief over lost possibilities threatens identity and meaning for breast cancer patients (Carr *et al*., 2023), which is detrimental to psychological functioning (Gilbert, 2022).

3. Compassion interventions for breast cancer patients and survivors

3.1. Self-compassion is protective against breast cancer-related psychological impact

One important psychological factor that has been shown to protect against depression, and other psychopathologies related to illness, is self-compassion (Pinto-Gouveia *et al*., 2014). Self-compassion is the ability to recognize one's suffering and respond to alleviate the suffering with supportive self-reassuring (Gilbert, 2009). Self-compassion is commonly conceptualized as comprising components of self-kindness (vs. self-judgment), common humanity (vs. isolation), and mindfulness (vs. over-identification with thoughts) (Neff, 2023). Self-compassion activates neurophysiological systems that regulate motivation, emotion, and behavior, toward a soothing, rather than threat-based, orientation (Gilbert, 2014). In this way, self-compassion counters shame and self-criticism, which are shown to be linked with mental health problems in breast cancer patients (Connolly-Zubot *et al*., 2020). Self-compassion is positively associated with many positive mental health outcomes, such as resilience and well-being (Kotera *et al*., 2021; Kotera *et al*., 2022b), and is negatively associated with many negative mental health outcomes, such as shame and depression (Colman *et al*., 2022; Kotera *et al*., 2022a), with longitudinal benefits for cancer patients (Zhu *et al*., 2019). Pinto-Gouveia *et al.* (2014) found self-compassion to be the only significant predictor of lower depression and higher quality of life within a mixed cancer cohort, which included 46% of breast cancer patients. Haj Sadeghi *et al.* (2018) demonstrated, through randomized controlled trial, that compassion-focused therapy, which emphasizes self-compassion, significantly reduced depression and anxiety in breast cancer patients. Todorov

et al. (2019) reported that self-compassion was protective for a range of psychological well-being self-report measures in 195 breast cancer survivors. Self-compassion has also been demonstrated to moderate stress and protect self-care behaviors, which are important for recovery post-treatment for breast cancer survivors (Abdollahi *et al.*, 2020).

3.2. Self-compassion is protective against infertility-related psychological impact

Self-compassion is also protective for infertile females. Hoyle *et al.* (2022) found that self-compassion is a protective factor against psychological distress in women in the U.S. experiencing infertility. This finding has recently been replicated in an Iranian study by Hajihasani & Ekhtiari Amiri (2023). These findings suggested that self-compassion may protect women from psychological distress derived from infertility. As Gilbert (2022) has outlined, self-compassion enables those experiencing grief at lost possibilities, such as infertility, to approach the complex arising emotions from a foundation of courage, protected against self-blame (Uneno *et al.*, 2022; Young & Kotera, 2022). Such psychological resourcing may explain the benefits of self-compassion within this population.

3.3. Proposal for integrative self-compassion interventions within breast cancer care

Psychological adjuncts to cancer treatment have been shown to lead to improved outcomes for patients when delivered before cancer treatment (Chen & Ahmad, 2018). We propose a novel integration of self-compassion interventions be applied within breast cancer clinical care, building on groundwork from both breast cancer and primary infertility research areas, since (a) self-compassion is found to be a protective factor for breast cancer and primary infertility populations independently, and (b) evidence suggests that the distressing experiences of each of these populations mirrors each other (Bártolo *et al.*, 2020). This intervention would seek to alleviate the psychological harm infertility risk related to breast cancer treatment may cause, or has caused, while concomitantly developing inner coping resources translatable to other life domains. To form an impression of what this intervention integration might offer, we can draw on recent intervention findings from each independent context. Systematic review and meta-analysis of compassion-based intervention trials for breast cancer patients (Fan *et al.*, 2023) show that self-compassion is enhanced and depression reduced regardless of delivery mediums, either in-person or web-based, with the strongest effects found for extended interventions (4–12 weeks) rather than brief interventions (30 min). Similarly, Njogu *et al.* (2023) found that both video and digital story self-compassion interventions were effective in reducing anxiety and depression and increasing self-compassion for women pursuing fertility treatment.

To improve the efficacy of compassion-focused therapy interventions with cancer patients Wei *et al.* (2023) identified self-compassion profiles that influence treatment outcome, recommending that interventions be tailored to match the individual's particular self-compassion profile. We, therefore, suggest that any compassion-based interventions be mindful of these profiles and tailor content to the individual as far as practical. Intervention coordinators must consider which practices to implement, as not all may be appropriate in cancer survivors, and some common self-compassion exercises, such as body scanning, could cause further distress (Lathren *et al.*, 2018).

4. Conclusion

The outcome of this propositional commentary based on the synthesis of literature from breast cancer and fertility research is a set of three specific recommendations.

First, further to the latest guidance from the ESO-ESMO (Paluch-Shimon *et al.*, 2022), we recommend that cancer treatment impact to fertility for pre-menopausal females be included within all breast cancer educational interventions. Consideration of inclusion of such information should be given to existing information campaigns as well as prospective campaigns. Appropriate messaging per audience should be determined through trials. The existing information leaflet template provided by ESHRE (2020) should be considered as a resource for such interventions.

Second, based on the foregoing review, we recommend that a self-compassion intervention addressing the specific reproduction concerns of young breast cancer patients and survivors be developed and implemented within a multidisciplinary care team. For maximum efficacy, the intervention should commence ahead of cancer treatment (Chen & Ahmad, 2018), account for individual self-compassion profiles (Wei *et al.*, 2023), and persist for a minimum of 4 weeks (Fan *et al.*, 2023). Delivery may be in-person or internet-mediated (Fan *et al.*, 2023), and can make use of innovations in therapeutic aids, such as digital storytelling (Njogu *et al.*, 2023).

Finally, it must be acknowledged that for young breast cancer patients and survivors, a measure of grief is associated with fertility loss (Campbell-Enns & Woodgate, 2017), indicating that this may be a crucial element of the individual experience that must be sensitively supported through any planned intervention.

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ACCSCIENCE PUBLISHING

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RESEARCH ARTICLE

Need for social services among disabled Chinese older adults in urban and rural areas

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Abstract

Using data from the Chinese Longitudinal Healthy Longevity Survey from 2005 to 2018, we examined the need for social services among disabled older adults in rural and urban China. Social services were classified into two types: Basic care and social connection. The Andersen model and ordered logistic regressions were employed to estimate how predisposing, enabling, and need factors are associated with the need for social services. We found significant rural–urban differences in the need for social services and its associates. Rural older adults reported a greater need for both types of services than their urban counterparts. Economic independence was associated with a decreased need for both types of services in urban residents; severe disability in activities of daily living was associated with increased need for both types of services in urban areas; coresidence with children was associated with decreased need for basic care services in both rural and urban areas. The findings suggest that developing social services is urgent in rural China to mitigate the decline of traditional family care.

Keywords: Social services; Older adults; Care need; Aging care; Eldercare; Chinese Longitudinal Healthy Longevity Survey; China

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1. Introduction

The population of mainland China (hereafter China) is rapidly aging due to declining fertility and substantial improvement in life expectancy (National Bureau of Statistics of China, 2022; United Nations, 2022). The total population aged 65 and older in China is projected to reach 395 million in 2050, rising from 180 million in 2020 (United Nations, 2022). This growth in the Chinese older adult population is associated with a rapid increase in the number of older adults with disabilities in activities of daily living (ADLs) and the need for long-term care (LTC) services. Several studies have projected that the number of people aged 65 and older with difficulty performing at least one of six ADLs and needing LTC could increase by as much as 2.5 times from 2023 to 2030 and 5 times from today to 2050 (Zou *et al.*, 2024). Disabilities in ADLs decrease older adults' ability to care for themselves and increase their need for assistance from others (Cox, 2005). To maintain their well-being, many older adults require support and care from family members and/or society. Given the sheer size of the older population and the increased need for care, strategies are urgently needed to provide proper support and care to older adults in China.

Traditionally, Chinese older adults rely primarily on family members for care and support (Xie & Zhu, 2009; Zhu & Xie, 2017). This practice is based on the Confucian norm of filial piety, which has long been a core societal value and is even written into the Law for Protecting Older Persons and into the Constitution (Gu & Vlosky, 2008; Zou *et al*., 2024). According to this norm, family members, particularly adult children, are obligated to provide care and support to old family members, including both financial assistance and personal care (Lai & Yang, 2021). Because filial piety is so deeply rooted in society, families may be reluctant to place their older members in a social or commercial care unit (Feng *et al*., 2012). However, the sustainability of this traditional practice is facing challenges. Dramatic demographic, social, and economic changes over the last several decades have weakened both the ability and willingness of family members to provide care to older adults (Feng *et al*., 2012; Lai & Yang, 2021; Leung, 1997). For instance, while women have traditionally been family caregivers, those aged 40 – 59 in China are now increasingly active in the labor force. In 2020, the labor force participation rate in each 5-year age group was 5 – 10% points higher than in 2010 (Feng, 2022). Meanwhile, increased geographic mobility further limits the availability of potential family caregivers (Feng *et al*., 2012; 2020), especially the pattern of rural residents migrating to cities for better job opportunities. The combination of all these changes over time contributes to the declining level of family support for older adults in China.

Another challenge to meeting older adults' care needs is China's underdeveloped system of formal, non-family sources for old-age care (Feng *et al*., 2020). Non-family care includes but is not limited to institutional care, home-based care, and community-based care. Institutional care has been mostly restricted to the "Three Nos," (i.e., older adults with no children, no income, and no relatives) as a public welfare system (Gu & Chu, 2021; Leung, 1997; Yang *et al*., 2016), or to those who need care and can afford the high cost of services (Gu *et al*., 2007). However, the rate of institutionalized care is still very low, at only about 1.5 – 2.0% of people aged 65 and older in 2010 (Feng *et al*., 2020; Gu & Chu, 2021). Home- and community-based care such as the service-reserve project, the friends and neighborhood mutual help project, service centers for older adults, and daycare centers emerged in the 1990s (Shanghai Civil Affairs, 2002). By 2023, there were 363,000 community-based old-age care service centers and facilities, including 41,000 full-time care centers (Ministry of Civil Affairs of China, 2024). However, these services still remain limited except in a few large cities due to high costs, lack of skilled professionals, and policies favoring urban areas (Feng *et al*., 2020).

With the growing need for care and the declining availability of family caregivers, the demand for non-family services is increasing (Feng *et al*., 2020). Hence, while filial piety is still accepted by younger generations and promoted by the Chinese government, policymakers are under pressure to develop formal care systems to complement family care and construct a more sustainable LTC system (Du, 2013; Lai & Yang, 2021). Among the various types of formal care service programs, community-based services, and especially home-based services, are preferred by most Chinese older adults and thus promoted by the government (Feng *et al*., 2012; 2020; Liu *et al*., 2015). These services are particularly relevant to the objectives of "aging in place" (Cesari *et al*., 2022) and "aging in the right place" (Golant, 2015; Hoh *et al*., 2021) that the Chinese government has prioritized since the mid-2010s (Jia *et al*., 2020; Krings *et al*., 2022). Studies have shown that older adults prefer to remain in their homes as they age (Hoh *et al*., 2021; Means, 2007). A central meaning of "aging in the right place" is to ensure older adults receive the right services at the right time by the right provider(s) at the right place (Hoh *et al*., 2021). In addition, aligning service provision with the specific needs of older adults facilitates meeting user needs and optimizing resources (Iglesias Souto *et al*., 2021). Therefore, to inform government policy initiatives to improve the old-age care system and reduce family burden, it is crucial to understand the need for social services among older adults in China. This understanding will enable better services to effectively support "aging in the right place."

To date, research on the need for social services in China remains limited. Most research focused on the availability and utilization of formal care (e.g., Li *et al*., 2017; Wu *et al*., 2005). Among the few studies that addressed the need for formal care in China, Liu *et al.* (2014) found that age, education, social support, and chronic diseases were associated with home health-care needs for empty-nest older adults in Shanghai. Liu *et al.* (2015) also conducted a qualitative study among empty-nest older adults in Beijing and reported that their major need was home-based care. Another study by Li *et al.* (2017) found that urban Chinese older adults' need for social services, including medical care and rehabilitation, instrumental care and support, and psychosocial services, varied by ADL/Instrumental ADL, depression, financial status, and support network. Zhou & Walker (2015) analyzed national data in 2008 and also found that older adults' need for community services varied. For instance, higher educational attainment has been linked to a reduced need for social services, whereas higher economic status has been associated with a greater demand for these services. A recent study by Xiao *et al.* (2023) examined the preferences for social services

among disabled older adults using cross-sectional data from a nationally representative sample. The study found that preferences were primarily influenced by health conditions, family care resources, and geographic region. While these studies have made important contributions to understanding the need for social services in China, most research—aside from those by Zhou & Walker (2015) and Xiao *et al.* (2023)—has focused on specific types of services, such as home and psychological care, within limited geographic areas, predominantly urban or large city settings. Moreover, these studies often lack a nationally representative sample. Given the significant demographic, social, and economic shifts in China over the past decade, there is a pressing need for updated research that encompasses both urban and rural regions.

Some key questions remain unanswered by previous research. What is the need for different social services among older adults with disabilities in China? What factors contribute to the need for social services? Are there any differences between rural and urban residents? Answers to these questions could improve our understanding of older adults' need for non-family care programs and are key to developing and promoting social care programs in China. To address these questions, the present study uses five waves of data from the Chinese Longitudinal Healthy Longevity Survey (CLHLS), a nationally representative longitudinal survey, to examine (1) the need for social service programs among older adults with ADL disabilities and (2) determinants of need based on Andersen's social behavior model. In particular, this study classifies eight social services into basic care and social connection services and examines how the need for services and its determinants vary with rural–urban residency. Therefore, this study not only provides a more comprehensive picture of service needs than the previous studies focusing on one or two types of services but also reveals differences in service needs between rural and urban areas.

We apply Andersen's social behavioral model to examine determinants of the need for social services. The Andersen model was developed to explain why individuals utilize health services (Andersen, 1995; Andersen & Newman, 1973; Chen & Gu, 2021). According to this model, factors that predict health-care utilization are summarized into three types: predisposing, enabling, and need. Predisposing factors are social structural elements that influence an individual's likelihood of using health care services, including age, sex, ethnicity, education, and attitudes toward services. Enabling factors mainly refer to resources that enable individuals to access health services, such as income, informal and formal caregiving resources, and availability of community resources. Need factors refer to health conditions and illnesses that measure an individual's level of need for care. Whether an individual uses services depends not only on their need for services but also on their predisposition to use them and whether they have the necessary resources (i.e., enabling factors) to facilitate their use. These three categories of factors together determine the use of health care services.

The Anderson model has been widely used to predict the use of health services (e.g., Dunlop *et al.*, 2002; Weaver & Roberto, 2017) and the need for care services (e.g., Calsyn & Winter, 2001; Richardson, 1992). For example, old age, female gender, living alone, and functional limitations were all associated with a high need for services in Western societies (Calsyn & Roades, 1993; Jackson & Mittlemark, 1997). Among the three categories of predictors, need variables were the strongest predictors of service need (Calsyn & Winter, 2001). While research findings in Western countries provided important evidence, determinants of service need could be different in China, given that need can be influenced by cultural, social, and economic factors in Eastern countries (Li *et al.*, 2017b; Liu *et al.*, 2014). See a recent review by Chen and Gu (2021).

Our study stresses potential differences in need between rural and urban residents because rural–urban disparities may shape older adults' need for social services. First, rural–urban disparities exist in pension coverage (Zimmer & Kwong, 2003). State pensions are mainly available to urban residents, whereas the majority of older rural residents do not qualify for retirement benefit programs (Gu *et al.*, 2021; Feng *et al.*, 2012; Lee & Xiao, 1998). Second, rural–urban disparities also exist with respect to care resources such as access to care facilities. Since policies to support formal care favor urban residents (Feng *et al.*, 2012; 2020), the availability of social support is limited in rural areas; when available, the cost of formal care is not affordable for most rural older adults due to their low economic status (Gu & Vlosky, 2008). Third, attitudes toward formal care differ between rural and urban residents. Due to stronger traditional values, rural residents are more likely to follow the practice of family care and are reluctant to be cared for by strangers (Feng *et al.*, 2012). Therefore, even if rural residents can afford formal care, they may still prefer receiving care from family members. Fourth, the massive rural-to-urban labor force migration since the 1990s has imposed more challenges on the traditional support practice among rural older adults (Liu, 2014), separating younger and older adults from rural households. In short, rural older adults face a higher risk of unmet need for care due to lack of financial resources, loss of family care, and lack of other forms of support.

This study focused only on disabled respondents who need assistance with daily care. Declines in functional abilities are associated with an increased need for care from others (Cox, 2005). Thus, those with disabilities in ADLs often have an urgent and higher need for services (Shooshtari *et al.*, 2012; Woodland, 2007). With few exceptions (e.g., Chen & Berkowitz, 2012; Li *et al.*, 2017), most previous studies have not differentiated between older adults who have or do not have ADL disabilities (e.g., Liu *et al.*, 2014; Liu *et al.*, 2015, Zhou & Walker, 2015). Because China is a developing country with limited resources and a rapidly growing size of older population, home- and community-based services are often tailored to meet the more urgent needs of older adults with functional impairments (Li *et al.*, 2017). Understanding the needs of older adults with ADL disabilities may provide more specific and practical estimates for program design and development.

2. Data and methods

2.1. Study sample

For this study, we utilized data from five waves of the CLHLS in 2005, 2008/2009 (hereinafter labeled as 2008), 2011/2012 (hereinafter labeled as 2011), 2014, and 2018. The CLHLS was initiated in 1998 to study factors contributing to healthy aging and longevity (Zeng, 2012). The first three waves of the CLHLS (1998, 2000, and 2002) were not included in this study because information on social services was not collected in these waves. The CLHLS was conducted in a randomly selected half of the counties/cities in 22 provinces throughout China. From the 2008 wave onwards, one county from the 23rd province (Hainan Province) was added to the sample of the CLHLS. The survey oversampled octogenarians (aged 80 – 89), nonagenarians (aged 90 – 99), and centenarians (aged 100+) in each wave to maintain sufficient sample size and statistical power. Respondent information was collected via in-home interviews. The age of a respondent was validated with various sources—e.g., birth certificates, genealogical documents, household booklets, and/or the ages of children and siblings—when available. Each able respondent provided written informed consent to indicate his/her willingness to participate in the CLHLS; for respondents who were not able to write, a proxy (usually the next-of-kin) was called in to sign the written consent with oral approval from the respondent. The response rate of the baseline survey was approximately 98%; however, the proportion of loss to follow-up at each subsequent wave was around 15 – 20% (Gu *et al.*, 2021). Further details of the sampling design and overall data quality have been documented extensively elsewhere (e.g., Gu *et al.*, 2021; Zeng & Gu, 2008).

For the purposes of this study, the five waves of the CLHLS data were pooled together to produce more robust estimates. This strategy has been used in previous research (e.g., Gu *et al.*, 2017; Zhu, 2015). The study sample includes 8,548 older adults (aged 65+) who reported difficulties in performing ADLs during interviews conducted from 2005 to 2018. These respondents contributed 16,387 observations during the analytical period from 2005 to 2018.

2.2. Measurement

2.2.1. Need for social services

Need for social services was measured by eight variables asking whether the respondent needed assistance and service with specific activities: (1) personal care, (2) home visits and health checkups, (3) psychological counseling, (4) daily shopping, (5) social and recreation activities, (6) legal aid, (7) health education, and (8) neighborhood relations. Respondents were asked to provide a yes or no response to each of the eight questions. To reduce the number of outcome variables for better presentation and interpretation, we used an exploratory factor analysis to test the number of possible classifications that would best fit the data for these eight variables. We found that these eight variables could be classified into two clusters. We thus classified the eight need variables into two summary variables (i.e., indices): the need for basic care services and the need for social connection services. Basic care services included the first four variables: Personal care, home visits and health checkups, psychological counseling, and daily shopping; social connection services included the remaining four variables: social and recreational activities, legal aid, health education, and neighborhood relations. The value of each summary variable was a summation of all dichotomous variables in that index, ranging from 0 to 4. The reliability coefficients (alpha) are 0.87 for basic care services and 0.92 for social connection services. These high coefficients indicate the adequate reliability of each summary index. Such practice has been frequently used in the existing literature (Mhaka-Mutepfa *et al.*, 2015; Pudrovska, 2015) and is thus considered appropriate.

2.2.2. Independent variables

Based on Andersen's framework and prior literature, we included predisposing, enabling, and needed variables in the analyses. Predisposing variables included age (in years), sex, years of schooling (0, 1 – 6, and 7+), primary lifetime occupation (white collar occupation vs. others), marital status (married vs. unmarried), and residency (rural vs. urban). White-collar occupations mainly refer to professional, technical, governmental, institutional, or managerial personnel. Non-white-collar occupations

included agriculture, forestry, animal husbandry, fishery, industrial worker, etc. Enabling factors included both economic and caregiving resources. Economic resources included economic independence (having a retirement wage/pension and/or own earnings vs. no), whether or not the respondent received adequate medication (yes vs. no), and whether medical expenses were paid by self or family members (yes vs. no). Caregiving resource variables included whether the primary caregiver was a family member (yes vs. no), the number of children alive, whether the respondent coresidence with a child (yes vs. no), and self-reported availability of social services in the neighborhood. Self-reported availability of social services in the neighborhood included eight items that are identical to those used to ask about social service needs. Similar to the need for social services, we classified these eight available services into two summary indices, availability of basic care services and availability of social connection services, with values ranging from 0 to 4. The reliability coefficients are 0.68 for the availability of basic care services and 0.80 for the availability of social connection services.

We restricted our sample to ADL-disabled respondents who need assistance with daily care. A respondent was considered disabled if he/she needed help performing any of the following six ADLs: Bathing, dressing, indoor transferring, toileting, eating, and continence. This definition is a common practice in the field (e.g., Feng *et al*., 2016; Zhu, 2015). After limiting the study sample to those who reported ADL disability, we included three variables to represent need as a predictor in the Andersen model: Self-rated health, whether a respondent's care needs were unmet, and severe ADL disability. Self-rated health was measured by the question "how do you rate your overall health?" with six response categories: very good, good, fair, poor, very poor, and unable to answer. Following previous research (e.g., Feng *et al*., 2016), we combined both very poor and poor into one category, "poor," and both good and very good into one category, "good," because the proportions of respondents in the "very good" and "very poor" categories are relatively small. We kept the response category "unable to answer" because this category accounted for about 20% of the sample (unweighted). Thus, we created a measure of self-rated health with four categories: Good, fair, poor, and unable to answer. An alternative approach using multiple imputations to impute missing values associated with "unable to answer" produced very similar results, so we kept "unable to answer" as a category to keep the original data intact as much as possible. Unmet need was measured by the question, "Does the assistance provided by caregivers meet your needs?" with three response categories: Fully met, partially met, and not met. Partially met and not met were combined into one category because only about 3% of the sample reported that needs were not met. Thus, unmet need was a dummy variable with fully met coded as 0 and unmet coded as 1. Following previous studies (e.g., Zhu, 2015), severe ADL disability was measured by whether the respondent was unable to perform at least four of the six ADL tasks, with yes coded as 1 and no coded as 0.

2.2.3. Control variables

We included health behavior, region, and survey year as control variables. Health behavior refers to the frequency of engagement in leisure activities. Research has found that social engagement activities are associated with the risk of experiencing disabilities (Mendes de Leon *et al*., 2003), which may indirectly influence the need for social services. Furthermore, participating in leisure activities may improve social interactions with others (Silverstein & Parker, 2002), which may affect a respondent's attitude and behavior toward social services (Fisher *et al*., 2015). The measure of leisure activities included six activities: (a) playing cards/mahjong, (b) watching television, listening to the radio, or accessing the Internet, (c) reading books or newspapers, (d) raising pets or domestic poultry, (e) gardening or doing housework, and (f) engaging in outdoor activities such as exercise or jogging. Each item was scored from 0 (no participation) to 4 (daily participation). These scores were summed across all six items (total score: 0 – 24) to calculate the overall frequency of involvement in leisure activities based on previous studies (Zhu, 2015). To better capture the skewed distribution of this variable, the scores were grouped into three categories: 0 – 3 (low frequency), 4 – 9 (medium frequency), and 10+ (high frequency). We also controlled for the region, which classified 23 provinces into five regions: North (Beijing, Tianjin, Hebei, and Shanxi), Northeast (Liaoning, Jilin, and Heilongjiang), East (Shanghai, Jiangsu, Zhejiang, Anhui, Fujian, Jiangxi, and Shandong), Central and South (Henan, Hubei, Hunan, Guangdong, Guangxi, and Hainan), and West (Chongqing, Sichuan, and Shaanxi). The wave variable has five values: 2005, 2008, 2011, 2014, and 2018. All analyses controlled for this variable.

2.3. Analytical strategy

We first performed descriptive analyses for the study variables. We reported appropriate statistics such as percentages and means for the total, rural, and urban samples. We also performed Chi-square tests for rural–urban differences in study variables (t-tests for age and a number of available social services). Multilevel ordered logistic regression models were used to examine whether the predisposing, enabling, and need variables were associated with the dependent variables of need for basic care and social connection services. We first ran multilevel

ordered logistic regression models for the entire study sample. We then replicated the analysis for rural and urban residents separately. At Level One, the units are observations at each wave, nested within Level Two units which are respondents. Each respondent contributes multiple observations across different waves. At the person level (i.e., Level Two), only the intercept was included in the analysis.

All independent variables in the multilevel logistic regression models were included simultaneously. Missing data among all covariates were generally low (<2%); to minimize potential bias due to missing values, we imputed the mode for categorical variables and the mean for continuous variables. Alternative imputation approaches were also assessed (e.g., multiple imputations) and the results were nearly identical. We also assessed possible multicollinearity among variables and found that all variance inflation factors were less than 3. All analyses were performed using STATA version 17.0.

3. Results

Table 1 presents the descriptive statistics of the study sample: older adults with ADL disabilities in China. In the sample, about half of the respondents resided in rural areas. The mean age was 94.8 for rural respondents and 94.1 for urban respondents. Men accounted for 29.2% of rural respondents and 47.8% of urban respondents. Overall, access to basic care and social connection services was very limited in both rural and urban areas, with an average of fewer than one available service out of four. Significant differences were observed between urban and rural residents in terms of socioeconomic status and care resources. For instance, urban residents generally had higher levels of education, were more likely to hold white-collar jobs, had better access to medication, and enjoyed greater economic independence. By contrast, they were less likely to coreside with their children or have a family member as their primary caregiver. All observed rural–urban differences were statistically significant.

Table 2 displays the percentage of respondents who reported a need for eight types of social services. More than half of respondents required assistance from each type of service; the need was greatest (>60%) for home visits, psychological counseling, health education, and personal care. Rural older adults reported a greater need for all eight social services compared to their urban counterparts. In particular, rural older adults had a much higher need for home visit service (80.3% vs. 73.5%) and neighborhood relations (61.3% vs. 56.7%). In terms of the two summary variables, rural residents had a higher need for both types of services compared to urban residents. All the rural–urban differences are statistically significant.

Table 3 reports the results from multilevel ordered logistic regression models for the entire study sample as well as for urban and rural sub-samples. Among predisposing factors, the results for the entire sample show that living in a rural area was associated with 9% and 13% higher odds of needing basic care and social connection services, respectively, compared to living in an urban area. The results for the total sample further show that, except for cases where Han ethnicity and being married were associated with higher odds of social connection service need, other predisposing factors related to demographics and occupation were not significantly associated with the need for social services when enabling and need factors were simultaneously modeled. In the urban sample, being married was associated with higher odds of need for both types of services. In the rural sample, all predisposing factors were not significant.

For enabling factors, the results were more complicated. Economic independence is the enabling factor that only affected urban residents and was associated with reduced odds of the need for both basic care and social connection services by about 29 – 30%; Some enabling factors affected both rural and urban residents: Coresidence was associated with 16% and 20% reduced odds of the need for basic care services in rural and urban areas, respectively. The availability of social services also affected both rural and urban residents. Availability of basic care services was associated with 27% increased odds of the need for basic care services in the rural sample and 31% increased odds of the need for basic care services in the urban sample, but it was not associated with the need for social connection services. Availability of social connection services was associated with 60% and 63% increased odds of the need for such services in rural and urban areas, respectively; it was also associated with 16% and 24% increased odds of the need for basic care services in rural and urban areas, respectively.

Among need factors, poorer self-rated health was significantly associated with 15 – 16% increased odds of the need for basic care and social connection services in urban areas only. Unmet need for care was associated with 12% and 16% greater odds of the need for basic care services in rural areas and urban areas, respectively. Severe ADL disability was associated with 13 – 17% higher odds of the need for basic care and social connection services in urban areas only. With respect to control variables, compared to the need in 2005, there was an increase in the need for both basic care and social services from 2008 to 2018.

An additional analysis comparing regression coefficients (results not shown, available upon request)

Table 1. Distribution of sample who needed assistance in performing activities of daily living by rural/urban status, CLHLS, 2005 – 2018

Variables	Total	Rural (47.1%)	Urban (52.9%)	Variables	Total	Rural (47.1%)	Urban (52.9%)
Total sample size	16,387	7,711	8,676	Coresidence with children			
				No	12.9	11.3	14.3
Mean age	94.4	94.8	94.1	Yes	87.1	88.7	85.7
Age groups				Family member as the primary caregiver			
Ages 65 – 79	7.5	7.0	7.9	No	11.6	5.0	17.3
Ages 80 – 89	18.0	17.0	18.8	Yes	88.4	95.0	82.7
Ages 90 – 99	34.8	34.6	35.1	Mean number of available social services (0 – 4)			
Ages 100+	39.7	41.4	38.2	Basic care	0.5	0.4	0.6
Sex				Social connection	0.7	0.6	0.9
Women	67.7	60.8	52.2	Self-rated health			
Men	32.3	29.2	47.8	Good	28.4	27.6	29.1
Ethnicity				Fair	27.9	26.6	29.4
Non-Han	4.3	5.0	3.6	Poor	20.6	21.1	20.0
Han	95.7	95.0	96.4	Unable to answer	23.1	24.7	21.5
Education (years of schooling)				Long-term care needs			
0	71.2	80.2	63.2	Unmet	55.1	59.3	51.4
1 – 6	21.0	16.6	24.9	Met	44.9	40.7	48.6
7+	7.8	3.2	11.9	Severe ADL disability			
Currently married				No	59.7	59.8	59.5
No	83.1	84.6	81.8	Yes	40.3	40.2	40.5
Yes	16.9	15.4	18.2	Frequency of leisure activities			
Occupation				Low	59.2	66.8	52.4
Non-white collar	93.0	97.7	88.8	Medium	32.7	27.7	37.1
White collar	7.0	2.3	11.2	High	8.1	5.4	10.5
Economic independence				Region			
No	79.1	93.1	66.7	North	7.7	3.3	11.5
Yes	20.9	6.9	33.3	Northeast	11.3	6.2	15.8
Got adequate medication				East	41.7	44.4	39.3
No	9.5	12.6	6.7	Central and South	27.2	34.8	20.5
Yes	90.5	87.4	93.3	West	12.1	11.3	12.9
Medical costs are mainly paid by self/family				Wave			
No	68.5	77.8	60.2	2005	24.0	23.9	24.0
Yes	31.5	22.2	39.8	2008	22.8	26.0	19.9
Average number of children alive	3.1	3.2	3.0	2011	17.0	17.6	16.6
				2014	10.7	10.9	10.5
				2018	25.5	21.6	29.0

Notes: Estimates were not weighted. All estimates represent a percentage unless otherwise noted; Higher values of available social service indicate greater availability of the services in the neighborhood; All rural–urban differences were significant at $p<0.001$. Significant differences are based on t-tests for age, number of children alive, and available social services and Chi-square tests for other variables.

revealed significant differences in the effects between rural and urban populations for enabling factors such as access to adequate medication and availability of social connection services. However, no significant differences were found for factors such as having a family member as a primary caregiver or coresidence with an adult child.

Table 2. Need for social services among older adults who need assistance in performing activities of daily living by rural and urban residence, CLHLS, 2005 – 2018

	Need (%)		
	Total	Rural	Urban
Type of services needed			
Personal care	61.8	63.0	60.7
Home visit	76.7	80.3	73.5
Psychological counseling	64.9	65.8	64.2
Daily shopping	54.7	56.5	53.0
Social and recreation activities	58.6	60.1	57.4
Legal aid	57.2	58.7	55.8
Health education	67.7	68.8	66.7
Neighboring relations	58.9	61.3	56.7
Indices of need for social services			
Mean # of basic care services (ranges 0 – 4)	2.6	2.7	2.5
0(%)	18.6	16.1	20.8
1(%)	11.9	12.8	11.2
2(%)	11.4	11.4	11.5
3(%)	8.8	8.8	8.9
4(%)	49.2	51.0	47.7
Mean # of social connections (ranges 0 – 4)	2.5	2.4	2.5
0(%)	27.0	25.1	28.6
1(%)	10.2	10.7	9.9
2(%)	6.6	6.6	6.7
3(%)	5.7	5.5	6.0
4(%)	50.4	52.1	48.9

Note: Chi-square tests were performed to test rural–urban differences. All rural–urban differences are statistically significant at $P<0.001$, except for health education ($p<0.01$).

4. Discussion

Family care for older adults has been prevalent in China due to the traditional norm of filial piety. However, this traditional practice faces challenges due to the increasing size of the older population and the decreasing number of potential family caregivers. These challenges raise an urgent need for research that explains the need for social care services among older adults, which can inform community program development and reduce family members' care burden. Based on five waves of data from the CLHLS, a nationally representative longitudinal survey with the largest sample size of older adults in contemporary China, this study examined the need for home- and community-based services.

Overall, we found that rural residents had a higher need for both basic care and social connection service programs than urban residents. This finding is not surprising. Given the rural–urban differences in socioeconomic conditions, health-care resources, and traditional values, rural older adults depend largely on family members for care. However, with the younger generations increasingly moving to big cities for better job opportunities, rural older adults are left at home without proper care (Giles *et al.*, 2010; Wu *et al.*, 2009). Moreover, the development of social services in rural areas is still in the preliminary stages (Wu *et al.*, 2009; Feng *et al.*, 2020), and it "faces many practical challenges because of the physical environment and the lack of resources and infrastructure" (Feng *et al.*, 2012, p. 2768). Taking all these factors together, rural older adults are less likely to receive proper care and more likely to have a higher need for all kinds of social services.

Among the determinants examined with the Andersen model, we found that enabling and need factors, but not predisposing factors, were significant predictors of the need for social services. Unlike some previous studies (Calsyn & Winter, 2001; Jackson & Mittlemark, 1997; Liu *et al.*, 2014), we did not find that older age and being a woman were associated with an increased need for social services after enabling and need factors were adjusted for. The major reason for these different results is likely because we focused on an ADL-disabled older population, while others focused on the entire older population. In particular, the majority of our respondents were the oldest (aged 80 years or older). Because women and more aged adults are more likely to be ADL-disabled, it is possible and logical that our sample of ADL-disabled older adults has a similar need for social services regardless of age and sex. We also found that, as expected, living with children was associated with a lower need for basic care services, while an unmet need for ADL assistance was associated with a higher need for basic care services in both rural and urban areas. These findings indicate that unmet needs could be due to insufficient care from family members, who provide the majority of care for older adults; as Table 1 shows, about 88% of the sample had a family member as the primary caregiver. Thus, older adults with disabilities may be more likely to seek from non-family resources for assistance with unmet needs for care (Fu *et al.*, 2017).

Among the significant enabling factors, we found that economic independence was associated with reduced need for both basic care and social connection services in urban areas but not in rural areas. We speculate that substantial rural–urban disparities in economic conditions and social welfare may account for this finding. Most economically independent urban older adults have pension income and are covered by medical insurance, so they can afford to hire a caregiver and/or use services from hospitals or special care facilities. Thus, urban older adults with disabilities may have a lower need for social

Table 3. Multilevel ordered logit models for need for basic care and social connection services among older adults who need assistance in performing activities of daily living by rural and urban residence, CLHLS, 2005 – 2018

Not compulsory	Total		Rural		Urban	
	Basic care	Social connection	Basic care	Social connection	Basic care	Social connection
Independent variables						
Predisposing factors						
Ages 80 – 89 (ages 65 – 79)	1.06	0.98	1.09	0.98	1.04	0.98
Ages 90 – 99 (ages 65 – 79)	1.03	0.89	0.96	0.88	1.08	0.89
Ages 100+ (ages 65 – 79)	1.03	0.92	1.08	0.97	0.98	0.86
Men (women)	1.05	1.04	1.13	1.08	0.99	1.01
Rural (urban)	1.09*	1.13***	---	---	---	---
Han ethnicity (non-Han)	1.20*	1.15	1.21	1.08	1.19	1.25
Currently married (no)	1.16**	1.14	1.04	1.05	1.25**	1.20**
1 – 6 years of schooling (0)	0.97	0.98	0.95	1.02	0.97	0.95
7+years of schooling (0)	0.93	0.94	1.11	1.18	0.88	0.87
White-collar job (non-white-collar)	0.97	0.99	0.94	0.86	0.97	1.02
Enabling factors						
Economic independence (no)	0.74***	0.77***	0.82	0.90	0.70***	0.71***
Got adequate medication (no)	0.95	1.00	1.08	1.03	0.82*	0.97
Medical cost mainly paid by self/family (no)	0.97	0.99	1.02	1.07	0.93	0.93
Primary caregiver is a family member (no)	0.92	1.04	0.93	1.01	0.91	1.05
Coresidence with children (no)	0.81***	0.90*	0.84*	0.93	0.80**	0.88
# of children alive	0.99	0.99	0.96	0.99	1.00	1.00
# of available basic care services	1.28***	0.96*	1.27***	0.97	1.31***	0.95
# of available social connection services	1.21***	1.62***	1.16***	1.60***	1.24***	1.63***
Need factors						
SRH fair (good)	1.11*	1.10*	1.04	1.05	1.16**	1.15*
SRH poor (good)	1.12*	1.00	1.10	0.98	1.15*	1.02
SRH unable to answer (good)	0.97	0.95	0.98	0.88	0.95	1.00
Unmet need (no)	1.14***	1.08*	1.12*	1.09	1.16**	1.08
Severe ADL disability (no)	1.09*	1.11**	1.05	1.05	1.13*	1.17**
Controls						
Medium frequency of leisure activities (low)	1.00	1.06	0.93	1.00	1.05	1.12*
High frequency of leisure activities (low)	0.94	1.14	0.92	1.06	0.99	1.22*
Northeast (North)	0.79*	0.90	1.00	1.08	0.76**	0.86
East (North)	1.44***	1.32***	1.88***	1.66***	1.33***	1.21*
Central and South (North)	1.83***	1.81***	2.48***	2.34***	1.61***	1.59***
West (North)	1.14	1.12	1.42*	1.24	1.06	1.12
2008 (2005)	1.14**	1.10*	1.11	1.17*	1.14	1.02
2011 (2005)	1.46***	1.44***	1.58***	1.54***	1.40***	1.34***
2014 (2005)	1.21**	1.25***	1.27*	1.37**	1.16	1.15
2018 (2005)	1.39***	1.49***	1.14	1.35***	1.64***	1.59***
n	16,387	16,387	7,711	7,711	8,676	8,676
σ^2	0.56	0.37	0.67	0.47	0.58	0.38
-log likelihood	−21939	−20108	−10296	−9467	−11596	−10613

Notes: Odds ratios were from multilevel ordered logistic regression including all variables listed in the table. Category in the parentheses is the reference group for each covariate; σ^2 is Level Two variance component; Each of the dependent variables was an ordinal variable with values ranging from 0 to 4. Basic care referred to personal care, home visits and health checkup, psychological counseling, and daily shopping; social connection referred to social and recreational activities, legal aid, health education, and neighborhood relations; *p<0.05, **p<0.01, ***p<0.001.
Abbreviation: ADL: Activities of daily living.

services. By contrast, most rural residents have no or very little retirement income and rely primarily on family for support (Li *et al*., 2013; Zou *et al*., 2024), and on average, they have a lower economic status compared to their urban counterparts. Even if rural older adults are economically independent, their purchasing power remains low, which may prevent them from affording scarcely available social services. As such, rural older adults who are economically independent may suppress their need for social services, producing no effect of economic status on the need for unavailable services.

One need factor, severe ADL disability, was associated with an increased need for both basic care and social connection services in urban areas but not in rural areas. This finding may also be attributed to the rural–urban disparities in economic conditions (Zhang *et al*., 2017). With access to better economic conditions, urban older adults with severe ADL disabilities are more likely to afford social care services. Consequently, they may have higher expectations for such services. However, due to lower economic status and limited caregiving resources, rural residents with severe ADL disabilities, often constrained by lower economic status and limited caregiving resources, may suppress their need for assistance and continue relying primarily on family members for caregiving.

At the community level, self-reported availability of social care services in the neighborhood was associated with an increased need for those services. Our measure of self-reported availability of social services is very similar to the previously studied concepts of awareness of social services (Mitchell, 1995) or perceived availability of social services (Tang & Pickard, 2008). Previous studies have shown that greater awareness of services available to older adults is associated with greater use of those services (Bradley *et al*., 2002; Moon *et al*., 1998; Ploeg *et al*., 2009; Tang & Pickard, 2008) and that the need for services is highly associated with the use of services (e.g., Calsyn & Roades, 1993), our finding is not unexpected. Furthermore, it should be noted that self-reported availability of services does not mean adequate quantity, good quality, easy access, or effective delivery of those services. Indeed, the coverage of social services is very limited in contemporary China except in a few big cities such as Beijing, Shanghai, and Tianjin; many services cannot provide professional care due to lack of skilled and trained staff, and the price of the services is beyond most older adults' affordability (Feng *et al*., 2012; Gu & Vlosky, 2008; Hung, 2022; Qian, 2017; Wu *et al*., 2005). For example, according to a study on community-based service centers in Shanghai (Wu *et al*., 2005), the largest and most developed city in China where social service programs have been developed for decades, staff lack education, relevant work experience, and training, while service programs lack quality management, monitoring systems, and government investment. Another study also conducted in Shanghai shows that the types of services offered at the community level are limited, and most services only provide basic assistance to older adults with ADL disabilities (Chen & Han, 2016). Therefore, even when social services are available, the services provided to older adults may not fully meet their needs, which could lead to an increased need for better social services.

Overall, this study provides several implications for developing social service programs in both rural and urban China. First, given the higher need and the importance of family members for rural residents, there is an urgent need to develop both basic care and social connection services in rural areas. Second, economic disparities contribute to rural–urban differences in need, which suggests that improving rural older adults' economic conditions and access to healthcare systems and services may increase their potential use of social services and decrease their reliance on family caregivers. Research has found rural residents are significantly less likely to use care services than their urban counterparts (Li *et al*., 2018). Therefore, expanding service availability, improving the quality of care services, and lowering the service cost by financing care services or providing reimbursement is necessary to reduce rural–urban disparities in accessing and utilizing care services. Third, the availability of social services was associated with an increased need for those services, which suggests that the government should develop new services or expand existing services to help older adults achieve "aging in the right place"; however, service programs should be evaluated for acceptance, accessibility, effectiveness, efficiency, and appropriateness to improve utilization.

This study has several limitations. First, in the CLHLS, the measurement of social care services is broad and not specific. For example, a question was asked to measure whether there was a need for personal care service. Respondents may lack clarity on the definition of personal care services, potentially leading to overestimation or underestimation of their need for such services. A clear definition of each type of service, with specific examples, is necessary to estimate needs more accurately in future studies. Second, because the awareness of social services does not provide information on whether those services were accessible, whether they were utilized, or whether utilization was satisfactory, we were unable to examine the effect of service-related characteristics on older adults' service needs, warranting future research on those measures. Third, our study focused on ADL-disabled older adults only and did not address the need for social services among the entire older population. Some older adults

without ADL disabilities may still require social connection services. Comparative studies between ADL-disabled and non-disabled older adults would add additional value to the existing literature.

Despite these limitations, this study advanced our understanding of the need for home- and community-based services in several ways. By utilizing a nationally representative longitudinal survey with the largest sample size of older adults, this study considered eight social services and classified them into two types of services, thus providing a more comprehensive picture of social service needs than previous studies, most of which only focused on one or two types of services (e.g., Liu *et al*., 2014; Liu *et al*., 2015). Second, we compared the differences in need and its determinants between rural and urban areas, which revealed important differences in the need for social services, as well as in enabling and need factors.

5. Conclusion

This study used a nationally representative sample from the CLHLS to examine the need for social services among 8,548 Chinese older adults (aged 65+) who reported difficulties with ADLs between 2005 and 2018. Our findings reveal significant rural-urban disparities in social service needs among disabled older adults in China. Rural residents exhibited a greater need for both basic care and social connection services compared to their urban counterparts, highlighting the increasing challenges faced by older adults in rural areas due to the decline of traditional family support.

Moreover, our study underscores the influence of economic and household factors on these needs. Economic independence was associated with a lower demand for social services in urban areas, suggesting that financial stability enables older adults to secure alternative sources of support. Conversely, severe disability in ADLs increased the need for both types of services among urban older adults, reflecting gaps in existing care structures. Additionally, co-residence with children was linked to a reduced need for basic care services in both rural and urban settings, reaffirming the critical role of family support in eldercare.

These findings highlight the urgent need to strengthen social service infrastructure, particularly in rural China, where the weakening of family-based care has left many older adults vulnerable. Policymakers should prioritize expanding accessible and affordable social services, such as home-based care and community engagement programs, while implementing tailored policies that address economic and disability-related disparities. As China undergoes rapid demographic shifts, a comprehensive and inclusive approach to social service development will be essential for enhancing the well-being of its aging population.

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Conceptualization: All authors
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Methodology: All authors
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Writing – original draft: All authors
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Ethics approval and consent to participate

The data used in this study were obtained from a publicly accessible database, the Chinese Longitudinal Healthy Longevity Survey (https://www.icpsr.umich.edu/web/NACDA/studies/37227).

Consent for publication

Not applicable.

Availability of data

The data are publicly available at https://www.icpsr.umich.edu/web/NACDA/studies/37227.

Further disclosure

Views expressed in the article are solely those of the authors and do not reflect those of Virginia Polytechnic Institute and State University or the United Nations.

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ACCSCIENCE PUBLISHING

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RESEARCH ARTICLE

The vulnerable workforce: COVID-19 and the fate of atypical workers

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Abstract

The Coronavirus disease 19 (COVID-19) pandemic has significantly affected the global workforce, with certain occupational groups facing greater challenges than others. Atypical part-time, temporary, and gig job workers are among the most vulnerable. This paper first examines the impact of the COVID-19 health crisis on atypical/contingent workers by firm size, industry, and region. Second, we explore the factors determining the increase/decrease of the temporary labor force at the firm level. Third, we aim to verify the empirical validity of the Schumpeterian "destruction creative" hypothesis since any crisis is associated with destroying old jobs and creating new job needs. We mobilized a firm-level database of 12,193 firms from 19 countries and a dynamic logit model methodology. Our empirical results show that atypical workers were among those most impacted by COVID-19. Results by firm size show that small firms raised the probability of increasing the level of the temporary labor force, as opposed to medium- and large-sized firms. Results by sector of activity revealed that firms operating in sectors other than construction (hotels and restaurants, retail trade, IT, transport, machinery, and equipment) were less likely to increase their temporary labor force. Geographic location is a key driver of the increase or decrease in a firm's temporary workforce. Furthermore, insufficiently educated labor and regulations drive temporary labor variations. Finally, the Schumpeterian "creative destruction" hypothesis was empirically confirmed.

Keywords: Atypical job; Coronavirus disease 19; Firm-level data; Africa; Middle East and North Africa; Europe

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1. Introduction

The Coronavirus disease 19 (COVID-19) pandemic has profoundly impacted the global workforce, with some occupational groups experiencing more significant challenges than others. The atypical workforce, which includes part-time, temporary, and gig workers, has been particularly vulnerable during this crisis. The pandemic has exposed the fragility of the atypical workforce, as these workers often lack access to traditional employment benefits such as health insurance and paid leave (Chen, 2021). Moreover, many atypical

workers are employed in industries hit hardest by the pandemic, such as hospitality and retail. The pandemic has highlighted growing issues in workplace safety, skill gaps, technology adoption, and work reorganization in the hospitality industry. The impact of technology adoption, shrinking labor pools, and workplace risks will likely be accelerated by the COVID-19 crisis (Huang *et al*., 2021).

COVID-19's impact on the real economy and the labor market has received extensive coverage in the empirical literature; however, few studies have investigated the impact of the COVID-19 health crisis on a vulnerable segment of the labor market, atypical/temporary workers. A contingent work or atypical job is defined as "*any job in which an individual does not have an explicit or implicit contract for long-term employment or a job in which the minimum hours worked may vary in a non-systematic way*" (Polivka & Nardone, 1989, p.11). Unlike a typical job whose main characteristics are the full-time, open-ended contract, contingent work materializes as a part-time, fixed-term contract. This type of employment is intended to promote employment in the labor market (Couprie & Joutard, 2017, p.60). Atypical jobs offer recruitment flexibility for employees in exchange for job insecurity for workers; this phenomenon is known under the neologism "*flexicarity*" (Everaere, 2016).

Contingent works are employment contracts with multi-party relationships (hiring through recruitment agencies and employment promotion agencies, etc.) or other "ambiguous" employment relationships (rights and obligations are unclear or legislation is inadequate or deficient) offering flexibility demanded by firms to meet unexpected labor needs, and many other advantages related to cost control, evaluation of recruits, and replacement of absent workers (Polivka & Nardone, 1989). A second form of atypical job is the status of a self-employed/independent or contractual employee, known as a "freelancer." Unlike standard atypical employment, "freelancers" have, in most cases, a specific expertise and a high qualification level (computer science or programming) that they sell to a firm or a public administration for the accomplishment of a project limited in time (Connelly & Gallagher, 2004, p.961).

Hlasny & Alazzawi (2022) examined the impact of the COVID-19 crisis and government responses on trends in worker outcomes in Arab countries. They focused on the vulnerable employment of youth and women, and used the Economic Research Forum's COVID-19 Middle East and North Africa (MENA) Monitors microdata for five countries – Egypt, Jordan, Morocco, Sudan, and Tunisia – and applied a multinomial logistic regression model to analyze employment status separately by gender. Empirical results showed that COVID-19 negatively affected most workers' employment and labor force participation, especially youth. Those who became unemployed during COVID-19 were mainly people with atypical work.

This paper investigates the impact of the COVID-19 health crisis on atypical/contingent workers and explores the factors determining the increase/decrease of the temporary labor force at the firm level. The authors aim to verify the empirical validity of the Schumpeterian hypothesis of "creative destruction" by examining whether the crisis is associated with destroying old jobs and creating new job needs. The authors use a firm-level database of 12,193 firms from 19 countries and a dynamic logit model methodology to analyze the data.

The paper's major contributions reveal that the COVID-19 health crisis severely impacted atypical/contingent workers, particularly those working in small firms and sectors other than construction. The firm's geographic location is a key driver of the increase or decrease in a firm's temporary workforce, with African and European firms experiencing a decrease in their temporary workforce, as opposed to MENA firms. The paper also confirms the Schumpeterian hypothesis of "creative destruction" suggests that large firms drive innovation by outcompeting less efficient, smaller firms, fostering economic progress through continuous cycles of innovation and renewal. The adjustment policies implemented at the firm level led to the elimination of former temporary jobs while creating new temporary labor demands. The results of this study offer valuable insights for policymakers in designing measures to support vulnerable segments of the labor market and to promote job creation in the post-crisis period.

The policy implications of our study are significant. Policymakers must implement measures that protect workers from the negative consequences of atypical jobs, such as job insecurity and lack of social protection. Such measures could include strengthening labor market regulations to ensure that atypical workers are not unfairly treated and are provided with adequate social protection, regardless of their employment status. In addition, policies that promote education and training for atypical workers could help improve their skills and employability, reducing their vulnerability to job insecurity. Finally, policies that support creating more traditional jobs and promoting economic growth could help reduce the prevalence of atypical jobs and improve the overall quality of work.

This article is structured into five main sections. The first section, the introduction, provides an overview of the topic, highlighting the relevance and significance of studying the relationship between the COVID-19 health crisis and atypical employment, particularly concerning contingent work. The second section presents stylized

facts related to the impact of the COVID-19 crisis on contingent work. The third section outlines the empirical methodology used in the study, including the data sources, variables, and the empirical model used to analyze the data. The fourth section discusses the study results, presenting key findings and critical analysis. Finally, the fifth section, the conclusion, summarizes the study's main findings and offers some recommendations for policymakers, employers, and employees to mitigate the adverse effects of the COVID-19 crisis on contingent work. This structure provides a clear and logical framework for the article, guiding readers through the research process and enabling them to engage with the topic effectively.

1.1. COVID-19 health crisis and contingent work: Stylized facts

On March 11, 2020, the World Health Organization (WHO) declared COVID-19 a pandemic. Several governments have introduced health and safety measures to limit the spread of the virus (i.e., social distancing and travel restrictions) and other economic measures to support the strategic sectors and vulnerable population segments. These measures aimed to preserve human lives and jobs (Enterprise Surveys, 2020). Atypical jobs are associated with higher vulnerability in employment, which is mainly related to job insecurity for workers. This situation aligns with the results of Probst *et al.* (2018), who mobilized a sample of 1228 employees from Italy, emphasizing that contingent jobs are more associated with job insecurity.

The COVID-19 pandemic has significantly impacted the global economy, with many countries experiencing high unemployment rates and economic instability. The impact of the pandemic on atypical workers has been particularly severe; many lost their jobs or had their work hours reduced. Figure 1 presents a graphical analysis of the impact of the COVID-19 health crisis on temporary jobs, showing that the African continent was hit the hardest. The lack of government support in the region, with <20% of firms receiving aid, has negatively impacted contingent workers, with some firms reducing their temporary workforce by over 60% in countries such as Togo, Somalia, and Guinea. In contrast, European countries experienced a less pronounced impact on temporary employment during the pandemic, likely due to greater government support for businesses and workers.

The study's findings have important policy implications, particularly in addressing the vulnerability of atypical workers in the labor market. Governments should support firms and workers, particularly in regions where atypical employment is more prevalent, to mitigate the negative impact of economic crises, such as the COVID-19 pandemic. Furthermore, efforts to improve labor market regulations and reduce job insecurity for atypical workers should be prioritized to ensure more secure and stable employment opportunities.

Figure 2 presents the relationship between the percentages of vulnerable jobs in an economy. As development levels increase, this type of employment decreases, mainly due to the institutional framework and regulation of the labor market in developed countries that offer flexibility in the jobs demanded by firms and that the security workers need. An example is the famous "flexicurity" model applied in Denmark (Tuchszirer, 2007).

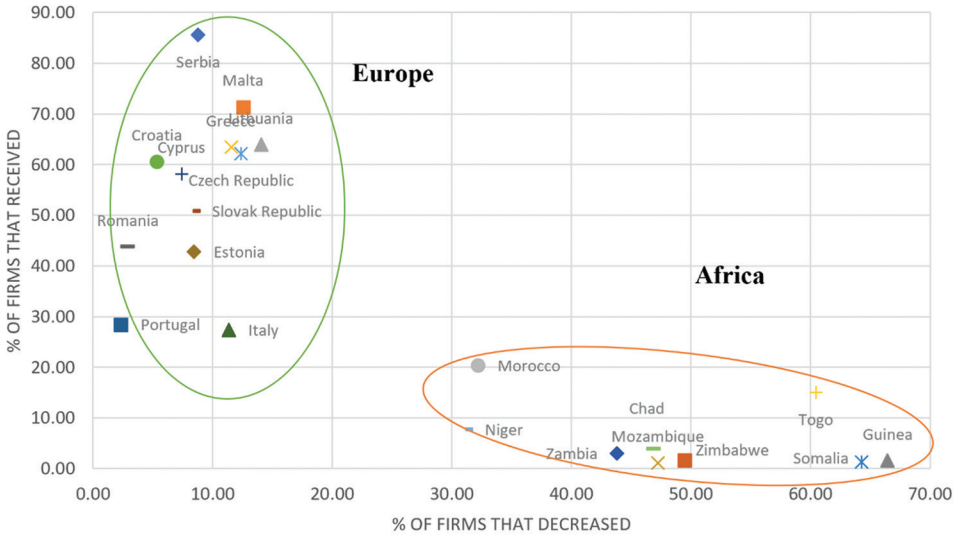

Figure 1. COVID-19 health crisis, government support, and contingent work: Europe and Africa
Source: Authors' elaboration, based on Enterprise Surveys (COVID-19: Impact on firms) Databases.

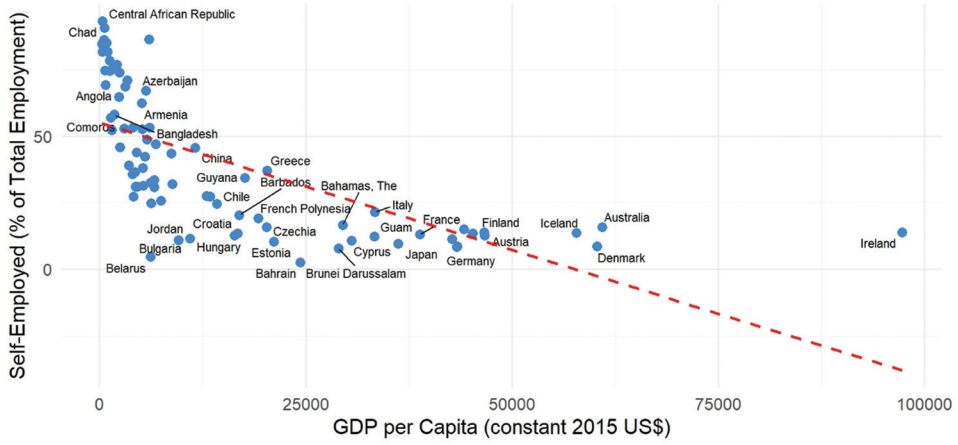

Figure 2. Self-employment share and level of development: World, 2019
Source: Authors' elaboration based on World Bank data.

The decision to adopt atypical forms of employment, such as temporary or part-time work, can be influenced by various internal and external factors. These may include the nature of the sector in which the firm operates, the level of technological development, and the overall regulatory environment in the labor market. For example, firms in highly competitive industries or those with high seasonal demand may be more likely to rely on temporary or contingent workers to increase workforce flexibility and reduce labor costs. Similarly, firms operating in technologically advanced sectors may be more likely to offer part-time or flexible work arrangements to attract highly skilled workers with a premium on work-life balance.

Atypical forms of employment are disproportionately occupied by workers with low levels of education or qualification and young people and women (MTIP[1], 2020, p.09). This may be partly because these workers may have fewer opportunities for stable, full-time work and may, therefore, be more likely to seek out temporary or part-time jobs to gain work experience and build their resumes. Women, in particular, may be more likely to work part-time or in temporary positions due to their caregiving responsibilities, which can make it difficult for them to work a traditional 9-to-5 job. However, while atypical forms of employment may offer some workers greater flexibility and autonomy in their work lives, they are often associated with lower wages, reduced benefits, and limited job security, negatively affecting their well-being and economic stability.

2. Data and methods

2.1. Data

Our data were extracted from the World Bank database, Enterprise Surveys [ES]: COVID-19 impacts on firms. To establish the profiles of firms by size, sector of activity, and region, whose atypical jobs were the most impacted during the COVID-19 crisis. This database has three components. (1) Follow-up surveys were carried out in countries where ES had previously been conducted. These surveys cover several business domains: the evolution of labor force levels, sales, and obstacles (Financing, informal sector practice, and labor market regulations) encountered by enterprises inherent to their environment. (2) A COVID-19 module for current ES that covers more than 18,300 firms surveyed in three waves of COVID-19 and belonging to 46 countries. Given that the empirical methodology we will mobilize requires panel data, we have limited our database to the enterprises that were the subject of 3 waves of follow-up surveys, which yielded 12,193 enterprises from 19 countries. The third component of the ES COVID-19 impact on firm databases is a COVID-19 module for informal enterprises.

2.2. Study variables

The ES database provides a variety of indicators related to firm-specific characteristics, including size, sector of activity, firm age, gender of the top manager, and number of temporary workers. Furthermore, regarding variables related to the external environment of the firm (such as the obstacles inherent to the environment of the firm), the following 15 barriers were identified: access to land, business licenses and permits, corruption, courts, crime, theft and disorder, trade and commercial regulations, electricity, education-labor market mismatch, labor market regulations, political instability, informal sector practices, tax administration, tax pressure rate, telecommunications, and transportation.

We examine the impact of the COVID-19 health crisis on atypical jobs by firm size, industry, and region. To do so,

[1] Ministry of Labor and Professional Insertion, Morocco

we mobilize the variable "*Since the outbreak of COVID-19, has the number of temporary workers increased, remained the same, or decreased*?" This approach allows us to capture firms that have decreased/increased their atypical jobs. For this purpose, we will create two binary variables: (1) Firms that increased temporary workers and (2) Firms that decreased temporary workers. Both variables are equal to 1 if the firm belongs to one of the two categories; otherwise, they equal 0.

To control for our model, we mobilize variables on firm-specific characteristics (size, age, gender of top manager, etc.) and other control variables that provide information on the obstacles firms face, particularly concerning labor market regulations and the adequacy of education and workforce needs. We use two variables: (1) How Much of an Obstacle: Labor Regulations? (2) How Much of an Obstacle: Inadequately Educated Workforce?

We mobilize other variables that inform whether the firm has implemented an adjustment policy captured by the variable "Has this establishment converted its production or services in response to COVID-19?" This approach allows us to capture the differences in measures implemented to cope with the COVID-19 pandemic and other variables that may affect the likelihood that a firm will reduce or increase its contingent workforce. Introducing this variable is intended to test the "Schumpeterian hypothesis" of creative destructiveness, according to which the conversion of the production technique could cause the loss of jobs of those who could not adapt to the change caused by the COVID-19 crisis.

In addition, our study uses variables indicating whether each firm received support from national or local government measures and includes a stringency index to capture the degree of measures implemented in each country to address COVID-19. A descriptive analysis of our data showed that only 4% of firms in our sample increased their temporary workforce compared to 16% of firms that reduced their temporary workforce, indicating how vulnerable the COVID-19 health crisis has impacted jobs.

2.3. Empirical model

Our study focuses on modeling the binary variable "*Since the outbreak of COVID-19, has the number of temporary workers increased, remained the same, or decreased?*" The firms in our sample were surveyed during three rounds after three waves of COVID-19. The econometric specification of our dynamic logit model on the microeconomic data of 12,193 firms is as follows:

$$\begin{aligned} \text{FTWFS}_{i,j,t} &= \alpha_1 + \alpha_2 \ln(\text{age})_{i,j,t} \\ &+ \alpha_3 \ln(\text{experience manager})_{i,j,t} \\ &+ \alpha_3 \text{Top manager female}_{i,j,t} + \alpha_k \sum_{k=4}^{8} X_{k,i,j,t} + u_{i,j,t} \\ &with: u_{i,j,t} = \alpha_i + \eta_j + \lambda_t + \varepsilon_{i,j,t} \end{aligned} \quad (1)$$

Where *FTWFS* is the firm's temporary labor force status captured by the two binary variables: first, firms that decreased temporary workers since the outbreak of COVID-19; second, firms that increased the number of temporary workers since the outbreak of COVID-19. Our model is controlled by a set of variables on firm-specific characteristics (the logarithm of the firm's age, the manager's experience, and the gender of the firm's top manager: Female = 1 female and male = 0) and variables related to the firm's environment X_k. These are equal to k = 5 variables presented in Table 1. The indexes *i, j,* and *t* are the firm, the sector, and the time. η_j, α_i, and λ_t are, respectively, the fixed effect of the sectors, the specific individual effect for each firm, and the temporal effect, respectively. Our database comprises data collected during three follow-up rounds, each assessing the firms' situations following three successive waves of COVID-19. ε is the error term.

3. Results

Tables 1 and 2 present the estimates of a dynamic logit model when the variables quantify the variation in atypical employment at the firm level. These variables are as follows: "*Firms that increased the number of temporary workers since the outbreak of COVID-19*" and "*Firms that decreased the number of temporary workers since the outbreak of COVID-19.*"

3.1. The impact of COVID-19 on atypical jobs by firm size

Our results indicate that an inadequately educated workforce and labor regulations are the main factors that thwart the increase in atypical employment levels at the firm level during the COVID-19 pandemic. A statistically significant effect of the variable inadequacy between training and the needs of the companies in terms of temporary workforce was found. Furthermore, results by firm size show that small firms significantly increased their temporary workforce during the COVID-19 pandemic. This situation can be explained by the fact that this firm category is constrained by labor market regulations regarding typical jobs, which directs firms to this temporary employment that guarantees workforce flexibility for the firm but at the expense of job security. However, medium- and large-sized firms experienced a

Table 1. Study variables

Variable	Obs.	Mean	Std. Dev.	Min	Max
1. Dependent variables					
Firms that have decreased the number of temporary workers since the outbreak of COVID-19	7,937	0.16	0.37	0	1
Firms that increased the number of temporary workers since the outbreak of COVID-19	7,937	0.04	0.19	0	1
2. Control variables					
Firm age	36,060	23.03	16.09	1	203
Manager experience	35,349	21.91	11.70	1	70
Top manager female	36,579	0.17	0.38	0	1
How much of an obstacle: Labor regulations?	36,153	0.14	0.35	0	1
How much of an obstacle: An inadequately educated workforce?	36,033	0.22	0.42	0	1
Adjustment policy: Has this establishment converted its production or services in response to COVID-19?	8,788	0.29	0.45	0	1
Has this establishment received any national or local government measures issued?	8,379	0.37	0.48	0	1
Stringency index	36,579	26.17	17.88	11.11	63.89

Source: Authors' calculations.

decline in their temporary workforce during COVID-19 (Table 2).

The study results highlight the need for policies addressing the inadequacy of education and training for the workforce, particularly concerning the skills required for atypical jobs. Policymakers must consider supporting workers in acquiring new skills that will enable them to adapt to changing labor market demands. Moreover, labor regulations must be reviewed to balance the need for workforce flexibility with employees' job security. For small firms, policy measures could reduce the constraints that direct them to rely on temporary employment, such as offering incentives to create more permanent jobs. Conversely, for medium- and large-sized firms, policies to increase job security for temporary workers could help mitigate the negative impacts of declining temporary employment.

One of the most critical findings from the firm size estimates is related to the adjustment policy brought forward by the COVID-19 crisis. The variable "Has this establishment converted its production or services in response to COVID-19?" is significantly and positively correlated with both dependent variables, whether for the increase and/or decrease in temporary employment at the firm level during the COVID-19 pandemic. This result confirms the Schumpeterian hypothesis of "destructive creation" insofar as in every crisis, there is "destruction of businesses, fortunes, products, and careers, as well as the emergence of new business models and new employment needs, all of which are the price of progress. This is what Joseph Schumpeter described as destruction creative" (Iqbal, 2015, p.01). The governmental subsidies implemented to mitigate the impact of the COVID-19 health crisis on firms did not contribute to maintaining temporary jobs at pre-crisis levels.

This study's findings have important policy implications for governments and policymakers. First, the positive correlation between converting production or services in response to COVID-19 and the level of temporary employment suggests that governments should incentivize firms to innovate and adapt to the new economic landscape. This could include providing support and resources for firms to develop new business models and strategies that will enable them to weather the effects of the pandemic and offering tax breaks or other financial incentives to firms that create new jobs or convert their operations to meet new demands. In addition, policymakers should consider reforms to labor market regulations that constrain firms from hiring atypical workers, particularly for small firms that are more likely to rely on temporary employment to maintain flexibility. Finally, while subsidies may be necessary to support firms during times of crisis, this study suggests that they may not be effective in maintaining pre-crisis levels of temporary employment. Therefore, policymakers should consider alternative measures, such as investments in education and training programs, to help workers acquire the skills and qualifications needed to secure more stable, long-term employment.

Similarly, Table 3 presents the estimates when the dependent variable is "Firms that decreased temporary workers since the outbreak of COVID-19." The regulation of the labor market and the mismatch between education and the firm's labor force needs are the main factors determining the decrease of the temporary labor force

Table 2. Empirical results: Atypical jobs and the impact of COVID-19 by firm size

Dependent variable: Firms that increased the number of temporary workers since the outbreak of COVID-19	(1)	(2)	(3)
Ln (age)	0.0968	0.0595	0.0895
	(0.115)	(0.112)	(0.114)
Ln (manager experience)	0.0871	0.0976	0.0888
	(0.108)	(0.108)	(0.107)
Top Manager Female	0.0300	0.0552	0.0396
	(0.165)	(0.164)	(0.164)
How Much of An Obstacle: Labor Regulations?	−0.276	−0.290	−0.285
	(0.207)	(0.207)	(0.206)
How Much of An Obstacle: An Inadequately Educated Workforce?	−0.475***	−0.486***	−0.478***
	(0.176)	(0.176)	(0.176)
Has this establishment received any national or local government measures issued?	−0.308**	−0.299**	−0.304**
	(0.133)	(0.133)	(0.133)
Adjustment policy: Has this establishment converted its production or services in response to COVID-19?	0.495***	0.494***	0.494***
	(0.132)	(0.132)	(0.132)
Stringency index	0.000242	0.000480	0.000503
	(0.00389)	(0.00389)	(0.00388)
Small	0.269**		
	(0.128)		
Medium		−0.145	
		(0.140)	
Large			−0.273*
			(0.156)
Constant	−4.005***	−3.773***	−3.808***
	(0.420)	(0.407)	(0.406)
Prob >chi² (Hausman test)	0.0909	0.0785	0.0845
Appropriate model	**Random effect (RE)**	**RE**	**RE**
Observations	7,396	7,396	7,396
Number of firms	3,452	3,452	3,452

Source: Authors' calculations. Standard errors are in parentheses.
*p<0.1, **p<0.05, ***p<0.01.

at the firm level. Furthermore, as the firm's age and the experience of its top manager increases, the probability of reduction of atypical employment decreases, but this result is insignificant.

Table 3. Empirical results: Atypical jobs and the impact of COVID-19 by firm size

Dependent variable: Firms that decreased the number of temporary workers since the outbreak of COVID-19	(1)	(2)	(3)
Ln (age)	−0.0828	−0.0914	−0.0988
	(0.0680)	(0.0668)	(0.0679)
Ln (manager experience)	−0.0709	−0.0677	−0.0670
	(0.0618)	(0.0617)	(0.0618)
Top Manager Female	0.0412	0.0464	0.0507
	(0.0991)	(0.0988)	(0.0990)
How Much of An Obstacle: Labor Regulations?	0.188*	0.187*	0.185*
	(0.109)	(0.109)	(0.109)
How Much of An Obstacle: An Inadequately Educated Workforce?	0.0501	0.0476	0.0441
	(0.0937)	(0.0936)	(0.0937)
Has this establishment received any national or local government measures issued?	0.0633	0.0644	0.0665
	(0.0752)	(0.0752)	(0.0752)
Adjustment policy: Has this establishment converted its production or services in response to COVID-19?	0.347***	0.347***	0.347***
	(0.0760)	(0.0760)	(0.0760)
Stringency index	−0.0175***	−0.0175***	−0.0174***
	(0.00256)	(0.00256)	(0.00256)
Small	0.0695		
	(0.0786)		
Medium		−0.0888	
		(0.0840)	
Large			0.0357
			(0.0899)
Constant	−1.284***	−1.212***	−1.230***
	(0.225)	(0.217)	(0.216)
Prob>chi² (Hausman test)			
Appropriate model	**RE**	**RE**	**RE**
Observations	7,396	7,396	7,396
Number of firms	3,452	3,452	3,452

Source: Authors' calculations. Standard errors are in parentheses.
*p<0.1, **p<0.05, ***p<0.01.

3.2. The impact of COVID-19 on atypical jobs by firm sector

We estimate a dynamic logit model in which the dependent variables are the two binary variables that inform on the

increase or decrease of the temporary labor force at the firm level. This approach allows us to investigate the factors determining the increase/decrease in the temporary labor force level by sector. Estimation results when the dependent variable is "Firms that increased temporary workers since the outbreak of COVID-19" confirmed the results highlighted previously (estimation by firm size). As for the variations in the temporary labor force levels by sector, firms in the hotel and restaurants, retail, IT, transport, machinery, and equipment sectors reduce the probability of increasing their temporary workforce during COVID-19. However, this is not the case for firms operating in the construction sector, which is the only sector that has seen a significant increase in the level of the temporary workforce (Table 4).

Table 4 presents the estimates of a dynamic logit model when the dependent variable is "Firms that decreased the number of temporary workers since the outbreak of COVID-19." Our empirical results support the evidence of a significant impact of the barriers experienced by firms regarding labor market regulations and maintaining their temporary workforce during the COVID-19 pandemic. The variable that captures the level of obstacles related to labor market regulations is positively and significantly associated with the probability that the firm will reduce its number of temporary workers. Firms that reduced their temporary labor force during the COVID-19 pandemic operated in the machinery and equipment, electronics, and fabricated metal product sectors. Results for the construction sector confirm the results found in Table 3 concerning firms that increased their temporary workforce. Firms in the construction sector decreased the probability of reducing their temporary workforce.

Some sectors identified as sectors that experienced a reduction in the temporary labor force were also found to be sectors where firms did not experience a reduction in the temporary labor force. These include hotels and restaurants, retail, IT, and transport. This is a striking result, as a firm operating in one of these sectors was expected to increase the probability of reducing its temporary labor force. This result can be explained by our two dependent variables being constructed from a multinomial variable, "*Since the onset of COVID-19, has the number of temporary workers increased, remained the same, or decreased?*" This variable takes three modalities, "increased," "remained the same," or "decreased." Our study focuses on firms that have experienced a change in their temporary workforce "increased" or "decreased." Each firm in our database answers this question. Therefore, a proportion of firms operating in a particular sector, such as hotels and restaurants, may have experienced fewer temporary workers while other firms hired more temporary workers in the same sector.

3.3. The impact of COVID-19 on atypical jobs by firm region

The regional analysis in our study (Tables 5 and 6) sheds light on the distinct impact of COVID-19 on atypical employment across different regions. The results reveal that MENA countries experienced a significant increase in temporary employment during the pandemic. In particular, firms in Morocco, Jordan, and Lebanon reported an increase in their temporary workforce, which can be attributed to the labor market regulations that allow for more flexibility in employment contracts. This increase suggests that these countries may have better adapted their labor regulations to the needs of the current crisis, enabling firms to hire temporary workers to meet fluctuations in demand.

In contrast, our study found that firms located in Africa and Europe experienced a decrease in their temporary workforce during COVID-19. This result could be due to the stricter labor regulations in these regions, which provide fewer opportunities for firms to hire temporary workers; however, this could also result from reduced overall economic activity and demand for labor during the pandemic. Regardless, it is essential to address the unique labor market challenges faced by firms in different regions and to tailor policy measures to support employment according to the specific needs of these regions (Table 7).

Therefore, our study highlights the importance of taking a regional approach to understand the impact of the pandemic on atypical employment. The findings suggest that MENA countries have fared better in maintaining temporary jobs, which could provide important insights for policy measures in other regions. Governments should consider streamlining labor market regulations to allow for more flexibility in employment contracts during times of crisis and invest in education and training programs that cater to the needs of the labor market in different regions. This approach could help bridge the skill mismatch gap, provide tailored support for firms in different sectors and regions, and promote a more resilient labor market in the face of future crises.

Our study also analyzed the factors that affect the likelihood of firms increasing or decreasing their temporary workforce during the COVID-19 pandemic. Our estimation showed that various factors are important in firms' decision-making process. Labor market regulations were found to have a significant effect on the level of temporary employment, suggesting that regulatory frameworks need to be streamlined to allow for greater flexibility while

Table 4. Empirical results: Atypical jobs and the impact of COVID-19 by sector

Dependent variable: Firms that increased the number of temporary workers since the outbreak of COVID-19	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Ln (age)	0.0537	0.0511	0.0600	0.0554	0.0562	0.0588	0.0564	0.0562
	(0.112)	(0.112)	(0.112)	(0.112)	(0.112)	(0.112)	(0.112)	(0.112)
Ln (manager experience)	0.0970	0.0983	0.110	0.0975	0.0970	0.0989	0.0974	0.0989
	(0.107)	(0.107)	(0.108)	(0.107)	(0.107)	(0.107)	(0.107)	(0.107)
Top Manager Female	0.0619	0.0725	0.0988	0.0575	0.0579	0.0546	0.0582	0.0544
	(0.164)	(0.165)	(0.164)	(0.164)	(0.164)	(0.164)	(0.164)	(0.164)
How Much of An Obstacle: Labor Regulations?	−0.294	−0.294	−0.279	−0.294	−0.294	−0.290	−0.292	−0.293
	(0.207)	(0.207)	(0.206)	(0.207)	(0.207)	(0.207)	(0.207)	(0.207)
How Much of An Obstacle: An Inadequately Educated Workforce?	−0.489***	−0.498***	−0.486***	−0.489***	−0.488***	−0.494***	−0.488***	−0.486***
	(0.176)	(0.176)	(0.176)	(0.176)	(0.176)	(0.176)	(0.176)	(0.176)
Has this establishment received any national or local government measures issued?	−0.296**	−0.294**	−0.301**	−0.296**	−0.297**	−0.299**	−0.298**	−0.298**
	(0.133)	(0.133)	(0.133)	(0.133)	(0.133)	(0.133)	(0.133)	(0.133)
Adjustment policy: Has this establishment converted its production or services in response to COVID-19?	0.494***	0.494***	0.492***	0.493***	0.493***	0.494***	0.494***	0.494***
	(0.132)	(0.132)	(0.131)	(0.132)	(0.132)	(0.132)	(0.132)	(0.132)
Stringency index	0.000698	0.000614	0.000903	0.000581	0.000517	0.000483	0.000531	0.000555
	(0.00390)	(0.0038)	(0.00389)	(0.00388)	(0.00388)	(0.00388)	(0.00390)	(0.00388)
Sectors								
Hotel and restaurants	−0.0754							
	(0.273)							
Retail		−0.139						
		(0.162)						
Construction			0.427**					
			(0.184)					
IT				−0.147				
				(0.527)				
Transport					−0.124			
					(0.355)			
Electronics						−0.572		
						(0.736)		
Machinery and equipment							−0.0444	
							(0.301)	
Fabricated metal products								−0.0767
								(0.235)
Constant	−3.798***	−3.767***	−3.902***	−3.804***	−3.800***	−3.809***	−3.805***	−3.804***
	(0.407)	(0.407)	(0.409)	(0.406)	(0.406)	(0.406)	(0.406)	(0.406)
Prob>chi2 (Hausman test)	0.0744	0.0719	0.0810	0.0735	0.0749	0.0779	0.0761	0.0762
Appropriate model	RE	RE	RE	RE	RE	RE	RE	RE
Observations	7,396	7,396	7,396	7,396	7,396	7,396	7,396	7,396
Number of firms	3,452	3,452	3,452	3,452	3,452	3,452	3,452	3,452

Source: Authors' calculations. Standard errors are in parentheses. *p<0.1, **p<0.05, ***p<0.01.

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Table 5. Empirical results: Atypical jobs and the impact of COVID-19 by sector

Dependent variable: Firms that decreased the number of temporary workers since the outbreak of COVID-19	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Ln (age)	−0.104	−0.0985	−0.0972	−0.0942	−0.0933	−0.0951	−0.101	−0.0948
	(0.0670)	(0.0667)	(0.0667)	(0.0668)	(0.0668)	(0.0668)	(0.0666)	(0.0668)
Ln (manager experience)	−0.0685	−0.0674	−0.0730	−0.0682	−0.0687	−0.0688	−0.0724	−0.0724
	(0.0617)	(0.0616)	(0.0616)	(0.0617)	(0.0617)	(0.0617)	(0.0616)	(0.0618)
Top Manager Female	0.0651	0.0631	0.0292	0.0481	0.0485	0.0498	0.0517	0.0576
	(0.0991)	(0.0992)	(0.0994)	(0.0988)	(0.0988)	(0.0988)	(0.0986)	(0.0991)
How Much of An Obstacle: Labor Regulations?	0.183*	0.184*	0.179	0.185*	0.184*	0.184*	0.172	0.185*
	(0.109)	(0.109)	(0.109)	(0.109)	(0.109)	(0.109)	(0.109)	(0.109)
How Much of An Obstacle: An Inadequately Educated Workforce?	0.0443	0.0357	0.0439	0.0459	0.0485	0.0477	0.0270	0.0402
	(0.0935)	(0.0937)	(0.0935)	(0.0936)	(0.0936)	(0.0936)	(0.0937)	(0.0937)
Has this establishment received any national or local government measures issued?	0.0698	0.0689	0.0682	0.0663	0.0657	0.0662	0.0762	0.0677
	(0.0752)	(0.0752)	(0.0752)	(0.0752)	(0.0752)	(0.0752)	(0.0752)	(0.0752)
Adjustment policy: Has this establishment converted its production or services in response to COVID-19?	0.347***	0.347***	0.347***	0.347***	0.345***	0.347***	0.346***	0.346***
	(0.0760)	(0.0760)	(0.0760)	(0.0760)	(0.0760)	(0.0760)	(0.0759)	(0.0760)
Stringency index	−0.0169***	−0.0174***	−0.0175***	−0.0175***	−0.0176***	−0.0174***	−0.0166***	−0.0174***
	(0.00257)	(0.00255)	(0.00256)	(0.00256)	(0.00256)	(0.00256)	(0.00256)	(0.00256)
Sectors								
Hotel and restaurants	−0.321*							
	(0.175)							
Retail		−0.156						
		(0.0981)						
Construction			−0.227*					
			(0.133)					
IT				−0.0742				
				(0.305)				
Transport					−0.253			
					(0.211)			
Electronics						0.178		
						(0.352)		
Machinery and equipment							0.525***	
							(0.159)	
Fabricated metal products								0.181
								(0.134)
Constant	−1.199***	−1.192***	−1.180***	−1.230***	−1.219***	−1.230***	−1.244***	−1.236***
	(0.217)	(0.217)	(0.218)	(0.216)	(0.216)	(0.216)	(0.216)	(0.216)
Prob>chi2 (Hausman test)	0.0744	0.0719	0.0810	0.0735	0.0749	0.0779	0.0761	0.0762
Appropriate model	RE	RE	RE	RE	RE	RE	RE	RE
Observations	7,396	7,396	7,396	7,396	7,396	7,396	7,396	7,396
Number of firms	3,452	3,452	3,452	3,452	3,452	3,452	3,452	3,452

Source: Authors' calculations. Standard errors are in parentheses. *p<0.1, **p<0.05, ***p<0.01.

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Table 6. Empirical results: Atypical jobs and the impact of COVID-19 by firm region

Dependent variable: Firms that increased the number of temporary workers since the outbreak of COVID-19	(1)	(2)	(3)
Ln (age)	0.0458	0.0647	0.0794
	(0.112)	(0.111)	(0.112)
Ln (manager experience)	0.0707	0.153	0.147
	(0.108)	(0.109)	(0.109)
Top Manager Female	0.0599	0.179	0.127
	(0.164)	(0.165)	(0.164)
How Much of An Obstacle: Labor Regulations?	−0.300	−0.213	−0.237
	(0.207)	(0.206)	(0.206)
How Much of An Obstacle: An Inadequately Educated Workforce?	−0.500***	−0.395**	−0.409**
	(0.176)	(0.176)	(0.177)
Has this establishment received any national or local government measures issued?	−0.298**	−0.323**	−0.321**
	(0.133)	(0.132)	(0.132)
Adjustment policy: Has this establishment converted its production or services in response to COVID-19?	0.502***	0.480***	0.469***
	(0.132)	(0.131)	(0.131)
Stringency index	0.00404	−0.00803*	−0.00567
	(0.00427)	(0.00437)	(0.00442)
Africa	−0.426*		
	(0.241)		
MENA		0.732***	
		(0.166)	
EUROPE			−0.501***
			(0.158)
Constant	−3.744***	−3.920***	−3.476***
	(0.406)	(0.409)	(0.413)
Prob >chi² (Hausman test)	0.0797	0.1134	0.1021
Appropriate model	**Random effect (RE)**	**RE**	**RE**
Observations	7,396	7,396	7,396
Number of firms	3,452	3,452	3,452

Source: Authors' calculations. Standard errors are in parentheses.
*p<0.1, **p<0.05, ***p<0.01.

Table 7. Empirical results: Atypical jobs and the impact of COVID-19 by firm region

Dependent variable: Firms that decreased the number of temporary workers since the outbreak of COVID-19	(1)	(2)	(3)
Ln (age)	−0.0938	−0.0896	−0.109
	(0.0669)	(0.0669)	(0.0669)
Ln (manager experience)	−0.0681	−0.0544	−0.0916
	(0.0622)	(0.0622)	(0.0620)
Top Manager Female	0.0483	0.0806	0.0135
	(0.0988)	(0.100)	(0.0994)
How Much of An Obstacle: Labor Regulations?	0.185*	0.206*	0.158
	(0.109)	(0.110)	(0.109)
How Much of An Obstacle: An Inadequately Educated Workforce?	0.0461	0.0709	0.00765
	(0.0937)	(0.0945)	(0.0943)
Has this establishment received any national or local government measures issued?	0.0658	0.0593	0.0762
	(0.0752)	(0.0753)	(0.0753)
Adjustment policy: Has this establishment converted its production or services in response to COVID-19?	0.347***	0.345***	0.356***
	(0.0761)	(0.0761)	(0.0761)
Stringency index	−0.0175***	−0.0204***	−0.0137***
	(0.00292)	(0.00291)	(0.00285)
Africa	0.00478		
	(0.145)		
MENA		0.258**	
		(0.117)	
EUROPE			0.308***
			(0.110)
Constant	−1.232***	−1.274***	−1.436***
	(0.217)	(0.218)	(0.229)
Prob >chi2 (Hausman test)	0.0797	0.1134	0.1021
Appropriate model	**Random effect (RE)**	**RE**	**RE**
Observations	7,396	7,396	7,396
Number of firms	3,452	3,452	3,452

Source: Authors' calculations. Standard errors are in parentheses.
*p<0.1, **p<0.05, ***p<0.01.

ensuring employee job security. Furthermore, there was a statistically significant effect for the variable inadequacy between educational training and firms' labor force needs, highlighting the importance of investing in education and training programs that cater to the needs of the labor market. Furthermore, the variable "Has this establishment received government assistance to mitigate the impact of COVID-19?" significantly determined whether a firm

increased or decreased its temporary workforce during the pandemic. This finding suggests that policy measures implemented to support firms during the pandemic must be reevaluated to ensure that they effectively support firms in maintaining their temporary workforce. Our findings underscore the importance of a multifaceted approach to addressing the challenges firms and employees face during the COVID-19 pandemic.

4. Discussion

The challenges posed by an inadequately educated workforce and labor regulations were significant barriers to expanding atypical employment at the firm level during the COVID-19 pandemic. This finding indicates a critical misalignment between training and the specific needs of companies seeking a temporary workforce. Hayat *et al.* (2022) similarly explored the impact of the pandemic on skill development, finding a notable increase in online searches related to upgrading skills during lockdowns. This result suggests that individuals were keen to enhance their skills, potentially utilizing the extra time afforded by lockdowns to invest in their human capital. They emphasize the critical role of online educational platforms in facilitating this upskilling, establishing a positive relationship between their use and human capital development. In contrast, our findings suggest that despite the increased interest in skills development (Hayat *et al.*, 2022), the educational offerings may not have adequately aligned with the labor market's specific needs. This misalignment may have prevented the effective integration of newly acquired skills into atypical employment opportunities; therefore, while there was a clear desire for skill enhancement, the training available may not have fully addressed the practical demands of companies, particularly for temporary roles. This situation underscores the need for better alignment between educational programs and market needs to support the growth of atypical employment in times of crisis.

Furthermore, small firms significantly expanded their use of temporary workers during the COVID-19 pandemic. This trend likely stemmed from small firms facing stricter constraints from labor market regulations regarding standard jobs, leading them to depend more on temporary employment. While this strategy provided firms with greater flexibility in managing their workforce, it often comes at the cost of reduced employee job security. Pizzinelli & Shibata (2023) supported this observation, highlighting that effective labor market policies can mitigate the negative impacts of economic disruptions, such as those seen during the pandemic. They argued that addressing labor market mismatches and providing adequate support for workers could help reduce the adverse effects of fluctuations in temporary employment. The Danish model combines flexibility with strong security measures, illustrating how well-managed labor market strategies can stabilize employment dynamics and support workers during economic shifts. This strategy is particularly important for medium and large firms struggling with declining temporary roles without such measures. In contrast, medium- and large-sized firms experienced a decrease in their temporary workforce during the COVID-19 pandemic. This finding corroborates the results of Elouaourti & Ezzahid (2022), who observed that medium-sized firms are more adversely affected by crises than micro, small, and large firms. Unlike micro and small firms, which can adapt by operating informally, medium-sized firms lack this flexibility. Conversely, large firms often have the resources and political clout to mitigate such impacts, placing medium-sized firms at a distinct disadvantage during periods of economic downturn.

Our findings highlight an urgent need for policies addressing the gaps in education and training systems, especially concerning the skills necessary for unconventional and emerging job sectors. This finding highlights the gap between current educational offerings and the evolving demands of the workforce. This observation aligns with Krishnamoorthy & Keating (2021), who explored the repercussions of COVID-19 on higher education and its effects on workforce readiness. Their study revealed how the pandemic has intensified existing disparities in higher education and workforce preparedness, particularly by highlighting the inadequacy of traditional educational frameworks in equipping students with relevant skills. They argued that the pandemic intensified the misalignment between the skills supplied by both conventional and corporate educational institutions and the changing needs of the job market. In this regard, Pizzinelli & Shibata (2023) provided a valuable perspective on the labor market mismatch during the COVID-19 pandemic. Utilizing the framework developed by Şahin *et al.* (2014), their research focused on the US and the UK, determining a significant increase in labor market mismatch at the onset of the pandemic; however, this mismatch returned to pre-pandemic levels within a few months. This situation indicates that the pandemic did not induce a sustained structural shift that would cause considerable friction in the alignment between workers and firms. Consequently, the impact of the mismatch on employment was relatively minor and short-lived, especially when compared to the more enduring disruptions seen during the Global Financial Crisis (Blankenburg & Palma, 2009).

Policymakers must explore ways to help workers acquire new skills that will enable them to adapt to the evolving demands of the labor market. In addition, labor regulations

should be reassessed to ensure that they balance the need for workforce flexibility and employees' job security. The Danish model of "flexicurity" offers valuable insights into achieving this balance. Kreiner & Svarer (2022) illustrated that Denmark's success in combining flexible labor market policies with high-income security is underpinned by its comprehensive active labor market programs (ALMPs). ALMPs mitigate adverse selection and moral hazard issues associated with generous unemployment benefits. Their model demonstrated that flexible hiring and firing rules are crucial; however, they must be complemented by robust active labor market policies to be effective.

For small firms, policy measures could focus on alleviating the constraints that lead them to depend on temporary employment, such as providing incentives to encourage the creation of more permanent positions. Conversely, for medium- and large-sized firms, policies to enhance job security for temporary workers could help mitigate the adverse effects of the decline in temporary employment. Davoine (2023) underscored that the Danish flexicurity model balances low employment protection with generous unemployment insurance and ALMPs, providing a framework for supporting workers in transitions and mitigating unemployment risks. Their model suggests that enhancing job security for temporary workers, particularly in medium- and large-sized firms, could be beneficial. The emphasis on comprehensive activation programs and education within the Danish model highlights the potential for policies that improve job stability and support transitions, aligning with the need for measures that address temporary employment in larger firms.

Burchardt (2019) provided a historical context by explaining that the Danish model's success is built on a century of balancing employer and employee interests through collective agreements and a strong welfare state. This balance, achieved through negotiation and societal consensus, indicates that policies must adapt to economic conditions while protecting workers' rights. For medium- and large-sized firms, integrating job security measures for temporary workers within this framework could help manage the impacts of reduced temporary employment and align with broader labor market policies.

These studies highlight the importance of tailoring policies to different firm sizes, drawing on the Danish model's principles. By offering incentives for small firms to create permanent jobs and enhancing job security for temporary workers in larger firms, policymakers can address employment challenges more effectively. Incorporating comprehensive support measures and adapting to economic conditions will help balance workforce flexibility with job security, benefiting both employers and employees.

One of the key insights from the firm size estimates pertains to the adjustment strategies implemented in response to the COVID-19 crisis. The variable "Has this establishment adapted its production or services due to COVID-19?" shows a significant positive correlation with both dependent variables, indicating changes in the levels of temporary employment at the firm level, whether an increase or decrease, during the pandemic. This result confirms the Schumpeterian hypothesis of "destructive creation" insofar as in every crisis, there is "The dismantling of businesses, wealth, products, and careers, along with the rise of innovative business models and evolving job demands, represents the cost of advancement. Joseph Schumpeter referred to this process as "creative destruction" (Iqbal, 2015).

Regarding the government subsidies introduced to alleviate the impact of the COVID-19 health crisis on businesses, they did not help sustain temporary jobs at their pre-crisis levels. The impact of the pandemic crisis on businesses is undeniable, as it has led to a significant increase in costs while limiting the availability of resources. When the survival period of businesses is very short, rapid government intervention is vital to mitigate the adverse effects of the economic shock and improve their resilience and performance (Ndiaye *et al*., 2018). Moreover, the literature emphasizes the importance of government support for the performance and resilience of businesses; however, this support is especially crucial during times of crisis (Sheng *et al*., 2011; Wei & Liu, 2015). Nonetheless, it is challenging to isolate the effects of government support on businesses during periods of general economic adversity. Some studies have used simulations to address this difficulty. For example, a study by the OECD (2020b) on a sample of European businesses compared the proportion of businesses that would become illiquid in the absence or presence of government support measures. The results show that 20% of businesses would be declared illiquid without support measures after just 1 month, 30% after 2 months, and 38% after 3 months. In contrast, with support measures, the proportion of businesses facing bankruptcy could be reduced from 30% to 10% after 2 months of lockdown.

Another study conducted by Gourinchas *et al*. (2020) measured the impact of the COVID-19 crisis on business shutdowns in 17 countries. The results revealed that the proportion of businesses facing bankruptcy after 1 year without liquidity injection or government support was 12.1% on average, compared to 4.5% before the COVID-19 pandemic. In Morocco, a survey conducted by the High

Commission for Planning and the General Confederation of Moroccan Enterprises in 2020 estimated that nearly 1.6 million jobs were at risk due to the lockdown, while the national economy lost 432,000 jobs. This difference highlights the importance of government measures implemented at the beginning of the pandemic, which helped preserve approximately 73% of at-risk jobs. A survey conducted by the African Development Bank and the International Labor Organization (ILO) in 2021 on 350 formal businesses and informal micro-enterprises showed that the mitigation measures helped preserve 71% of the jobs directly threatened by the lockdown.

Furthermore, labor market regulations and the mismatch between the education system and firms' labor force needs are key factors influencing the reduction of temporary labor at the firm level. In addition, as the firm's age and the experience of its top manager increase, the likelihood of a reduction in atypical employment decreases; however, this result is not statistically significant. Hansen (1992) and Mazzarol *et al*. (2010) found a positive relationship between firm age and the adoption of innovation among small- and medium-sized enterprises (SMEs). They argue that as SMEs mature, they develop greater absorptive and organizational learning capabilities, enabling them to implement more effective innovation-driven strategies. This accumulated experience and knowledge allows older firms to adapt more readily to changing market conditions, potentially reducing the need for atypical employment as they become more stable and capable of managing their workforce efficiently. This finding aligns with the resource-based view of the firm, as proposed by Wernerfelt (1984), which posits that firms accumulate valuable resources and capabilities over time, contributing to their competitive advantage. Older firms will likely have developed a wealth of knowledge, networks, and experience, which can facilitate innovation adoption as a resilience strategy. This accumulation of resources may lead to a more stable and consistent workforce structure, with less reliance on atypical employment forms.

Furthermore, Jones & Coviello (2005) emphasized the role of entrepreneurial orientation in driving innovation and adaptation among small firms. They suggest that older firms may exhibit a stronger entrepreneurial orientation and be willing to take risks and explore new opportunities. This orientation can encourage the firm to invest in long-term strategic initiatives rather than relying on atypical employment, which may be seen as a more short-term or flexible solution. Older firms with more experienced leadership tend to develop greater stability and resilience. This may reduce the necessity for atypical employment as they leverage their accumulated resources and capabilities to maintain a steady workforce and pursue innovation-driven growth strategies.

Regarding sectoral variations in temporary labor force levels, hotel, restaurant, retail, IT, transport, and machinery and equipment firms were less likely to increase their temporary workforce during COVID-19. The pandemic has disproportionately impacted the hospitality industry, highlighting key workforce vulnerabilities such as workplace safety, skill gaps, technology adoption, and work reorganization (Huang *et al*., 2021). The tourism and hospitality sectors experienced substantial losses, with projected permanent layoffs of up to 24% of COVID-19-induced job losses (Foote, 2004; Huang *et al*., 2021). This situation has had significant spillover effects on other industries and occupations beyond tourism (Pham *et al*., 2021); however, firms in the construction sector experienced a notable increase in their temporary workforce levels, unlike those in other sectors.

Firms that reduced their temporary labor force during the COVID-19 pandemic were primarily in the machinery and equipment, electronics, and fabricated metal products sectors. Conversely, the construction sector was less likely to reduce its temporary workforce. This result can be discussed in the context of the study by Pamidimukkala & Kermanshachi (2021), which examined the impact of the COVID-19 pandemic on the construction industry. Pamidimukkala & Kermanshachi (2021) identified several health and safety challenges faced by construction workers during the pandemic, including a lack of safe working environments, heavy workloads, and concerns about job stability. These factors contributed to heightened anxiety and stress among workers, necessitating the implementation of robust management strategies to ensure their well-being. The study highlighted the need to maintain a safe distance between workers, provide sanitizers and washing stations, and leverage effective technologies to enhance workplace safety and productivity. In this context, the increase in temporary employment in the construction sector could be linked to the industry's response to these challenges. The need for flexibility in managing fluctuating workloads and ensuring compliance with safety protocols may have led firms to rely more on temporary workers. This approach allows firms to adjust their workforce size in response to project demands and health and safety requirements, providing adaptability that permanent staff structures might not offer. Moreover, the construction sector's reliance on temporary labor could be influenced by the uncertainty surrounding job stability, as Pamidimukkala & Kermanshachi (2021) noted. Firms may prefer temporary contracts to manage financial risks and maintain flexibility in an unpredictable economic environment; however, this

reliance on temporary employment could exacerbate job security and worker mental health issues, highlighting the need for comprehensive safety and support measures.

Contrary to expectations, sectors such as hotels and restaurants, retail, IT, and transport did not experience the anticipated reduction in their temporary labor force. This outcome was surprising, given the assumption that companies in these sectors would be more inclined to cut temporary positions. Maria del Rio-Chanona *et al.* (2020) identified significant supply and demand shocks across various sectors due to the pandemic. They found that sectors like transport were likely to be constrained by demand shocks, while manufacturing, mining, and services industries were more affected by supply shocks. The entertainment, restaurant, and tourism sectors were particularly vulnerable and faced substantial shocks on the supply and demand sides. At the occupational level, they noted that high-wage occupations were relatively insulated from these shocks, whereas low-wage occupations were more susceptible. The observed result, where some sectors did not reduce their temporary labor force, is striking, given the expected downturns in these industries. Several factors may explain this outcome in the case of hotels and restaurants, retail, IT, and transport. For instance, the initial expectations of a reduction in the temporary workforce could have been based on the anticipated severe disruptions; however, these sectors might have adapted by shifting toward more flexible work arrangements, such as remote work in IT or e-commerce solutions in retail. Such actions could have helped these sectors maintain or even increase their reliance on temporary labor to manage fluctuating demands and operational changes.

Furthermore, the demand for certain services, such as IT support for remote work infrastructure or increased online retail, may have offset the expected reductions. While facing reduced demand for passenger services, the transport sector might have seen increased logistics and delivery services activity, again necessitating a temporary workforce. The complexity and dynamism of these industries, coupled with the initial uncertainty surrounding the pandemic's impact, could have led firms to maintain a flexible labor force to adapt to changing conditions quickly. This outcome highlights the nuanced nature of economic shocks and the importance of sector-specific dynamics in determining labor market outcomes. Broad trends can indicate general vulnerabilities; however, individual sector responses can vary significantly based on a range of factors, including the ability to pivot business models, the critical nature of services provided, and the overall adaptability of the workforce.

Our regional analysis highlights the varying effects of COVID-19 on atypical employment across different areas. The findings indicate that MENA countries have seen a notable rise in temporary employment during the pandemic. Conversely, firms in Africa and Europe experienced a reduction in their temporary workforce throughout COVID-19. The actions of public authorities varied across regions during the pandemic, influencing the resilience of businesses in each area. In Asia, governments quickly implemented strict measures, including quarantines and travel restrictions, along with rapid economic support measures such as subsidies and preferential loans, which helped businesses maintain operations and liquidity. Similarly, although lockdown measures were implemented later in Europe, governments launched massive financial support programs for affected businesses. In contrast, North America's response to lockdowns and economic policies varied by state, creating uneven business conditions. Economic support programs were available but sometimes challenging for some businesses. In Latin America and Africa, governments faced greater difficulties in providing adequate economic support for businesses due to less developed economic and institutional systems, which influenced the resilience of businesses in each region (Karam *et al.*, 2022; WHO's Annual Report, 2021).

4.1. Policy recommendations

Our study highlights the urgent need to address the mismatch between workforce education and the skills required for atypical jobs, particularly during crises like the COVID-19 pandemic (Ibourk, 2021; Ibourk & Elouaourti, 2023; Krishnamoorthy & Keating, 2021; Pizzinelli & Shibata, 2023). Governments and educational institutions should collaborate to develop and expand vocational and technical training programs to enhance workforce resilience (Soomro *et al.*, 2022) and ensure alignment with industry needs (ILO and The World Bank, 2021). These programs must be closely aligned with the evolving industry demands. In addition, firms should implement continuous professional development programs that enable employees to upskill and reskill, ensuring they remain adaptable to changing job requirements.

Labor market regulations significantly impact the dynamics of temporary employment during pandemics (Dütsch, 2022). Policymakers should streamline labor market regulations to balance workforce flexibility with job security, allowing for more flexibility in employment contracts, especially during crises (Davoine, 2023). Ensuring adequate job security measures is crucial. For small firms, targeted policy measures are essential to reduce regulatory constraints, enabling them to create more

permanent jobs rather than relying heavily on temporary employment (Burchardt, 2019; Kreiner & Svarer, 2022).

The positive correlation between firms converting their production or services in response to COVID-19 and the level of temporary employment underscores the importance of innovation (Nunes *et al*., 2023; Osuna & García Pérez, 2022). Governments should support business transformation by providing financial incentives, such as tax breaks or grants, to firms that innovate and adapt their business models to meet new market demands. In addition, incentivizing research and development activities will enable firms to explore new products, services, and operational strategies, promoting long-term growth and employment stability (Fasano *et al*., 2022; Turkson *et al*., 2021).

Given the distinct impact of COVID-19 on atypical employment across different regions, adopting region-specific policy measures is critical. Policymakers should streamline labor market regulations in regions with stricter policies to allow for greater employment flexibility during crises, ensuring that firms can adapt to fluctuating labor demands. Developing region-specific education and training programs that address the unique needs of local industries will bridge the skills gap and enhance workforce readiness (Herod *et al*., 2022).

The study also highlights the need to reassess government subsidies and assistance programs to support firms during crises (Lalinsky & Pál, 2022). It is essential to design targeted subsidies and financial assistance programs that specifically address firms' needs for maintaining their workforce. These programs should focus on both temporary and permanent employment. Continuously evaluating the impact of government assistance programs and adjusting them based on feedback from businesses and labor market trends will ensure that they provide meaningful support in maintaining employment levels (Liouaeddine *et al*., 2024).

Firms should invest in comprehensive human resource development strategies to build a more resilient workforce capable of navigating future crises. Implementing programs focusing on employee well-being and mental health is crucial (Al-Jubari *et al*., 2022), as a supportive work environment enhances productivity and job satisfaction. Developing clear career paths and opportunities for advancement within firms will provide employees with a sense of stability and long-term growth prospects (Chen *et al*., 2022).

Finally, firms should prepare themselves for a pandemic-like occurrence through special scenario planning (Rawson & Stevens, 2023). This approach involves developing contingency plans that address potential disruptions and ensuring that they have the flexibility to adapt their operations quickly. By implementing these recommendations, policymakers and businesses can create a more resilient labor market better equipped to handle future crises, ensuring workforce flexibility and job security.

5. Conclusion

This paper investigated the impact of the COVID-19 health crisis on contingent/atypical employment. For this purpose, we mobilized a firm-level database of 12,193 firms from 19 countries. A dynamic logit model was used as the empirical methodology.

Atypical workers were among the most impacted segments of the population by the COVID-19 health crisis. Our empirical results showed that an inadequately educated workforce and labor regulations were the main factors that hindered the increase in atypical employment levels at the firm level during the COVID-19 pandemic. Results by firm size showed that small firms raised the probability of increasing the level of the temporary labor force, as opposed to medium- and large-sized firms.

Furthermore, results by sector of activity showed that, except for firms operating in the construction sector, firms belonging to other sectors (hotel and restaurants, retail, IT, transport, machinery, and equipment sectors, etc.) were less inclined to increase their temporary workforce. However, this is not the case for firms operating in the construction sector, which is the only sector that has seen a significant increase in the temporary workforce of its firms.

Furthermore, the firm's geographical location is a key determinant of the increase/decrease in the firm's temporary workforce. The firms in Africa and Europe experienced a decline in their temporary workforce, unlike those in the MENA region, which experienced an increase in the temporary workforce during the COVID-19 crisis.

Finally, national or local government measures issued to firms failed to mitigate the impact of the COVID-19 health crisis on the contingent worker segment. Regarding the empirical verification of the Schumpeterian hypothesis of "creative destruction," the latter is confirmed insofar as the variable "has this establishment converted its production or services in response to COVID-19" is statistically positively correlated with our two dependent variables. In other words, the adjustment policies implemented at the firm level in our sample destroyed old temporary jobs in these firms, but these adjustment measures created new needs in the temporary labor force for the firms.

Our study contributes to the literature on the impact of the COVID-19 pandemic on atypical employment,

which has received limited attention to date. The firm-level database used in this study provides a comprehensive understanding of the issue, highlighting the specific factors that hinder or promote the increase in atypical employment levels during the pandemic. Future research might include case studies of firms that did not have as negative experiences as their peer-firms and showcase what the "better" firms did that resulted in the more-positive results.

The study's policy implications emphasize the need for policymakers to address the inadequacy of education and training for the workforce, balance labor regulations between workforce flexibility and job security, and incentivize firms to innovate and adapt to the new economic landscape. Specifically, policies should be targeted toward small firms to reduce constraints on their reliance on temporary employment, while policies for medium- and large-sized firms should focus on increasing job security for temporary workers. Furthermore, investments in education and training programs can help workers acquire the skills and qualifications needed for more stable, long-term employment. Finally, policymakers should consider providing support and resources for firms to develop new business models and strategies that will enable them to weather the effects of the pandemic while offering tax breaks or financial incentives to firms that create new jobs or convert their operations to meet new demands. Governments and policymakers should design policies that promote hiring atypical workers during a crisis while improving their working conditions and wages.

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Author contributions

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Investigation: All authors
Methodology: All authors
Writing–original draft: All authors
Writing– review & editing: All authors

Ethics approval and consent to participate

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RESEARCH ARTICLE

Therapeutic cultural resilience perspectives during the COVID-19 pandemic: An ethnographic qualitative study of Faisalabad, Pakistan

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Abstract

Collective trauma is instigated on a wide scale by warfare, poverty, natural disasters, or global health crises such as the COVID-19 pandemic. For instance, natural disasters have a significant impact on the social fabrics of communities. This fallout can cause long-term social support networks to disintegrate, especially when combined with a high level of risk. In Faisalabad, Pakistan, COVID-19-induced collective trauma resulted in social and cultural upheavals, particularly in the initial phase of uncertainty when no effective medical interventions were indicated. At the community level, such difficulties were overcome through traditional cultural resilience. In this regard, cultural folk practices are generated and modified to comprehend and navigate challenging circumstances. Thus, this study investigates how community awareness and treatment alternatives during the COVID-19 pandemic were rooted in traditional and folk knowledge. Specifically, we conducted an ethnographic investigation to determine how individuals endured the pandemic during the first wave in 2020. The primary qualitative investigation revealed various aspects, including how religion influenced societal attitudes and provided individuals with the resilience to cope with the crisis. In addition, a number of cultural perspectives that emerged during the initial COVID-19 breakout and subsequent lockdown phase were investigated. Meanwhile, our empirical investigation considered therapeutic stances, such as herbal remedies, natural therapy methods, and traditional beliefs, on the socially constructed nature of illness. Overall, such therapeutic cultural resilience enhanced the emotional well-being, sense of personal power, and self-awareness of individuals in this community.

Keywords: Therapeutic cultural resilience; Cultural perceptions; Natural healing methods; Spiritual healing; Home remedies; COVID-19

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1. Introduction

The COVID-19 pandemic, recognized as a collective trauma, resulted in significant social and cultural disruptions, especially during the early phases when effective treatments or preventive measures were not yet accessible. During such uncertainty, communities in

Pakistan, such as Faisalabad, relied on traditional beliefs and practices, acting as a form of cultural resilience. Thus, this study examines the community's understanding of COVID-19 and the significance of traditional healing practices, such as herbal remedies, spiritual healing, and folk knowledge, in promoting resilience. For this purpose, it employs a qualitative ethnographic approach to investigate the complex relationships among health, culture, and survival, highlighting the strategies that the community implemented to deal with the challenges of the pandemic.

As of February 28, 2024, Pakistan (the fifth-most populous nation) reported a total of 30,664 deaths attributed to COVID-19. However, due to underreporting, it is likely that this number is significantly higher (Nasir *et al*., 2024). Among the general population, people aged 60 years and above encountered the greatest risk of serious illness or mortality. The virus also underscored significant socioeconomic disparities, rendering individuals in poverty more susceptible. This was due to restricted access to healthcare and preventive measures, and the challenges of maintaining social distance. In communities with limited healthcare infrastructure, traditional healing practices were essential in offering both physical and psychological support, especially when formal medical services were unavailable.

Collective trauma, generally arising from war, poverty, natural disasters, or global health crises, such as COVID-19, has long-lasting impacts on societies (Mukhtar, 2021). In Pakistan, the impacts extended beyond the physical consequences of the virus and significantly affected the social structures that kept communities together. Natural disasters, regardless of their origin, can significantly disrupt the social fabrics of communities, leading to extended interruptions of social services and the breakdown of support networks (Magruder *et al*., 2017). In these situations, established systems of care, spiritual practices, and family dynamics often serve as vital mechanisms for maintaining social cohesion and resilience.

The notion of cultural resilience provides an analytical perspective on how Pakistani communities navigated the challenges of the pandemic. In this regard, folk practices, religious rituals, and traditional methods emerged as important strategies for addressing the uncertainty brought about by COVID-19 (Ali, 2022). As for the concept of resilience, it embodies a strategic method for addressing certain challenges and is a vital characteristic that allows both individuals and communities to recover and adapt (Strand & Peacock, 2003). In Pakistan, cultural resilience during the pandemic demonstrated how communities adapted by integrating traditional knowledge systems with contemporary health practices. Such adaptation functioned as a strategy for survival and a means of strengthening cultural identity and continuity during such a disruptive period. (Magruder *et al*., 2017; Iftikhar, 2018; Lam *et al*., 2021)

Although initial efforts to address the pandemic mainly focused on understanding the virus's transmission, prevalence, and fatality rates, there was a notable lack of emphasis on how cultures adjusted to the crisis and how the states of emergency impacted the social lives of the population (Akhter *et al*., 2022). Nevertheless, the pandemic underscored how cultural practices and social structures can enhance a community's response or expose its vulnerabilities, depending on the activation of these practices. In this regard, ethnographic research is essential for understanding the lived experiences of individuals within their cultural frameworks and highlighting how they navigated the intersections of tradition, trauma, and survival during the pandemic. Meanwhile, by focusing on the connection between traditional healing, collective trauma, socioeconomic disparities, and cultural resilience (Strand & Peacock, 2003), it can reveal the complex nature of the crisis, particularly in Faisalabad, Pakistan. Thus, the present study analyzes the community's response to the pandemic through an ethnographic perspective, emphasizing the adaptive strategies utilized to withstand and recover from the significant disruptions. The findings emphasize the importance of integrating cultural and social dynamics into public health strategies, especially in times of crisis, to create a more thorough and culturally sensitive approach to disaster management.

Understanding the responses of communities to COVID-19 is just as important as comprehending the biological and epidemiological aspects of the pandemic. This information can be especially helpful for guiding preventive and control strategies (Ali, 2022). Pakistan has a notable history of investigating the viewpoints of local communities on disease, treatment, and care-seeking behaviors, particularly in relation to diarrheal illnesses (Rabbani *et al*., 2021), influenza (Aslam *et al*., 2020), malaria (Soofi *et al*., 2019), and Ebola and dengue infections (Iftikhar, 2018; Li *et al*., 2018). However, there has been insufficient focus on the sociocultural dynamics of COVID-19 in the country, especially through ethnographic research or comprehensive studies.

The impact of culture on health is significant, since it shapes individuals' perceptions of illness, their approach to treatment, and their responses to medical interventions. Meanwhile, examining emerging diseases and pandemics requires a comprehensive analysis of cultural beliefs and their influence on symptom recognition, healthcare delivery, treatment accessibility, and stigma perception.

Previous research has shown that each culture includes unique beliefs about the origins of health and illness (Turan, Bostan, & Demir, 2022a:2022b). Hence, interventions must be culturally relevant to ensure a community's understanding, participation, and compliance with public health measures (Shaikh & Hatcher, 2005). Moreover, an in-depth evaluation of the impact of culture on health is essential for avoiding the misattribution of illnesses to erroneous cultural factors (Bruns *et al*., 2020).

Hence, this study also examines the role of societal traditions, specifically cultural healing practices and folk knowledge regarding illness, in enhancing the resilience of social structures during traumatic events such as the COVID-19 pandemic. By employing Kleinman's cultural explanatory model (Kleinman, 1980), we analyze the interpretations of COVID-19 within Faisalabad and determine how they influenced care-seeking behaviors in the context of illness. This approach provides valuable insights into the wider sociocultural changes brought about by the pandemic and the methods employed by the community to uphold social well-being.

The research questions are as follows: (1) what is the perception of natural and spiritual healing practices in the context of COVID-19?; (2) what are the fundamental cultural interpretations of the virus's existence?; and 3) what cultural resilience practices have been developed in response to COVID-19? This discussion centers on the relationship between spiritual healing and natural remedies, alongside the community's cultural interpretations of COVID-19, to highlight the role of cultural resilience in addressing the uncertainties and effects of the virus.

1.1. Conceptual construction of "cultural resilience"

Resilience has been defined as the ability to achieve positive outcomes in high-risk situations, maintain competence under certain threats, and recover from trauma (Clauss-Ehlers, 2004; Southwick *et al*., 2014). As for cultural resilience, it refers to how the cultural heritage of individuals/communities, including their language, habits, traditions, and values, enables them to overcome adversity. In other words, this suggests that individuals/groups can overcome adversity by drawing on their own distinctive attributes as well as the support of larger sociocultural factors. Meanwhile, Clauss-Ehlers (2008) defined "culturally focused resilient adaptation" as a dynamic process that considers an individual's values, cultural heritage, and supportive aspects of his/her sociocultural surroundings. Thus, examining previous research on resilience can provide a basis for comprehending the current trend of resilience within a broader sociocultural framework (Southwick *et al*., 2014).

Recently, resilience research has shifted from solely defining individual traits to emphasizing the intricate relationships between individuals and their ever-changing personal, community, and cultural environments. In this regard, resilience encompasses both neurological and cultural factors, with the former including genetic factors, epigenetics, stress-response systems, the immune system, and brain circuitry, and the latter consisting of shared belief systems and accepted beneficial adjustments. Importantly, deliberate practice on the part of the individual and evidence-based interventions has an impact on resilience. To provide a better understanding of how people react to a crisis under cultural contexts, we use the COVID-19 outbreak as a case study (Kaye-Kauderer *et al*., 2021).

The COVID-19 pandemic has demonstrated that exclusively depending on our biological properties is insufficient for the efficient control of diseases. As stated earlier, resilience refers to the capacity to successfully adjust and optimize one's circumstances in the face of certain challenges. This capacity encompasses both internal elements, such as personal experiences and behavioral habits, and external variables such as orchestrating collective endeavors to overcome risky situations. However, previous studies have primarily focused on social resilience as an external issue, neglecting the significance of culture as a separate component of identity. Thus, this research emphasizes the significance of understanding cultural resilience in relation to therapeutic beliefs and determines how culture can provide opportunities to address previously unknown diseases from traditional healing perspectives (Baskin & Bartlett, 2021).

2. Data and methods

This exploratory study aims to gain a deeper understanding of how COVID-19 influenced Pakistani society and how ordinary individuals responded to the crisis. Specifically, this research examines the factors that affected the experiences of survivors, families, community members, and care providers during the pandemic in Faisalabad, based on the "what," "how," and "why" of their responses (Vindrola-Padros *et al*., 2020).

This study also uses a qualitative approach that focuses on the comprehensive explanations of certain occurrences (Lincoln & Guba, 1985). In addition, it employs an ethnographic design, which collects data from various sources about a single social phenomenon in a given cultural context and timeframe (Cruz & Higginbottom, 2013; Richards *et al*., 2012). This design was chosen because it is effective for obtaining specific data from various viewpoints within a greater focus of enquiry (Richards & Morse, 2012). In this case, the data focused on disruptions

and cultural resilience during the traumatic first wave of the COVID-19 outbreak (Farooq & Quadri, 2020).

As the third-largest city in Pakistan, Faisalabad is located in the middle Punjab area. Often referred to as the "Manchester of Pakistan," the city features an established textile industry, with a population of more than 3.2 million (Pakistan Bureau of Statistics, 2017). The city also functions as an essential industrial hub, while exhibiting urban-rural disparities that greatly influence social behaviors and access to healthcare services.

The Majhi dialect of Punjabi is the primary language in Faisalabad, while Urdu is the national language commonly used in educational and professional settings. Meanwhile, English is extensively utilized in corporate and formal environments (Shackle, 1976). As for the city's healthcare infrastructure, it includes notable government hospitals, such as Allied Hospital, the Faisalabad Institute of Cardiology, and District Headquarters (DHQ) Hospital, along with a wide range of private facilities. Nevertheless, the healthcare system faces ongoing challenges, especially in the provision of services to low-income populations. During the COVID-19 pandemic, Faisalabad experienced significant difficulties, due to the scarcity of healthcare facilities (with intensive care units at full capacity), limited essential supplies, and insufficient testing. The socioeconomic impact of the pandemic also heightened vulnerabilities, especially among the underprivileged, highlighting the difficulties of healthcare access in this growing urban area (Nasir *et al.*, 2024).

2.1. Data collection and sampling methods

In this study, this researcher employed purposive random sampling to select the interlocutors from Faisalabad, whose insights regarding COVID-19 served as the primary data source. The data collection process was carried out in two distinct phases: (1) the initial phase, which was entirely conducted online, due to the lockdowns of the pandemic; and (2) the second phase, which involved in-person focus group discussions after the restrictions were eased. The details of each phase are as follows.

The initial phase, which occurred from February 2020 to October 2020, included 321 online interviews, which was a necessary adaptation due to the COVID-19 restrictions and lockdown measures in place. Before conducting the interviews, a preliminary survey was distributed, after which online discussions were recorded. Subsequently, invitations for interviews were issued to the individuals who expressed an interest in participating. Initially, we reached code saturation with 56 interviews, but additional interviews were conducted to obtain a more comprehensive understanding of the participants' perspectives.

The second phase began with the easing of lockdown restrictions in Pakistan from May to October 2020. During this period, in-person focus group discussions were conducted to deepen the insights obtained from the online interviews. A total of three focus group discussions, each consisting of seven to nine participants, were conducted, allowing the opportunity to explore the participants' perspectives in a face-to-face setting.

Data collection predominantly occurred in Punjabi and Urdu, the primary languages in Faisalabad. This researcher (proficient in both languages) transcribed the interviews into English for analysis. The quantitative data were analyzed using Excel to ascertain the frequency distribution, while qualitative data were systematically organized into thematic categories for a more comprehensive analysis (Table 1). In addition, succinct dialogic story vignettes were created to illustrate how the participants responded to COVID-19, emphasizing the interplay between reasoning, beliefs, facts, rumors, conspiracy theories, debates, and religious perspectives within the context of the pandemic.

Table 1. Demographic attributes of the participants

Characteristics	Percentage (N=321)
Age	
15 – 25 years	46
25 – 35 years	37
35 – 45 years	10
Above 45 years	7
Gender	
Male	51
Female	49
Household monthly income	
<20,000 PKR/89.7 US$	32
20,000 – 40,000 PKR/89.178.14 US$	21
40,000 – 60,000 PKR/178.14 – 267.21 US$	13
Above 60,000 PKR/267.21 US$	34
Family structure	
Nuclear	49
Joint	51
Household location	
City	66
Town	6
Village	28
Education	
More than 16 years of education	18
16 years of education	57
14 years of education	13
12 years of education	7
10 years of education	3
<10 years of education	2

2.2. Data analysis

This researcher thoroughly examined all the written responses to find significant assertions made by the participants. Subsequently, the responses were systematically arranged and categorized using appropriate labels that accurately represented the responses. During this coding process, this researcher manually identified the commonalities and contrasts evident in the texts. Overall, the interview data revealed four primary themes and several sub-themes, which are shown in Figure 1. In this regard, the two most important concerns included: (1) understanding the sickness itself; and (2) preventative measures and support for public health initiatives.

Overall, the majority of the respondents disagreed that COVID-19 was an infectious disease. Instead, we found culturally created ideas regarding the disease's origin such as the assumption that wealthy, evil individuals are more likely to get the virus than poor people, or that the virus came into the world as an act of retribution from God to punish sinners.

The participants also expressed their opposition to the lockdowns, due to the significant economic challenges that they anticipated. In particular, the interviewees shared their apprehension regarding the potential threat of hunger, which they believed posed a greater threat to their lives than the sickness itself. Meanwhile, the participants preferred engaging in prayer, as a means of seeking deliverance from the affliction, in contrast to adopting practices such as wearing masks, avoiding eye contact, and adhering to stay-at-home measures. They also preferred self-care remedies and expressed reluctance to seek medical attention at hospitals, primarily due to their inherent distrust of such institutions.

2.3. Ethical permissions

n receiving assurances on the protection of their data in terms of privacy, confidentiality, and anonymity, all the participants duly completed and signed the informed consent forms in compliance with internationally recognized standards. Specifically, the researchers made a deliberate effort to employ vocabulary and phrases that were relevant to the specific local context and culture. This was to ensure that the participants were able to make well-informed decisions about their involvement in the study. Moreover, to be eligible for inclusion, the participants were required to provide explicit confirmation of their voluntary participation and acknowledge that their involvement was not obligatory.

3. Results

Narratives are commonly constructed and modified to comprehend situations that are characterized by ambiguity and difficulty. They also serve an indication of the gravity of the issue at hand. Numerous narratives have been collected from the occurrences of natural disasters, armed conflicts, epidemics, and pandemics such as COVID-19. Regarding the latter, as the number of COVID-19 reports increased, a corresponding rise in conspiracy theories emerged

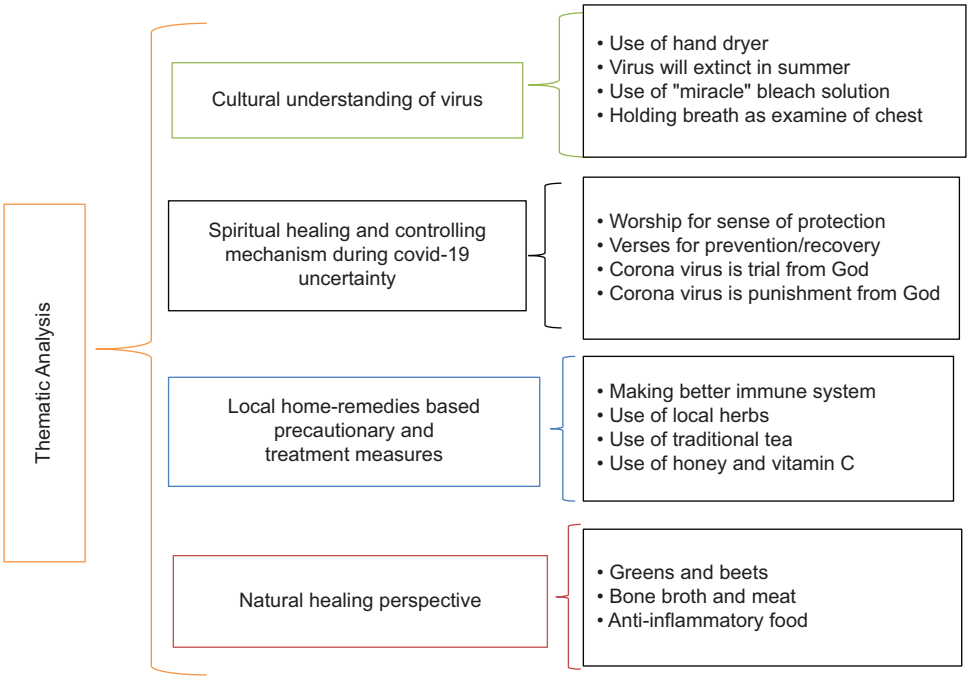

Figure 1. Map outlining the study's major themes (image created by the authors)

(Ali, 2020). Specifically, numerous ideas were propagated regarding the genesis of the virus, including the possibility of it being a bioweapon intentionally produced by either the Chinese or American governments, with the intent of engaging in hostilities against one another (Myers, 2020). Meanwhile, others focused on prevention and treatment, based on the perception that standard clinical care could not be trusted and that individuals should use alternative treatments to combat the infection (Garcia, 2020).

It is not surprising that conspiracy theories flourished during this period. According to previous research, since individuals feel driven to explain massive occurrences with comparably massive reasoning (Leman & Cinnirella, 2007), they are more likely to believe in conspiracy theories against the backdrop of pivotal moments (Mccauley & Jacques, 1979) and significant crises (Van Prooijen & Douglas, 2017). The possible reason for this is that individuals tend to be drawn to conspiracy theories when their basic psychological needs are not satisfied (Graeupner & Coman, 2017).

3.1. Community perceptions about the existence of COVID-19

This study relied on a wide range of contradictory stories that appeared across Pakistan, particularly in suburban areas, with anonymous and untraceable sources. These rumors were not unique because there have always been rumors and conspiracies involving the transmission of harmful diseases. In this case, we specifically analyze five distinct narratives that were popular in Pakistan during the first wave of COVID-19.

Regarding the presence of COVID-19, there were mixed responses. Some people were intrigued by the news, while others assumed that it was a hoax. The dissemination of information suggesting that the virus was either a hoax or a form of propaganda rapidly proliferated across the country, thereby undermining the efforts of governmental and other institutional bodies aimed at containing its transmission. Meanwhile, less educated people did not consider the virus as a dangerous disease, but rather as a common cold/seasonal flu. As a result, they avoided taking any countermeasures. In other words, they treated this sickness as a normal affair and were unwilling to acknowledge its severity. For example, a 29-year-old woman working as a domestic maid in a local neighborhood stated:

The virus is no more dangerous than a common cold. Flu and colds are common occurrences throughout the changing seasons each year. It is those with advanced degrees who give new titles to the same illness to gain attention and fame.

Hot air inhibits the growth of viruses, which decay quickly and render surfaces clean. Most homes have a hair dryer, which is an inexpensive and frequently used appliance. The surfaces of common objects can be sterilized by its hot blower. To clean products that were acquired from the market, people have been using hot blowers.

Similarly, a 46-year-old woman working in a local fabric manufacturing factory stated:

Hand dryers have the capacity to effectively eradicate the virus. Previously, I held the belief that the sterilization procedure employed at our workplace during the manufacturing process engenders trust in the quality of our products. The potential efficacy of hot air in eradicating germs raises the question of its applicability in combating the current viral infection.

During the initial stages of COVID-19 transmission, there was a prevailing belief that the virus would not be able to survive in the hot summer season in Pakistan, due to its extended duration and high intensity. There was also the expectation that the virus would see a decline as the seasons changed and that exposure to sunlight would contribute to its eradication. For instance, a 38-year-old merchant selling cotton candy at the local market claimed:

It has been postulated that the virus may potentially undergo extinction during the summer season. It is plausible to assert that this statement holds validity since the elevated temperatures experienced during the summer season within our locality possess the potential to cause harm or even fatality to individuals.

Meanwhile, ascorbic acid, commonly referred to as "Vitamin C," was prescribed by several of the local doctors. This is because it is widely believed that it strengthens the immune system, which, in turn, helps fight off sickness. For example, a 47-year-old man working with a pharmaceutical distribution service claimed:

Vitamin C can help you fight against the virus. Our community is made up of poor individuals who do not prioritize meeting their nutritional needs. As a result, they are susceptible to becoming rapidly ill. Vitamin C pills are inexpensive and easy to obtain to increase immunity.

In this regard, numerous studies have established a correlation between the anti-inflammatory, antioxidant, anticoagulant, and immunomodulatory activities of Vitamin C. Several studies have revealed that individuals diagnosed with sepsis and pneumonia tend to exhibit elevated levels of oxidative stress and reduced ascorbic acid levels. However, some evidence suggests that the administration of Vitamin C to patients diagnosed with pneumonia may reduce the severity of their symptoms and the duration of the illness. As for patients diagnosed with sepsis, receiving intravenous vitamin measurements has

been shown to standardize plasma levels (Shahbaz *et al*., 2022).

According to a claim on social media, American novelist Dean Koontz foresaw the COVID-19 pandemic in his 1981 book *The Eyes of Darkness*. As of February 27, 2020, tweets with the book cover and the page where Koontz discusses the virus had at least 39,000 shares and at least 2,000 retweets. Despite its dissemination, the claim that the virus was created in a laboratory was false. Instead, a Wuhan food market, where animals were being illegally sold, was where the infection is said to have started. Health professionals also believe that it may have originated in bats before moving on to people, most likely through another species (Hossain, 2021).

Amidst the proliferation of misinformation on social media platforms, a self-assessment tool for COVID-19 emerged on *Facebook*, *Instagram*, *Twitter*, and *WhatsApp*. Specifically, there was a widely shared *Facebook* post-suggesting that individuals can assess their daily COVID-19 status by attempting to hold their breath for duration of 10 s. Completing the task without encountering any sensations of discomfort, stiffness, tightness, coughing, or similar symptoms supposedly indicated the absence of COVID-19.

However, despite extensive research on this subject, the definition of misinformation remains a complex and enigmatic concept. For example, Vraga *et al*. (2020) simply defined the term "misinformation" as information that, based on the best available evidence from relevant experts, is considered incorrect, while Del Vicario *et al*. (2016) stated that the alignment of misinformation with an individual's belief system and societal norms significantly influences the willingness to accept such misinformation. Meanwhile, the widespread use of social media in recent years has greatly amplified the prevalence of misinformation on various health topics (Chou *et al*., 2018). Interestingly, such misinformation has been shown to increase feelings of anxiety and stress (Zarocostas, 2020). In Pakistan, there was a notable increase in the online search for "cures and home remedies," due to the prevailing anxiety and confusion.

3.2. Local home-based preventive and therapeutic approaches

As alternative therapies, many developing countries continue to depend on traditional medicine, while developed nations are increasingly focusing on plant-based herbal formulations for safe medical applications (Garcia, 2020). In this regard, the World Health Organization (WHO) has recognized (and endorsed) the use of complementary, alternative, and traditional medicine in the management of COVID-19. Such recognition is important since these treatments must adhere to recognized safety standards (Chaachouay *et al*., 2021).

During the early stages of the COVID-19 pandemic, traditional Chinese medicine was extensively employed in hospitals across China, either as a standalone treatment or in conjunction with modern medical approaches. This approach demonstrated significant efficacy in alleviating certain symptoms (Hong-Zhi *et al*., 2020). The efficacy of traditional Chinese medicine in managing the 2003 SARS outbreak underscored its importance (Lee *et al*., 2012; Leung, 2006). Meanwhile, given the genetic similarities between the viruses responsible for SARS and COVID-19, it has been suggested that herbal remedies effective against SARS may also offer advantages in the treatment of COVID-19 (Akhtar *et al*., 2022). This resulted in a comprehensive assessment of public views on the antiviral characteristics of plants. In Pakistan, these cultural customs and beliefs played a key role in shaping individual responses to the crisis. In fact, a considerable proportion of the participants reported a heightened sense of security when utilizing natural treatments and home remedies, in the absence of approved medications.

In Faisalabad, as in many areas of Pakistan, many people have depended on established practices such as herbal remedies and cooperative support networks. This study demonstrated that these practices were not merely supplementary, but crucial to the manner in how the local population navigated the pandemic. This cultural response, rooted in historical resilience, provided both physical and psychological relief, especially in a region with such a constrained healthcare infrastructure. Table 2 outlines the various home remedies employed in Faisalabad, emphasizing the considerable impact of cultural practices on the local response to COVID-19.

Globally, numerous recommendations have surfaced promoting the implementation of home treatments to address viral infections, especially in the context of the COVID-19 pandemic. Such apprehension regarding the virus has led to a significant increase in information on prevention strategies, prompting many individuals to explore traditional remedies. In Asia and Africa, various formulations have been documented as preventive measures against COVID-19 (Adebiyi *et al*., 2022; Sadio *et al*., 2021), while in nations, such as Bangladesh, Pakistan, and India, the utilization of hot water, herbal juices, decoctions (including *kadha*), and steam inhalation has become prevalent (Azam *et al*., 2020; Singh *et al*., 2021). Drinks rich in Vitamin C, combined with ginger, garlic, and lemon, have also been recognized as effective remedies

Table 2. Home remedies to treat COVID-19 patients

Home remedies	Ingredients for preparation
• Inhaling steam • Nim (also known as *margose*) tree leaves	• Nim tree and lime. • Nim tree and lemon. • Pawpaw leaves and nim tree leaves. • Moringa tree leaves with lemon, ginger, pineapple peels, and nim tree leaves. • Inhaling unidentified plants, while receiving the steam treatment. • Employing menthol crystals or other menthol-based materials. • These simple home remedies quickly relieved coughs and stuffy noses. Only one/two teaspoons of Vicks VapoRub should be added to a hot water basin. Inhale the vapors gradually, allowing your body to unwind with each exhalation.
• Herbal baths	• Nim tree leaves were the most widely used approach. • Unknown plants. • Pawpaw leaves on a nim tree.
• Ginger-based beverages	• The mixture can be blended with various herbs, such as garlic, lemon, and hibiscus, and included in beverages, with/without sugar or honey.
• Lemon-based beverages	• Warm water and lemon, with/without sugar or honey. • Fresh lemon juice. • Lemon juice combined with other fruits. • A lemon-ginger dish, with garlic and honey as additional options.
• The process of preparing herbal beverages using locally sourced ingredients	• Consumption of guava leaves as a beverage can be performed, either in isolation or in combination with other herbal ingredients. • Boiling pineapple peels. • Different moringa leaf preparations. • Consuming moringa leaves in their unprocessed form, incorporating cinnamon, cocoa powder, or honey as optional ingredients.
• Spice-based drinks	• Aidan fruit, also known as *prekese*.
• Hibiscus-based beverages	• A beverage made with hibiscus and ginger, with/without sugar or honey. • A fruit-based hibiscus and ginger beverage with pineapple, lemon, or lime. • Spices, such as ginger, hibiscus, and Aidan fruit, are often referred to as *prekese* in the region.

(Sadio *et al*., 2021). Despite the absence of pharmaceutical endorsements, these treatments have been widely regarded as effective, with many individuals attesting to their success in preventing the virus.

In Faisalabad, with local populations experiencing insufficient healthcare infrastructure, individuals have turned to immune-boosting foods and herbal supplements for the treatment and prevention of the virus. Various remedies, including citrus fruits, honey, and turmeric, are believed to enhance immunity and aid in recovery (Adebiyi *et al*., 2022). Research from India has also demonstrated the advantages of turmeric in addressing a wide range of conditions, including colds and liver disorders (Hewlings & Kalman, 2017). The extensive adoption of these supplements and foods indicates a broader dependence on natural approaches to bolster immunity before and during exposure to COVID-19 (Soleymani *et al*., 2022). In addition, this response was intricately connected to cultural practices, reflecting the ethnographic context of Faisalabad, where traditional remedies not only served as health interventions but also as integral components of the community's social and cultural fabric.

Finally, these non-pharmacological approaches were generally effective. They were also economical, broadly available, and presented as a safer alternative to contemporary medical interventions. In a context where the healthcare system faced significant challenges and access to treatment was limited, these home-based approaches were vital, especially for patients exhibiting mild/moderate symptoms. Meanwhile, many individuals felt reassured in overseeing their health conditions at home and utilizing time-honored methods that had been passed down for generations. In this case, these non-pharmacological treatments, firmly established in local traditions, served as both medical solutions and reflections of cultural resilience.

In sum, this ethnographic study underscores the importance of these cultural practices during the pandemic. The application of home remedies, such as herbal teas and spices, emerged as a representation of cultural resilience, highlighting the ways in which communities adjusted to the healthcare challenges presented by COVID-19. This study also elucidates the interconnection between these traditions and contemporary public health measures, demonstrating that cultural practices played a pivotal role in the survival strategies of many individuals during the pandemic.

3.3. Natural healing methods

Natural healing, commonly referred to as "herbal or traditional medicine," has been an integral part of cultural practices for centuries, serving as an essential resource for health and wellness. The utilization of traditional medicine worldwide significantly increased during the COVID-19 pandemic, since many individuals sought herbal remedies to alleviate symptoms when contemporary medical systems faced overwhelming challenges. In this case, a wide variety of herbs were recognized for their therapeutic properties, which helped alleviate respiratory symptoms and/or enhance immunity. In many areas, the authorities (both officially and unofficially) supported the application of traditional remedies, due to their cultural significance and perceived efficacy. This practice highlights the significance of cultural beliefs, geographical location, and historical medical knowledge in influencing the responses to public health crises such as COVID-19 (Umeta Chali *et al.*, 2021).

The significance of traditional medicine in the context of COVID-19 was especially evident in Pakistan, where the healthcare infrastructure is lacking and communities frequently depend on established healing practices. As mentioned earlier, individuals sought natural remedies, including herbal teas and home decoctions, not only to alleviate symptoms but also to obtain psychological reassurance during such a period of uncertainty. This exemplifies the broader global trend of incorporating conventional treatments in response to the pandemic. On May 4, 2020, the WHO recognized the significance of these practices, advocating for global innovation in the pursuit of effective COVID-19 treatments, which included the repurposing of pharmaceuticals and traditional remedies (Brazzaville [Producer], 2020). In this regard, Faisalabad presents a significant case study of how cultural resilience (manifested through traditional healing practices) enabled the community to successfully deal with the crisis while balancing contemporary public health measures with established cultural beliefs. Moreover, traditional healing emerged as both a health strategy and a means of preserving cultural continuity, enabling individuals to uphold their sense of control and identity during the tumult of the pandemic.

The interaction between contemporary medical practices and traditional methods in Faisalabad also represents a wider global movement toward the integration of cultural beliefs with scientific health interventions, highlighting the significant role of culture in influencing health behaviors and outcomes during the pandemic. In this regard, one of the most significant observations was given by a 42-year-old dietician working at the city's main hospital:

Unfortunately, there is still much to learn about the condition and treatment possibilities for post-COVID symptoms. Therefore, experts are unable to offer a specific response. We may look at what we do know, such as some of the virus's mechanisms and how other viruses react, to elicit suggestions and provide some possibilities. The good news is that research has demonstrated how particular foods, lifestyle choices, and nutritional supplements can enhance a healthy, balanced immune and inflammatory response.

It is important to acknowledge that the information in this study does not aim to replace the advice or therapy provided by healthcare practitioners. It simply demonstrates how the community actively adopted various concepts to facilitate the healing and well-being of individuals. Table 3 summarizes the indigenous treatments asserted by community members for the treatment and prevention of COVID-19.

As shown in Table 3, the consumption of nutrient-rich foods, such as greens and beetroot, not only represents a focus on nutrition but also a significant connection to cultural healing practices. In this study, the participants often talked about adding steamed or roasted beetroot. This root vegetable is known to increase the production of nitric oxide (NO), which protects against oxidative stress and inflammation. This is consistent with local practices of utilizing natural foods to enhance the body's inherent immune responses, especially in the respiratory system, which was pivotal to the symptoms of COVID-19.

Similarly, the consumption of bone broth, known for its rich mineral content and glutathione precursors, was regularly consumed in Faisalabad to enhance the immune function. This cultural practice exemplifies the local

Table 3. Indigenous treatments asserted by community members for COVID-19 treatment and prevention

No.	Type	Details
1	Greens and beets	• Black mustard, black cumin, jalapeno, *Bergamo adi, togo*, and garden cress (either steamed, roasted, or juiced).
2	Bone broth	• Bone broth, either homemade or obtained from the market, is derived from the bones of various animals such as cows, elks, buffalos, and chickens.
3	Anti-inflammatory food	• There is a wide array of fresh fruits and vegetables available, along with whole-grain foods such as oats, porridge, brown rice, and whole-grain bread. • Consuming oily fish as well as nuts and seeds is recommended for a balanced diet. • The topic of discussion pertaining to grass-fed beef.
4	Probiotics	• Zinc, Vitamin C

community's perspective on utilizing food as a form of medicine, which is a concept passed down from previous generations. Specifically, the selenium and magnesium content in bone broth helps reduce inflammation, which played a vital role in managing post-COVID-19 recovery. This cultural practice also enhanced formal health interventions, demonstrating the important role of cultural resilience in such recovery (Melissa *et al*., 2021).

Finally, the incorporation of herbal supplements and probiotics alongside traditional food practices was an additional dimension of traditional healing in Faisalabad. The significance of probiotics in supporting gut health and the immune system was notably highlighted by the participants. Meanwhile, herbal remedies, such as turmeric, quercetin, and ginger, were frequently utilized for their anti-inflammatory properties. In particular, the participants cited turmeric (in the form of curcumin) as an integral component of their recovery regimen. These traditional practices, linked to cultural and practical health benefits, were also essential in managing stress, sleep disturbances, and immune responses during the pandemic (Melissa *et al*., 2021).

In sum, the consumption of specific foods and herbal remedies not only addressed the physical symptoms of the illness but also provided psychological support during the pandemic. This application of traditional medicine and food, as a means of cultural resilience, underscores the connection between health, culture, and survival, especially in resource-limited regions. This integrative approach also highlights the adaptability and resilience of the communities in Faisalabad during the crisis.

3.4. Spiritual healing and coping strategies for dealing with COVID-19's uncertainties

Despite advancements in scientific medicine, spiritual healing continues to be a significant practice for many communities, especially where traditional beliefs are essential to daily life. According to Jawaid (2020), religious values and practices shape individuals' perspectives on health as well as their approaches to seeking care, adhering to medical treatments, and interpreting their experiences with illness. For example, during the COVID-19 pandemic, numerous followers of Islam sought comfort in their faith, utilizing it as a means to navigate the uncertainty and lack of control over their situations.

Religious coping mechanisms, especially those grounded in Islamic teachings, also emerged as a significant form of cultural resilience during the pandemic. In this case, the principles of Islam, as detailed in the Qur'an and Hadith, offered frameworks for addressing the crisis and provided emotional, psychological, and spiritual support throughout the extended lockdowns. Specifically, the Islamic teachings emphasized the importance of depending on Allah, while also utilizing available resources for protection and prevention. Similarly, the guidance of the Prophet Muhammad to limit movement during periods of illness, refrain from social interactions, and reduce travel served as essential principles for Muslims navigating the difficulties posed by COVID-19 (Osei-Tutu *et al*., 2021; Piwko, 2021). In addition, Shariah underscored the importance of preserving life and faith, which was evident in the measures implemented by Islamic communities to control the spread of the virus while following religious guidelines.

Interestingly, Islamic teachings have consistently highlighted the importance of hygiene and cleanliness, which are practices that are strongly aligned with contemporary public health guidelines. Moreover, ritual ablutions (mandated before daily prayers) underscored the significance of cleanliness, an essential factor in controlling infectious diseases such as COVID-19. Even from the era of the Prophet Muhammad, the Islamic teachings offered practical guidance on avoiding regions impacted by disease, a principle that is still relevant in contemporary times. These fundamental aspects of faith significantly influenced the ways in which communities addressed health and disease prevention throughout the pandemic (Lone, 2018; Piwko, 2021).

Overall, there is a significant connection between religious practices and beliefs and the ways in which communities managed the challenges posed by the pandemic. In this regard, the Islamic teachings offered a structured approach for individuals and families to navigate the psychological and social challenges posed by the lockdowns, illness, and uncertainty. Meanwhile, the religious rituals, along with the focus on hygiene and spiritual resilience, effectively addressed physical health, while also mitigating the mental impact of the pandemic. In Faisalabad, faith emerged as a significant instrument in addressing the public health crisis, highlighting the necessity of incorporating religious and cultural insights into comprehensive health strategies (Al Eid & Arnout, 2020).

In the present study, the participants, predominantly including those who identified as Muslims, expressed the belief that spiritual conviction has the potential to facilitate healing in individuals. Such examples are as follows. First, a 36-year-old woman working as a housekeeper stated:

God possesses absolute authority over all things, and in the event that He was to subject us to a test, we would assuredly encounter severe affliction in the form of a debilitating illness. If not, then the COVID-19 virus lacks the ability to cause harm to individuals.

Next, a 41-year-old woman with three children, whose husband was hospitalized from COVID-19, shared her story:

> *I asked God to provide my husband with a speedy recovery so that he could resume living a healthy life. I was worried due to his deteriorating health (he had problems breathing and speaking) and ongoing cough. The doctor disregarded it and put off sending him for a comprehensive examination until the 5th day of his sickness. He was admitted to the hospital and was unconscious for 2 days. Sadka helped bring him back to life by organizing all of this chaos. The sitting arrangement for prayers was useful and bestowed God's favor.*

To protect themselves and their loved ones from COVID-19, the participants stated that they repeated verses from the Qur'an. They also contended that religious instruction empowers people to overcome challenges in life. The following are more examples. First, one male participant working as a cab driver for a private company stated:

> *If God has already decided that someone will die of COVID-19, then there is no way to prevent it. Nobody can prevent or postpone death. At the same time, Islamic religious teachings show that the Prophet forbade his followers from traveling to any area where an epidemic was present. Consequently, self-care is essential.*

Another male participant working as a shopkeeper at the local market stated:

> *With COVID-19, I began praying and worshiping frequently to stay healthy. According to my religious beliefs, there are various passages that are said to bring protection against terrible times and wrongdoings. It gave me strength and relieved my tension to know that we are under God's protection.*

When asked about the potential curative effects of praising God as a remedy for COVID-19, the prevailing viewpoint among the participants indicated skepticism toward such a notion. Initially, it was considered that medication alone was the exclusive remedy. However, it was later believed that the assistance and blessings of a higher power could instill the necessary fortitude to confront this health crisis. In this regard, a 20-year-old man working as a laborer for a housing construction company stated:

> *While religious conviction alone cannot make them well, it unquestionably gives them the courage that they need to battle the illness. I learned that this virus chokes the throat and willfully kills people. May God spare everyone from contracting this disease.*

Another male participant managing a garment shop at the local market stated:

> *Any sickness, not simply COVID-19, can be cured with help. Yet, in the absence of medicine, it is improbable that these methods of healing would be effective on their own. According to the teachings of Islam, God only helps those who attempt to avoid harmful circumstances. It would be silly to pray for divine intervention while lying in bed and not taking your medication. Nothing is outside the purview of God's kingdom, so there is still the possibility that He will act. However, medication is still recommended.*

This researcher also asked the following question: do you believe that the virus was a test from God? Interestingly, there were a wide range of responses. First, a 26-year-old man working as a server in a restaurant stated:

> *People have an opportunity to apologize for their mistakes to God. It serves as a warning to end misbehavior and criminality. God has given us an ultimatum that we must leave our sins behind and turn from them if we want to avoid the worst possible outcomes.*

A 29-year-old man working as a manager in a cafeteria stated:

> *If you look at the world, then you will find that nudity in the media is on the rise, that the sincerity of love is being questioned, and that we are putting our relationships above our morals, disdaining orphans, and having extramarital affairs. We are also abandoning our relationships for financial gain. All of these actions go against human nature. If we do not care and continue, then God will, without a doubt, remind us of the actual meaning of being a human.*

A 22-year-old woman working as polio eradicator in the local council stated:

> *It is definitely a trial because, if you look at the judicial system, then it mainly serves the higher, wealthier classes. Poor people cannot access the legal system and have no other options than to pray.*

However, several participants expressed skepticism over the notion that sins are responsible for the propagation of viruses and the subsequent loss of innocent lives. According to a renowned religious scholar:

> *Religious instruction constitutes a distinct form of knowledge, while the state of being unwell is characterized by its uniqueness. In this case, the act*

> *of prayer possesses inherent benefits. However, it is essential to maintain a clear distinction between the realms of knowledge and religious principles. Although it is possible that illness may be perceived as a test, it is important to note that it should not be regarded as a type of punishment. Meanwhile, the notion that all aspects of life may be universally associated with religion and punishment is unfounded.*

Conversely, another religious professor asserted that this is unquestionably the result of sins, stating, "Our God is angry with us, and the fact that the world cannot move freely is proof." Another participant mentioned that we only need to notice the smog, dry air, torrential rains, floods, and pandemic breakouts to understand God's will:

> *When our wrongdoings continue, God traditionally sends pandemics and natural disasters, such as earthquakes, floods, and locusts, to demonstrate his power and presence. Unquestionably, COVID-19 is an expression of God's wrath. In other words, it is his retaliation for all the wrongdoings and crimes committed by humans.*

Based on these responses, Islamic teachings do not offer any specific justifications for why certain people are more prone to pandemics than others. Nevertheless, an individual's vulnerability to illness can be influenced by genetics, underlying health conditions, and lifestyle choices. In this regard, the Islamic faith places significant importance on adopting a healthy lifestyle to enhance the immune system and reduce the risk of illness. It should also be emphasized that Islamic scholars may apply various interpretations to these principles within the framework of a modern-day pandemic. Thus, since the choice of how to address a pandemic is a matter of personal determination, it is important to consult with individuals in the religious community and healthcare experts.

Finally, numerous scientific studies conducted over the last three decades have demonstrated the unique contributions of religion and spirituality to improving well-being (Brown *et al.*, 2020; Roman *et al.*, 2020; Koenig, 2020). In regard to the COVID-19 pandemic, the link between spirituality/religious practices and COVID-19-related approaches may be validated in terms of positive emotional outcomes such as life satisfaction, hope, and well-being (Peteet, 2020; Fardin, 2020). Meanwhile, related research has shown that religion and spirituality are critical components that activate unique coping mechanisms to assist individuals in achieving life satisfaction (Dymecka *et al.*, 2022; Krok *et al.*, 2021). In other words, when people have complete confidence in God, such religiousness and/or spirituality can serve as a protective role in their lives (Mahamid & Bdier, 2021; Piwko, 2021), by reducing stress and maintaining their emotional stability (Koenig, 2020).

4. Discussion

The COVID-19 pandemic highlighted significant socioeconomic disparities, particularly for individuals living in poverty, who faced greater susceptibility due to limited access to healthcare and challenges in maintaining social distance. In regions, such as Faisalabad, where the healthcare infrastructure is insufficient, traditional healing practices played a vital role, providing essential physical and psychological support in the absence of formal medical services. This dynamic also highlights a significant aspect of cultural resilience in which communities depended on various customs, beliefs, and practices to effectively manage the crisis (Agyeman, 2020).

Throughout the pandemic, many individuals in Faisalabad utilized herbal remedies, spiritual healing, and collective coping strategies as their primary methods of care. These practices offered physical relief and helped reduce anxiety and uncertainty during the crisis. The reliance on these cultural frameworks underscored the critical role of cultural resilience in maintaining well-being and continuity, especially in light of the healthcare system's limitations (Rahman & Janjua, 2021).

Meanwhile, the implementation of stringent lockdowns by the federal and provincial governments in Pakistan resulted in considerable challenges for numerous healthcare systems. Consequently, communities utilized traditional healing methods, religious practices, and collective coping mechanisms to address the challenges presented by the pandemic (Ndumbe-Eyoh *et al.*, 2021). These culturally embedded practices provided essential support for both physical and mental well-being (Zarzycka, Śliwak, & Zarzycki, 2019). For many individuals, these practices were not only additional resources but also essential to their survival strategies (Ahmad *et al.*, 2021).

In the present study, analyzing the community's responses to the pandemic through an ethnographic lens highlighted the significant contribution of traditional remedies and religious practices in managing the virus, alongside public health interventions. Moreover, the direct testimonies concerning symptom relief underscored the considerable impact of these cultural frameworks as well as the effectiveness of these traditional practices (Nasution *et al.*, 2022; Mukhtar, 2021; Rabbani *et al.*, 2021). Their widespread adoption became notable due to their accessibility, with many solutions incorporated into common household practices or provided at no cost. This study also emphasized the tensions between current public

health measures (e.g., physical distancing and hygiene practices) and established communal and religious traditions in Faisalabad (Adebiyi *et al*., 2022). In this regard, cultural resilience signified active adaptation, rather than a passive response, as communities reinterpreted their practices to effectively deal with the emerging health challenges.

This study also emphasized the importance of further investigations into regional perceptions of illness and healthcare-seeking behaviors. In this case, the pandemic presented opportunities to advance innovative health programs and treatments through the use of qualitative data (Baskin & Bartlett, 2021). However, the rapid progress in such treatments required careful attention to prevent the spread of misinformation, especially regarding unverified remedies promoted on social media platforms. For example, various plant-based solutions were identified as deficient in empirical evidence. This provided a false sense of security and led to the neglect of critical preventive measures, such as physical distancing and hygiene practices, ultimately increasing the transmission of the virus (Brazzaville, 2020).

Finally, this study highlighted the impact of social relationships on healthcare-seeking behaviors, with cultural therapeutics receiving social endorsements (Carruth, 2014; Hampshire *et al*., 2017). In addition to public health interventions, various practices, such as handwashing, prayer, and traditional remedies, played a significant role in alleviating despair and fostering a sense of hope. In this regard, previous research has shown that individuals with chronic illnesses, such as AIDS and cancer, remained optimistic through faith-based practices and standard treatments (Zarzycka *et al*., 2019). Similarly, the pandemic highlighted the importance of religion on individual behaviors and social interactions, providing emotional support (Dein *et al*., 2020). However, future research should investigate the therapeutic benefits of traditional treatments and prayer, as cultural components in the management of emerging diseases.

4.1. Rigor and limitations of the study

Rigor is widely regarded as the most appropriate standard for evaluating qualitative research. In this case, rigorous research must satisfy four requirements to be credible: reliability, dependability, confirmability, and transferability. Credibility was achieved in this study by prolonged engagement and meticulous observations to comprehend the context of the phenomena in which it was situated and minimize the potential for data distortions. Transferability was enhanced by utilizing purposive sampling and providing a comprehensive and precise description of the participants. In addition, an experienced qualitative researcher thoroughly reviewed the transcriptions to validate the identified themes and descriptors, ensuring this study's reliability, dependability, and confirmability.

There are also several limitations in this study that should be noted. First, due to the use of a convenient sample approach, this study only provided a glimpse into the perspectives of cultural healing within one particular city. Thus, the findings are not generalizable to the total population of Pakistan. Second, no statistical analysis was performed to investigate the correlations between the components or to offer a comprehensive statistical explanation of the findings. Third, this study employed a qualitative approach, utilizing interviews as the primary method to collect the participants' viewpoints on COVID-19. Finally, the participants' opinions were purely self-reported, with no verification of their accuracy. In this regard, it is important to recognize that the potential for selection bias cannot be entirely eradicated, even in cases where participation is voluntary.

4.2. Policy implications

This study suggests that the healthcare sector in Pakistan lacked the necessary resources to meet the needs of healthcare workers during the COVID-19 pandemic. This research-based information is important for forecasting and dealing with future pandemics. It is also important to establish communication strategies within the system to enable efficient communication between health managers and service providers in all hierarchical levels. This can enable the authorities to better analyze the dissemination of information, allay people's worries and fears, and boost the morale of healthcare professionals.

5. Conclusions

This ethnographic study conducted in Faisalabad during the COVID-19 pandemic highlights the notable influence of cultural resilience in dealing with this public health crisis. Given the limitations of the healthcare infrastructure, many individuals heavily relied on traditional healing practices, religious beliefs, and communal support systems to address the physical and psychological impacts of the virus. The established cultural frameworks significantly contributed to their survival strategies, providing a supportive response during times when formal healthcare systems encountered significant challenges. Our findings are also in line with previous research on the importance of integrating cultural resilience into public health strategies, particularly in resource-constrained regions (Rahman & Janjua, 2021; Agyeman, 2020).

This study also indicates the necessity of exercising caution regarding misinformation, especially regarding

unverified traditional remedies disseminated through social media. While these practices have been acknowledged through social networks, it is important to perform a comprehensive assessment of their overall safety and effectiveness. Thus, this study suggests a more holistic approach that combines cultural and scientific methods in public health initiatives (Carruth, 2014; Dein *et al*., 2020). Moreover, this study underscores the use of botanical substances to enhance immunity, demonstrating Pakistan's reliance on bioactive components in traditional diets. In this regard, it is crucial to protect indigenous medicinal knowledge, since it offers important insights for future studies in biochemistry and the immune system.

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The authors declare that they have no competing interests.

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Writing – review & editing: All authors

Ethics approval and consent to participate

Participants were told of the study's goals and methodology before the interview process began, and their verbal informed consent to participate was then obtained. The Committee of University of Sun Yat Sen University Guangzhou, University's Department of Sociology accepted Ethical Consent (Ethics-PK-2020).

Consent for publication

Consent was obtained from participants to publish their data.

Availability of data

Data used in this study are primary data collected through focused survey approach and could be available on demand from the corresponding author.

Further disclosure

This paper was adapted from the author's PhD thesis titled COVID-19 as a collective trauma in cultural repercussions: a qualitative analysis in Pakistan.

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ACCSCIENCE PUBLISHING

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RESEARCH ARTICLE

Older adults, gender, and emotions: Fear during the COVID-19 pandemic in Buenos Aires City, Argentina

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Abstract

The COVID-19 pandemic profoundly impacted society, with older adults and men experiencing higher mortality rates. Paradoxically, despite lower mortality risk, women reported higher levels of fear than men. This study examines gendered emotional responses among adults aged 65 and older during the pandemic, using data from 322 individuals (219 women, 103 men) living in non-institutionalized settings and distributed in 45 of Buenos Aires' 48 neighborhoods. Participants, recruited through snowball sampling, completed three waves of telephone surveys over 63 days during the peak COVID-19 period in 2020. The survey included 57 questions – both open and close ended – aimed at assessing emotional well-being during lockdown. This article focuses on data from three open-ended questions, which were instrumental in uncovering key themes about the emotional experiences of respondents during lockdown. Findings reveal that 63% of respondents experienced fear, with women consistently reporting higher levels. This fear often stemmed from a sense of loss, as qualitative analysis identified four categories of perceived loss: autonomy, socio-affective ties, economic stability, and health concerns. Gendered patterns emerged, with women frequently associating fear with the loss of social connections and emotional support, while men emphasized autonomy and economic stability. These differences underscore how social expectations and subjective beliefs shape emotional responses during crises. Our study highlights the importance of crisis response strategies, mental health support, and policies that address these gender-specific emotional needs.

Keywords: Gender differences; Older adults; Fear; COVID-19; Emotional response; Perceived loss

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1. Introduction

On March 11, 2020, the World Health Organization (WHO) declared COVID-19 a global pandemic (WHO, 2020). Just days before the declaration, Buenos Aires had confirmed its first positive case (Ministerio de Salud, 2020), and the Argentine government responded by introducing some of the world's most stringent containment

measures. These included a mandatory preventive social isolation that began on March 20 and lasted for 8 months. The restrictions – closing schools, workplaces, and public spaces, and severely limiting mobility – were among the strictest globally (Porcher, 2020). While these measures effectively slowed the virus's spread, they disrupted everyday life and imposed profound psychological and social costs across demographic groups.

Older adults were disproportionately affected by the COVID-19 pandemic across different geographical levels (Bonanad *et al.*, 2020). In Argentina, between February and July 2020, individuals aged 60 and older accounted for 81.5% of total COVID-19 deaths (Rearte *et al.*, 2020), confirming the heightened vulnerability of this age group. This pattern was even more pronounced in Buenos Aires City, where individuals aged 65 and older represented 87% of COVID-19-related deaths nationwide in 2020 (Carpinetti & Lascano, 2022). These data reaffirm that both at the South American, national, and local levels, older adults constituted the most affected demographic group, with men being the most affected by mortality, highlighting their disproportionate risk during the pandemic (PAHO, 2020). This demographic trend mirrored global patterns, where older adults were most vulnerable to severe illness and death (United Nations, 2020). Yet, paradoxically, the emotional toll of the pandemic often weighed heavier on women, who consistently reported higher levels of fear and anxiety than men (Capraro & Barcelo, 2020; Kleinberg *et al.*, 2020). This emotional disparity highlights the role of gendered expectations and caregiving roles, which amplify women's perceptions of vulnerability during crises.

1.1. Fear as a sociological phenomenon

Fear, a dominant emotional response to the pandemic, provides a lens through which the interplay between individual experiences and societal structures is examined. Brooks *et al.* (2020) emphasize that quarantine settings amplify fear and anxiety by fostering uncertainty, isolation, and disrupted routines. Their review highlights how prolonged lockdowns can exacerbate psychological distress, particularly when compounded by fears of infection and economic instability. Similarly, Fitzpatrick *et al.* (2020) identify COVID-19-related fear as a multifaceted construct, which encompasses not only health concerns but also worries about financial security, family dynamics, and societal change. These findings illustrate the complexity of fear as both an adaptive and maladaptive emotional response.

Drawing on Bericat's sociology of emotions (2016), fear can be understood as both a relational and structural phenomenon. Emotions are deeply embedded in social interactions and cultural norms, shaping how individuals perceive and react to threats. Fear emerges in contexts of perceived powerlessness or vulnerability, with inequalities in societal structures at its core (Kemper, 1987; Barbalet, 1998). During the COVID-19 pandemic, this emotion was heightened by the uncertainty surrounding the virus's spread, coupled with the dislocation of social and economic systems.

In Buenos Aires, the dense urban environment and strict lockdown measures amplified these dynamics. Research by Etchevers *et al.* (2020) documented the psychological toll of prolonged isolation, noting increases in anxiety, loneliness, and frustration among diverse populations. For other national contexts (e.g., the United States or South Africa), emotional responses were not evenly distributed; women, individuals from lower socio-economic backgrounds, and those with preexisting vulnerabilities reported heightened distress (Fitzpatrick *et al.*, 2020; Manderson & Levine, 2020). Such findings align with Brooks *et al.*'s observation (2020) that social isolation, compounded by economic uncertainty and fear of infection, disproportionately impacts marginalized groups.

1.2. Gendered dimensions of fear

The gendered nature of fear during the pandemic offers a critical area for analysis. Studies consistently showed that women reported higher levels of fear and anxiety than men, often linked to their roles as caregivers and emotional managers within families (Hochschild, 1983; Brody, 1999). In Buenos Aires, this disparity was evident early in the lockdown, with women expressing greater concerns about health risks, economic instability, and disruptions to social connections (Alomo *et al.*, 2020). These findings reflect broader patterns observed globally, where women's emotional labor and societal expectations contribute to their heightened vulnerability to psychological distress (Capraro & Barcelo, 2020; Kleinberg *et al.*, 2020).

Fitzpatrick *et al.* (2020) argue that gendered responses to fear are influenced by cultural norms and structural inequalities. Women's roles as caregivers often place them at the intersection of multiple stressors, including managing family health, navigating financial pressures, and sustaining social bonds. This emotional labor exacerbates feelings of fear and anxiety, as women perceive themselves as responsible for mitigating the pandemic's impacts on their families. In contrast, men's fear responses are often suppressed or redirected due to cultural norms associating masculinity with stoicism and control (Bericat, 2016; Burkitt, 2002).

1.3. The role of isolation in amplifying fear

Prolonged isolation during lockdowns significantly exacerbated fear and anxiety across populations (Pietrabissa & Simpson, 2020). Brooks *et al.* (2020) identify key factors contributing to this psychological distress, including social disconnection, disrupted routines, and uncertainty about the future. These stressors were particularly pronounced in older adults, who faced heightened risks of severe illness and death. Research in Buenos Aires highlights how isolation severed critical support networks, leaving many older adults feeling vulnerable and powerless (Etchevers *et al.*, 2020).

Isolation's psychological impacts extend beyond individual experiences, influencing collective emotional climates. Bericat (2016) emphasizes the relational nature of emotions, noting that fear often emerges from breakdown in social bonds and shared experiences. During COVID-19, this dynamic was evident in the collective anxiety surrounding economic instability and public health crises. Fitzpatrick *et al.* (2020) further illustrate how these shared fears molded societal responses to the pandemic, fostering both solidarity and division within communities.

1.4. Fear and public health behavior

Fear also played a critical role in influencing public health behaviors during the pandemic. Mertens *et al.* (2020) describe fear as an adaptive response that motivates protective behaviors, such as mask-wearing and social distancing. However, excessive fear can lead to maladaptive outcomes, including panic, stigmatization, and resistance to public health measures. Brooks *et al.* (2020) warn that poorly managed fear can undermine trust in authorities and exacerbate societal tensions, highlighting the importance of clear communication and targeted interventions.

In Buenos Aires, public health campaigns sought to leverage fear as a motivator for compliance with lockdown measures. However, the psychological toll of prolonged isolation and uncertainty often leads to emotional fatigue, reducing adherence to guidelines over time (GCBA, 2020b). These dynamics accentuate the need for approaches that balance the use of fear in public health messaging with strategies to support emotional resilience and well-being (Ornell *et al.*, 2020).

1.5. Research objectives and key questions

Research questions of this study are as follows:

(i) This study seeks to analyze how fear evolved among older adults during the COVID-19 pandemic, with a particular focus on gender differences, given the paradox that women reported greater fear despite men experiencing higher mortality rates. Specifically, this study is guided by the following research questions: How did fear of COVID-19 evolve among older adults throughout the time study (between the 92nd day of social isolation and the 155th day)?

(ii) What factors contributed to gender differences in the expression and experience of fear?

To address these questions, this research applied a mixed-method approach, combining quantitative techniques and qualitative analyses of participants' narratives. This methodological design allows for a more comprehensive understanding of how fear fluctuated over time, how it differed by gender, and how broader social factors influenced individual emotional experiences. By integrating sociological insights with empirical evidence, this study aims to contribute to the growing body of research on the emotional dimensions of crises and their implications for public health policies.

2. Data and methods

The qualitative data were analyzed through a cross-sectional approach at each collection point and a longitudinal observation of continuities and changes over time. Following an inductive, data-driven approach, this analysis facilitated a deeper understanding of participants' social experiences (Holland, 2011). Although the longitudinal analysis focused on individual cases to observe changes in emotions and perceptions of loss over time, we were also interested in identifying specific associations between fear and loss perception. To achieve this, an aggregated analysis strategy was applied. This aggregated approach, while less focused on individual cases, enabled us to observe patterns in emotional subgroups (with/without fear) relative to temporal fluctuations.

By incorporating this aggregated analysis, the study was enriched by capturing associations between emotions and perceptions within a dynamic context. This approach complements rather than replaces the longitudinal findings by emphasizing the effects of fear on loss perception, regardless of each case's temporality. As will be shown later, some participants experienced fluctuations in their emotional responses across waves, reflecting the inherent emotional variability present throughout the pandemic.

2.1. Sampling

The data for this study were obtained from a fixed panel sample, ensuring that the same individuals participated in three waves of data collection. The longitudinal design incorporates the influence of time, a critical factor for capturing changes experienced by subjects under isolation conditions. The sample comprised men and women aged 65 and older, residing in 45 of the 48 neighborhoods of

Buenos Aires. Institutionalized older adults, as well as those with cognitive and hearing impairments, were excluded from the sample.

In the first wave, 356 cases were surveyed, followed by 332 cases in the second wave and 322 cases in the third wave, resulting in a final retention rate of 90% relative to the initial sample. A total of 322 individuals participated in all three waves, constituting the final sample, which had sociodemographic characteristics comparable to the older adult population of Buenos Aires. Data collection was conducted through telephone interviews over a span of 63 days, coinciding with the period of highest recorded COVID-19 cases in 2020. The initial calls began on the 92nd day of social isolation, and the final calls were completed on the 155th day, with an average of 25 days between the first and second waves and 16 days between the second and third waves.

The recruitment process was conducted in two stages using a combination of techniques. Initially, a snowball sampling method was employed, complemented by the intentional selection of cases from underrepresented areas of the city. Snowball sampling was applied as a contact method rather than a strict sampling strategy, in line with recommendations from Atkinson and Flint (2001). This process started with a list of 100 reference individuals who were tasked with identifying potential respondents. These respondents, in turn, provided further contacts, following predefined criteria of location, sex, and educational level to ensure diversity.

Despite the effective recruitment process, a total of 34 individuals dropped out across the three waves: 24 cases between the first and second waves and 8 cases between the second and third waves. Reasons for discontinuation included loss of interest, health issues, inability to re-establish contact, family problems, lack of time due to work, distrust regarding the potential political use of the data, and family disapproval of continued participation. However, most participants demonstrated a strong willingness to answer all questions, honored their commitment to participate in all three waves, and expressed interest in the study's topic. Preliminary findings, focusing on the development of a well-being scale as well as emotions and sentiments, have been previously published (Llovet *et al*., 2021; Llovet *et al*., 2022).

2.2. Survey questionnaire

For each wave of the study, an online form was generated and completed by the interviewers responsible for data collection. In the second and third waves, the questionnaire was modified by removing sociodemographic items and adding new ones related to disability and loneliness, respectively. Participants were instructed to base their responses solely on experiences from the previous 7 days, and the questionnaire included both closed and open-ended questions. The questionnaire had a total of 57 questions, of which 49 were closed and 8 were open-ended. The survey covered a range of topics, including sociodemographic characteristics, housing and place of residence, activities performed inside and outside the home, types of assistance received, interest in COVID-19-related news, methods of accessing information, medical check-ups, perceived health status, specific questions related to symptomatology, physical activity, fear of contracting COVID-19, volunteer activities, loneliness, disability, and post-pandemic suggestions.

To capture the emotional impact of the COVID-19 pandemic, we designed questions exploring individual's experiences of fear, loss, and personal challenges. Each question aimed to elicit specific aspects of participants' internal responses, revealing both immediate concerns and the broader effects of social isolation. Through this approach, we sought to understand how individuals perceived and coped with the threat of infection, the sense of loss, and the challenges introduced by the health crisis.

When asking the question, "During the past week, did you have a fear of getting infected with COVID-19?" we aimed to explore the level of fear individuals experienced regarding the possibility of contracting the virus. This question was designed to assess the emotional response and health-related concerns individuals might have had about the potential risk of infection. Similarly, by asking the question, "Think of one word to describe what you lost in this situation," we sought to capture a succinct and meaningful expression of the sense of loss. This approach aimed to uncover the range and nature of losses individuals may have encountered during the lockdown period. By asking the question, "Why did you choose this word?" we aimed to delve deeper into the respondent's reasoning behind the selected word describing a sense of loss. This question sought to uncover the individual's specific thoughts, emotions, and experiences associated with the chosen word, as well as its connection to their perception of the pandemic's impact on their life.

2.3. Coding

We conducted a coding process to organize and interpret participants' emotional responses across three waves of data collection. Participants shared their feelings and emotions in response to the extended isolation, varying from brief to more detailed expressions. Successive coding stages were established to systematically analyze and organize this information. Given the interpretative nature of coding and following the procedures formulated by

Saldaña (2013), two researchers conducted the analysis independently, reaching consensus through collaborative review. Data were stored and organized using MAXQDA 2020 software (VERBI, Germany).

Following a data-driven inductive approach, a conventional content analysis was conducted, allowing codes to emerge directly from participants' verbatims to capture the full range of cognitive and emotional responses without imposing predefined categories. In the first coding cycle, preliminary codes were established; during the second cycle, texts were re-read, and codes were reviewed and adjusted as needed. To facilitate broader classification, codes were grouped into categories representing different themes.

2.4. Statistical analysis

To assess the association between categorical variables, Pearson's Chi-square test was employed. This statistical test was used to determine whether the observed differences in the frequencies of the variable categories were statistically significant. Pearson's Chi-square value was calculated along with the degrees of freedom (df) and the level of significance (p-value). A statistical significance level of $\alpha = 0.05$ was established. A p-value below this threshold was considered sufficient to reject the null hypothesis, suggesting that the variables are significantly associated. In addition, the likelihood ratio test was used as a complement to the analysis. Although both tests are highly correlated, the likelihood ratio can offer an alternative approach to interpreting the relationship between the variables. The analysis included a total of 322 valid cases. The statistical analysis was performed with IBM SPSS Statistics version 29, which automatically computed the relevant statistics for hypothesis testing.

3. Results

3.1. Descriptive analysis from quantitative and qualitative data

Table 1 illustrates the proportion of older adults who reported fear of infection across three survey waves. A stable 40% of participants expressed fear in the first two waves, with a slight increase to 43.5% in the third wave. This rise may reflect shifts in the perceived threat level or pandemic context by the third wave. Notably, these fear levels are lower than those found in other Argentine studies among adults aged 18 and older, which could suggest distinct perceptions of risk or coping mechanisms among older adults. Throughout the study, response rate remained consistent ($n = 322$), attesting to the validity of cross-wave comparisons.

Table 2 provides insight into the intra-case variation in fear responses across three waves, showing that 63% of participants reported fear at some point. Persistent fear (Yes-Yes-Yes) was observed in 22% of cases, while 41% experienced fear intermittently. These fluctuations in fear align with the natural variability of emotions over time.

Table 1. Percentage of older adults reporting fear of infection across three survey waves

	1st wave		2nd wave		3rd wave	
	n	%	n	%	n	%
Not fear	190	59	190	59	181	56.2
Fear	130	40.4	131	40.7	140	43.5
Missing cases	2	0.6	1	0.3	1	0.3
Total	322	100	322	100	322	100

Abbreviations: *n*: Number of participants; %: Percentage of participants.

Table 2. Intra-case variations in fear responses across three survey waves

Intra-case variation	Cases	Percentage
No-No-No	114	35.4
Yes-Yes-Yes	70	21.7
No-No-Yes	32	9.9
Yes-No-No	26	8.1
No-Yes-No	22	6.8
No-Yes-Yes	20	6.2
Yes-No-Yes	17	5.3
Yes-Yes-No	17	5.3
Missing cases	4	1.2
Total	322	99.9

Notes: Each row represents a pattern of responses ("Yes" indicating fear and "No" indicating no fear) across the waves, with the corresponding number of cases and their percentage distribution. The total percentage is slightly off 100 because of rounding. Missing cases include responses that were not provided or were invalid.

To further explore the associations between fear and demographic and situational variables, we conducted Chi-square tests of independence. Table 3 presents the results, highlighting that gender was the only variable showing a statistically significant association with fear ($p < 0.05$). This finding underlines the role of gender in shaping emotional responses during the pandemic, as previously discussed. Other variables, including age group, self-perceived health, and living arrangements, did not exhibit significant associations with fear.

Building on the findings from Table 3, which identify gender as the only variable significantly associated with the perception of fear, we directed our attention to examining intra-case variability across the three waves, with the information disaggregated in terms of gender. Figure 1

Table 3. Chi-square test of demographic and situational factors related to fear

Variable analyzed	Chi-square statistic	*p*-value	Degrees of freedom
Gender (male, female)	9.81	0.0073	2
Age group (65 – 79, 80 and +)	3.30	0.19	2
Self-perceived health	3.40	0.99	12
Living arrangement (living alone)	5.46	0.48	6
Number of cohabitants	14.90	0.78	20
Open space availability	2.55	0.63	4
Health condition (using medication regularly)	1.09	0.57	2
Property ownership (owner/tenant)	9.32	0.15	6

Note: The *p*-values indicate whether there is a statistically significant association between the analyzed variable and the perception of fear ($p<0.05$). "No response" cases were included in the analysis.

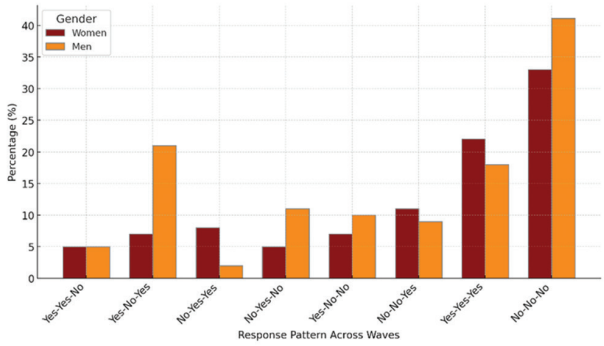

Figure 1. Intra-case variations in responses by gender across three survey waves

illustrates the temporal variation in intra-case responses across distinct patterns. The No-No-No category, where participants did not experience fear in any wave, is most common among men (41.1%) compared to women (33%), suggesting that men are less likely to consistently report fear. In contrast, the Yes-Yes-Yes pattern, indicating persistent fear, is more frequent among women (22%) than men (18%), reflecting a greater consistency in fear expression among women. Intermittent patterns, where fear appears in one or two waves, show a more balanced distribution between genders. This analysis suggests a gender difference in the perception and persistence of fear during the pandemic. Men appear less affected in terms of persistent fear, while women show a more consistent reporting of fear.

The relationship between fear and gender leaves the question of the sources of loss for men and women unanswered. To address this, we used word clouds to graphically represent the perceived losses in the third wave (Figure 2). The dominant term across all groups is "freedom," highlighting a shared sense of autonomy loss. For women with fear (top left), "freedom" and "contact" are central, reflecting a strong yearning for social connections and family ties, along with concerns about physical health and face-to-face interaction. For men with fear (top right), "freedom" and "contact" also prevail, but "happiness" and "sociability" emerge as significant themes, indicating that the loss of social engagement affects their emotional well-being. In addition, "loneliness" is a prominent issue. Women without fear (bottom left) continue to emphasize "freedom" and "contact" but also mention "family" and "life," suggesting a less intense impact. Men without fear (bottom right) highlight "freedom" and "contact," though with less emphasis on specific losses. Together, these clouds illustrate a generalized experience of restricted freedom, with emotional impacts varying by gender and fear status. These word clouds provide a visual summary of the predominant terms associated with loss among distinct groups with "freedom" as the central theme reflecting autonomy-related constraints. This aligns with the thematic categories presented below, where we further explore perceptions of loss – ranging from heteronomy and socio-affective bonds to economic stability and health – each varying by gender and fear status.

In Table 4, we see how different themes of perceived losses – heteronomy, socio-affective bonds, economic stability, and health – were experienced by older adults across gender and fear status during the pandemic. We understand heteronomy as a scenario that constrains individuals' independence by placing their ability to make choices under the control of an external force, and socio-affective bonds as the interconnected elements associated with the restoration of physical, social, and emotional connections, including relationships within family and friendship circles. In addition, economic limitations and anxieties are linked to financial welfare, while health issue pertains to restraints and anxieties arising from limitations in both physical and mental well-being.

By examining, through an aggregated analysis of participants' responses across the three waves, how men

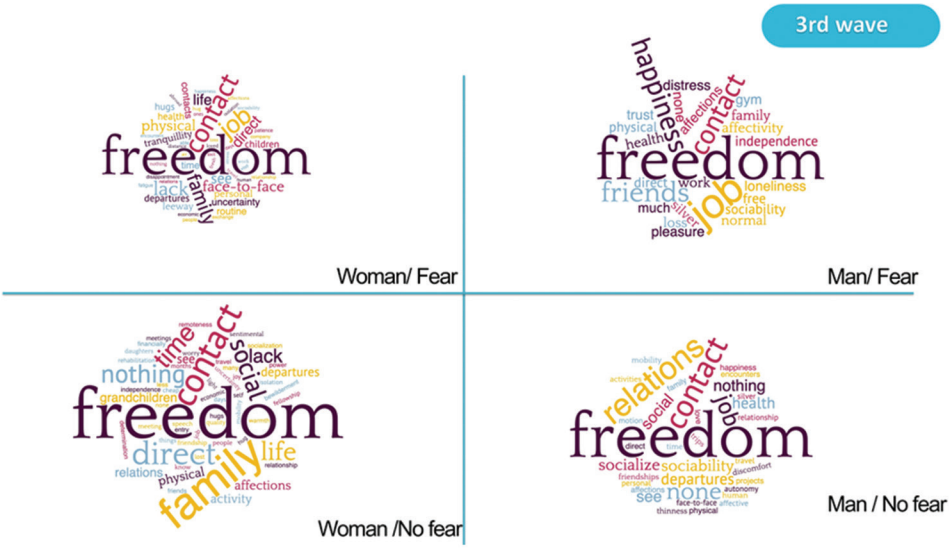

Figure 2. Word clouds representing perceived losses in the third wave of the pandemic, by gender and fear status. A word cloud representing the emotional responses and perceptions of participants across diverse groups was segmented into quadrants. The quadrants categorize participants by gender (men/women) and emotional state (fear/no fear) during the third wave of data collection. Larger words indicate more frequent responses, highlighting dominant themes within each group.

Table 4. Percentage distribution of perceived loss categories by gender and fear status (*n*=322, three waves)

Category	Women with no fear	Men with no fear	Women with fear	Men with fear
Heteronomy	9.8	8.7	9.3	15.2
Neutral	9.8	10.1	2.8	9.1
Socio-affective	61.6	50.7	63.6	36.4
Economic	8.0	10.1	13.1	27.3
Health	10.7	20.3	11.2	12.1

and women, both with and without fear, prioritize these losses, distinct patterns emerge. While socio-affective concerns are the most prevalent across all groups, especially among women, other categories show specific associations with fear status and gender. For example, men with fear place higher importance on economic and autonomy-related issues, while men without fear show a greater focus on health-related concerns. These findings highlight the complex ways in which emotional states and gender influence the perception of loss during times of crisis. The following presents a detailed breakdown of these patterns, supported by data from Table 4. The perception of autonomy loss is mentioned across all groups, though its importance varies. Men with fear exhibit the highest percentage (15.2%), indicating that loss of independence is a significant concern for them in the context of fear. Women without fear and men without fear also mention this loss but to a lesser extent (9.8% and 8.7%, respectively), suggesting that heteronomy is a more pressing concern for those experiencing fear.

The socio-affective theme has the highest representation across all groups, especially among women with fear (63.6%) and women without fear (61.6%). Men without fear (50.7%) and men with fear (36.4%) show lower percentages, suggesting that women place higher value on social connections and affective bonds, particularly when experiencing fear. This pattern reinforces the significance of socio-affective factors for women, while men may prioritize these factors less relative to others.

Economic concerns are highest among men with fear (27.3%) and women with fear (13.1%). In contrast, women and men without fear have lower percentages in this aspect (8.0% and 10.1%, respectively). These figures indicate that fear may intensify economic concerns.

Health concerns are most prominent among men without fear (20.3%), which may suggest a preventive attitude or a focus on health as part of general well-being. Women without fear and men with fear report lower concern for health (10.7% and 12.1%, respectively). Men

with fear have the lowest percentage in this category (12.1%), indicating they may prioritize other aspects, such as economic stability.

The "Neutral" category in Table 4 includes responses where no clear opinion can be discerned in a specific direction. Notably, women with fear have a very low presence in this category (2.8%) compared to women without fear, who reach 9.8%. In contrast, men show very similar percentages: 10.1% in the no-fear group versus 9.1% in the fear group, suggesting that fear as a variable has a stronger impact on neutral responses among women than among men.

In addition, we present a selection of verbatim quotes to enrich and substantiate the categorization process. These direct quotes provide valuable insights into participants' experiences, offering a qualitative depth that complements the statistical analysis. By showcasing these personal expressions, we highlight how specific themes emerged from the data, demonstrating the alignment between participants' responses and the analytical framework. This material not only illustrates the diversity of experiences but also underscores the contextual and emotional dimensions underpinning the broader patterns identified in the study.

3.1.1. Heteronomy

Men: "*Actually, I am a man who has become accustomed to living alone all the time. I have managed my life with freedom, and I am not dependent on anyone. But being confined, I feel like I have lost my freedom*."

This statement, from an older man accustomed to an independent lifestyle, reveals the emotional impact of pandemic-induced confinement. While previously managing his life freely, the restrictions have brought about a profound sense of lost autonomy and freedom, underscoring the toll that isolation takes on those who highly value independence.

Women: "*I want to decide whether I buy green or red apples, whether I wear pants or a skirt, whether I go to the doctor or not. We have lost the power of decision*."

An older woman shares her frustration over losing the ability to make everyday decisions, like choosing specific foods or clothing. The limitations imposed by the pandemic have led to a diminished sense of personal agency, reflecting the broader impact on autonomy and independence among older adults. This highlights the psychological challenges faced by individuals who prioritize self-determination.

3.1.2. Social-affective

Women with no fear: "*Friendship, having that thing of saying "let's go for a coffee," we meet up, come to my house, I'll go to yours, very important things at one's age, I'm 78 years old, family, going away for a weekend. it's a lost year of life, that's how I feel. Anguish, the future scares me, I do not see anything, I do not see that little light,//. I do not know what to tell you.*"

This verbatim highlights the importance of social connections in her life, expressing how the pandemic's restrictions made her feel like she lost a year. She shares a sense of hopelessness about the future, reflecting common feelings of isolation and uncertainty among older adults.

Women with fear: "*Because I need to work, spiritually I feel bad, I don't feel like getting myself together, taking a shower. The problem is not being able to maintain normal activity. I have had it for almost ninety years. I never liked talking on the phone much, I prefer physical contact. If I stop connecting and looking at the face, the eyes, that is how a friendship is maintained, a lot*."

A woman with fear describes how pandemic limitations have diminished her motivation and disrupted her routine. She values in-person connections deeply, accentuating the emotional importance of face-to-face interactions and physical presence to support her well-being.

3.1.3. Economic

Men with fear: "*I can´t work*."

Women with fear: "*I feel bad being in a lockdown I need to get out, my husband can´t go to work and my income has decreased significantly*."

In these verbatims, the man expresses fear centered on his ability to work and the financial insecurity brought by lockdowns, emphasizing how income uncertainty threatens his livelihood. In contrast, the woman's fear extends beyond her personal well-being to the economic strain on her family, noting both her confinement-related distress and the financial impact of her husband's inability to work. Together, these verbatims illustrate how men and women may experience and express pandemic-related fears differently: the man's concern is primarily economic, while the woman's includes both emotional and financial challenges. These gendered perspectives highlight the varied effects of the pandemic on personal and financial well-being.

3.1.4. Health

Men with no fear: "*.//fears of various kinds of the same illness: when I read the news, I experience all the symptoms// sometimes with the healthcare systems, they can be a bit extravagant or exaggerated with the suits they wear. The stigma towards a person who gets sick is better to die from a heart attack and receive condolences, (at least) they do*

not kick you out of the building. The fear of brain tricks, one is afraid, panic, and sadness that can turn into depression. 50 years ago, I had a panic attack, and this week I had something similar for no reason, I realized it, calmed down, and attributed it to the quarantine atmosphere."

Men with no fear: "*I'm sad, it bothers me, I'm somewhat distressed. Physical problems, a lot that I did not have before and now have appeared, like the issue with my legs, obesity, I have gained a tremendous amount of weight. The fact of isolation, not being able to have encounters with anyone*."

The first verbatim reflects an individual's fear related to the illness itself, noting how news triggers symptoms and raises concerns about healthcare practices and social stigma. They reference past and recent panic attacks, illustrating the quarantine's impact on their mental well-being. In contrast, the second verbatim portrays a man who feels sadness and frustration due to physical health issues (leg pain and weight gain) and isolation-related challenges. While the first individual's distress is illness-focused with psychological implications, the second man's distress centers on physical limitations and reduced social contact, highlighting distinct sources of pandemic-related anxiety.

4. Discussion

The findings of this study reveal significant gendered differences in emotional responses to the COVID-19 pandemic among older adults in Buenos Aires. Women consistently reported higher levels of fear, primarily linked to socio-affective losses, while men expressed concerns rooted in autonomy and economic stability. These differences align with existing research on gender roles and emotional labor during crises (Capraro & Barcelo, 2020; Kleinberg *et al*., 2020; Alsharawy *et al*., 2021). Quantitative data show that 63% of respondents experienced fear at some point, with women exhibiting greater consistency in their reports. Our results highlight not only gender-specific emotional responses but also the ways in which fear is embedded in relational and structural contexts. This brings us to a key consideration: how fear is shaped by social structures and interpersonal dynamics.

4.1. Relational and structural dimensions of fear

Our findings support the idea that emotions are relational and structural phenomena shaped by cultural and societal norms (Bericat, 2016). In particular, we observe that women, who generally rely more on social connections for emotional support, reported greater distress linked to disruptions in these bonds. The significant differences in fear responses between men and women highlight how shared vulnerabilities during the pandemic translated into gendered emotional experiences, reinforcing previous research on the socio-affective impact of isolation (Finlay *et al*., 2021; Etchevers *et al*., 2020). One respondent vividly described the emotional toll: "*The silence in the house is deafening. I feel like I'm disappearing*." This aligns with Kemper's (1987) theory that emotions arise from power dynamics and relational disruptions, highlighting the role of societal structures in shaping emotional experiences.

In contrast, men prioritized economic and autonomy-related concerns, reflecting traditional expectations of men as providers and self-sufficient individuals. A male respondent stated, "*It's not just about getting sick; it's about losing control over my life and my ability to provide.*" This highlights how fear amplifies concerns tied to financial responsibility and independence (Capraro & Barcelo, 2020; Daoust, 2020). These findings reveal how emotional states like fear influence perceptions of loss differently for men and women, with women emphasizing socio-affective aspects and men focusing on economic and autonomy needs. While these patterns are important, they do not remain static over time. Fear is not a fixed state but fluctuates in response to evolving circumstances, requiring an examination of how individuals navigate emotional variability and resilience.

4.2. Fluctuations in fear and emotional resilience

The intra-case variation in fear levels with 41% of participants experiencing it intermittently points to the natural variability of emotions over time in response to the uncertain and evolving context of the pandemic. Emotional fluctuations in fear responses, as evidenced by these shifts, resonate with the findings of Özmen *et al.* (2021) and Khan *et al.* (2021), who observed that individuals' fear levels rose and fell with changing public health information, case numbers, and personal circumstances. One respondent shared, "*I started video-calling my family every day. It's not the same as being together, but it helps*." This demonstrates how adaptive strategies, such as leveraging social networks, can mitigate fears and enhance resilience.

Such fluctuations reflect the concept of emotional plasticity, where individuals adapt their emotional responses based on situational changes and coping strategies. Studies have noted that exposure to information about health risks can exacerbate anxiety, while social and family support can mitigate these fears over time (Caycho-Rodríguez *et al*., 2020).

However, not all individuals possess equal access to coping resources, a disparity that must be addressed in future interventions. While women emphasized the emotional toll of losing social connections, men reported a greater focus on disruptions to autonomy, reflecting a

gendered divergence in coping mechanisms (Buckley, 2016). These gendered divergences in coping strategies underscore the broader implications of isolation. The prolonged lockdown in Argentina exacerbated these losses, particularly in the socio-affective domain, which was especially salient for women.

4.3. Implications of isolation and socio-affective loss

Prolonged isolation during Argentina's strict lockdown had profound psychological effects, particularly on older adults. Quantitative results revealed that socio-affective losses were the most frequently reported category, with women significantly more likely to cite the loss of emotional support and connection. One respondent noted, "*It's not just loneliness – it's the fear that this will never end*." These narratives emphasize the compounded effects of isolation and uncertainty, as previously documented by Brooks *et al.* (2020) and Etchevers *et al.* (2020). Men, while less likely to report socio-affective losses, emphasized the erosion of autonomy caused by lockdown restrictions, further illustrating the complex interplay between societal norms and individual perceptions of loss. This interplay of societal expectations and personal experiences is also evident when examining age differences in fear perception. Older adults displayed notable stability in their emotional responses, which raises questions about the role of life experience in shaping fear management.

4.4. Age differences in fear perception

Older adults in this study demonstrated relative stability in fear levels compared to younger populations, a finding that aligns with Caycho-Rodríguez *et al.* (2020). This stability may stem from established coping mechanisms and a broader perspective on mortality, as Daoust (2020) noted. However, the stability observed should not diminish the emotional toll of isolation and perceived losses, particularly as these impacts vary significantly by gender. Understanding these emotional patterns is crucial for designing effective public health strategies. The varying expressions of fear across gender and age groups have direct implications for the formulation of interventions that account for diverse emotional needs.

4.5. Public health implications

The findings highlight the need for gender-sensitive public health interventions. Fear, as Mertens *et al.* (2020) argue, can motivate protective behaviors, such as mask-wearing and social distancing. However, excessive fear may lead to maladaptive outcomes, including panic and resistance to public health measures. This duality was evident in the responses, with some individuals describing fear as a motivator and others as a source of paralysis.

As Fitzpatrick *et al.* (2020) note, fear is a complex, multifaceted emotion that requires refined responses. By acknowledging the diverse ways fear manifests across demographics, public health officials can design more effective interventions that address both immediate needs and long-term emotional resilience.

4.6. Future research directions

The varying patterns of fear and loss perception among older adults underscore the importance of developing crisis response strategies that address gender-specific emotional needs. For women, particularly during periods of social isolation, mental health interventions should emphasize socio-affective support due to their stronger reliance on social connections and caregiving roles, as suggested by Reppas-Rindlisbacher *et al.* (2022). For men, targeted mental health services should focus on coping strategies for financial stability and autonomy, as these concerns are often tied to traditional social roles that emphasize self-sufficiency and economic independence (Lebrasseur *et al.*, 2021; Martins Van Jaarsveld, 2020).

Recognizing the diversity within the older adult population, interventions could be further refined by considering demographic variables such as educational and socioeconomic status, which shape access to coping resources and social support. Future research should explore how emotional responses to loss differ not only by gender but also across these age subgroups, age, socioeconomic status, physical and mental health, living conditions, support networks, residential typology, and geographic location, given that older adults are not a homogeneous group. Studies could investigate the role of media consumption and social support networks in shaping perceptions of fear and loss, as suggested by Burlacu *et al.* (2021) and Xue *et al.* (2020). In addition, examining how cultural values influence responses to autonomy and socio-affective losses may provide perspective into creating more culturally responsive interventions for diverse populations.

Understanding the contextual factors that drive fluctuations in fear, such as media exposure, health protocol changes, and personal health experiences, would also be valuable. Research by Khan *et al.* (2021) and Daoust (2020) suggests that these contextual influences are key to fostering resilience and adapting long-term mental health strategies. Such approaches could support older adults through the dynamic challenges of public health crises, enhancing their capacity to manage fear and perceived loss effectively over time.

4.7. Study limitations

This study has several limitations. The sample, consisting of older adults residing in Buenos Aires, may limit the

generalizability of findings to other geographic and sociocultural contexts. In addition, emotional responses and perceptions of loss were self-reported, which could introduce reporting biases. While the longitudinal approach allowed us to observe intra-individual fluctuations in fear over time, future studies could benefit from more frequent data points to capture finer variations in emotional response (Czymara *et al*., 2020; Schelhorn *et al*., 2022).

5. Conclusion

This study demonstrated that emotional responses to COVID-19 are deeply influenced by gender and social expectations. Our findings highlight the importance of considering gender dynamics in public health strategies during health emergencies. Gender differences in the perception of fear and emotional losses suggest that interventions should be specifically designed to address needs. Future research should explore how these dynamics vary across diverse cultural and socioeconomic contexts. Ultimately, understanding these differences is crucial for building more resilient societies in the face of future crises.

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Conflict of interest

The authors declare that they have no competing interests.

Author contributions

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Ethics approval and consent to participate

The consent form was evaluated and approved by the Academic Committee of Bioethics of the Universidad Nacional de Luján (DISPSEACAD-LUJ: 187-20).

Consent for publication

Survey participants gave their consent verbally during the telephone interviews.

Availability of data

Data can be obtained upon request to the corresponding author.

Further disclosure

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RESEARCH ARTICLE

Endowment insurance and family consumption behavior in China: A comparison based on the participation and payment stages

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Abstract

This paper examines the relationship between endowment insurance and household consumption in China, a key issue in understanding the role of social security policies in shaping household financial behavior. Using data from the China Family Panel Studies spanning 2012 – 2018, we employed a two-way fixed effects model and fuzzy breakpoint regression to analyze how participation in endowment insurance influences both consumption levels and structures. We focus on heterogeneity in consumption behavior across household registration types, geographic regions, and demographic characteristics such as age and income. The findings reveal that participating in endowment insurance generally enhances household consumption across various family types, with particularly strong effects for rural households, those in central regions, and families with members aged 60 and above. In addition, while participation in endowment insurance is associated with consumption upgrading, the receipt of pension benefits alone does not appear to influence consumption levels in the same way. A key result is the identification of a breakpoint in consumption behavior at pension age, after which household consumption tends to decline, especially in households with lower pension benefits. These results suggest that enhancing endowment insurance coverage and security could significantly boost household consumption and optimize spending patterns, particularly in rural and economically disadvantaged regions. Moreover, the findings have important policy implications for addressing income inequality and improving the economic welfare of vulnerable populations.

Keywords: Endowment insurance; Consumption level; Consumption structure; Heterogeneity; Fixed effects mode

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1. Introduction

The relationship between pension insurance and household financial behavior has long been a focal point in economic research, particularly as pension systems continue to evolve across different countries. In China, distinct pension policies for urban and rural residents have led to varied impacts on consumption, savings, investment patterns, and income distribution. Theoretical frameworks, such as the Life Cycle Hypothesis

(Ando & Modigliani, 1963) and the Permanent Income Hypothesis (Friedman, 1957), suggest that pension insurance serves as a substitute for savings, fostering consumption by providing future financial security. According to these models, pension income reduces the need for precautionary savings, thereby encouraging higher household consumption.

However, Feldstein (1974) argued that expectations of pension income could lead households to reduce savings and increase consumption, particularly in the case of early retirement. In addition, Barro & MacDonald (1979) contended that social security benefits could mitigate the negative consumption effects of taxation by redistributing wealth to younger generations. These theoretical underpinnings suggest that pension insurance can have significant effects on household financial behavior, though the precise influence depends on various factors such as the type of pension system and household characteristics.

Empirical evidence from China further supports the notion that participation in pension insurance generally leads to higher household consumption. Kotlikoff (1982) & Blake (2003) affirmed the positive relationship between pension insurance participation and household consumption. Similar findings by Li *et al.* (2023) found that financial literacy plays a crucial role in shaping how pension insurance influences household portfolio decisions. Urban households, with higher financial literacy, are more likely to invest in risky financial assets, whereas rural households, with lower financial literacy, are less inclined to hold such assets, thus exacerbating the urban-rural divide (Friedman, 1957). Moreover, Zheng *et al.* (2023) provided compelling evidence that pension expectations significantly influence household financial behavior. Evidence from Deng *et al.*'s study (2019) further reinforced these findings, demonstrating that social security programs, including pension insurance, reduce income inequality and alleviate financial uncertainty, thus stimulating household consumption. Wang & He (2024) extended this body of work, showing that commercial insurance can decrease precautionary savings, ease liquidity constraints, and, consequently, enhance consumption. However, the timing and structure of pension payments complicate the relationship between pension insurance and household consumption. Gale (1998) noted that households facing credit constraints may reduce current consumption despite future income guarantees, due to the higher marginal propensity to consume current income. This holds particularly true for households in situations where pension payments are irregular or insufficient to meet their immediate consumption needs.

The Absolute Income Hypothesis, further developed by Keynes (1936), asserts that consumption expenditure is directly correlated with current disposable income, making the receipt of pension benefits a critical determinant of consumption behavior. Lachowska & Myck (2018) demonstrated that public pension wealth in Poland serves as a substitute for private savings, a pattern similarly observable in China, where participation in social insurance correlates with lower household savings rates. Liu *et al.* (2023) examined the effects of pension insurance and demographic changes on asset allocation, revealing that younger, urban households with pension insurance are more inclined to hold risky assets, while older individuals, particularly in rural areas, tend to own safer assets such as cash deposits.

The Life Cycle Hypothesis proposed by Ando & Modigliani (1963) also sheds light on this relationship, suggesting that consumer spending is influenced by lifetime income, with rational consumers seeking to smooth consumption over their lifetimes. This theory posits that savings accumulated during working years should suffice for post-retirement needs, positioning pension insurance as a substitute for household savings, thereby facilitating current consumption. By alleviating concerns about retirement and providing future financial security, pension insurance enhances consumer confidence, which, in turn, stimulates current consumption. Pecchenino & Utendorf (1999) suggested that pension insurance facilitates the shift toward more sophisticated consumption structures.

The influence of pension insurance on income inequality has also been extensively studied. Upon evaluating China's New Rural Society Endowment Insurance Program, Shie *et al.* (2019) found that the program increased consumption in rural areas, particularly in food, daily necessities, and utilities. Li & Tang (2024) found that the development of pension insurance initially widened the urban-rural income gap, but ultimately contributed to its narrowing over time. Further, Lei & Yanping (2022) demonstrated that pension insurance enhances consumption structures in rural areas, particularly in less developed regions, though its impact is weaker in wealthier urban centers. Chen & Han (2024) corroborated these findings, showing that pension insurance has a more pronounced effect on consumption among low-income households, particularly in economically disadvantaged regions, with a less significant impact on higher-income families. In addition to its influence on financial behavior, pension insurance also affects health-related decisions. Yu & Xia (2024) discovered that basic endowment insurance increases individuals' awareness of health risks, which leads to higher health-related consumption. Similarly, Jin & Shu (2024) revealed that flexible workers who participate in pension insurance tend to exhibit higher

consumption levels. In addition, Tian & Huang (2024) found that pension insurance reduces income uncertainty, encouraging households, particularly in rural areas, to diversify their asset holdings.

Research has also explored pension insurance's role in shaping housing wealth and asset allocation. Ertuğrul & Gebeşoğlu (2020) found that Turkey's private pension system significantly contributed to domestic savings and economic growth. Unnikrishnan & Imai (2020) showed that India's pension scheme enhanced consumption and asset accumulation, particularly among women. However, Madeira (2022) & Kang *et al.* (2022) noted that large-scale pension withdrawals, such as those during the COVID-19 pandemic in Chile and South Korea, temporarily boosted consumption but ultimately led to long-term reductions in savings.

In this investigation, we aimed to better understand how endowment systems influence household consumption based on the participation and payment stages in the context of China's pension landscape. The primary contribution of this article lies in three key areas. One of the most innovative aspects is its comparative approach to understanding the impact of pension insurance on household consumption. The research distinguishes between different stages of pension insurance—participation and payment—and analyzes their effects on consumption at each stage. By examining how these two aspects influence household behavior, the study offers crucial insights into how pension systems can be structured to optimize consumption patterns. The second contribution lies in its macroeconomic analysis of the heterogeneous effects of pension insurance policies. Rather than assuming a uniform impact across households, the research provides a nuanced understanding of how pension insurance influences various consumption categories—food, clothing, housing, healthcare, and more. This detailed breakdown allows for a deeper exploration of the consumption dynamics within different segments of society. The third aspect focuses on the equity implications of pension insurance in promoting inclusive economic development and social welfare. By examining how pension insurance affects household consumption across different income and age groups, this study highlights the role of social security policies in addressing inequalities. Taken together, the findings from this study are crucial for optimizing pension systems to reduce disparities and for ensuring that benefits are distributed in ways that foster broader economic stability and welfare.

2. Methods

2.1. Data

In this study, we utilized data from the China Family Panel Studies (CFPS) conducted by the Institute of Social Science Survey at Peking University, China. The CFPS surveys were conducted in 2012, 2014, 2016, and 2018, and the 2010 survey was excluded due to missing variable information. To address the issue of missing data, we employed multiple imputations, a method that allows for the creation of several plausible datasets based on observed values, ensuring more accurate and unbiased estimates. Winsorization was conducted on continuous variables, adjusting them to the 1st and 99th percentiles. Economic variables were adjusted for price using the national Consumer Price Index with 2012 as the base year. In regression analysis, the logarithm of adjusted quantities was used for smoother results. A balanced panel dataset of 35,872 observations from 8,968 households across the 4-year period formed the basis for analysis and findings.

2.2. Variables

The explanatory variables related to endowment insurance included a participation dummy variable, a variable denoting the type of endowment insurance, and the amount of pension income received. Control variables were incorporated to account for a range of demographic and socioeconomic characteristics. At the individual level, these characteristics include age, total income, gender, household registration status, marital status, education level, health status, and employment status. Household-level variables encompassed the number of household members, demographic composition, financial assets, property values, liabilities, and expenditures on commercial insurance. In addition, a dummy variable was employed to indicate the presence of risky financial assets. A comprehensive overview of these variables is provided in Table 1.

2.3. Model

We use a two-way fixed effects model with panel data to study the effect of endowment insurance on household consumption behavior. The Hausman test indicated that the fixed effect model was more appropriate for our data, as it suggested a significant correlation between the individual effects and the explanatory variables. The function is specified as follows:

$$\ln(\text{consumptio}_{i,t}) = \alpha + \beta_1 \text{insured}_{i,t} + \beta_2 \ln(\text{payment}_{i,t}) + X_{i,t}\gamma + \lambda_t + \delta_t + \varepsilon_{i,t} \quad (I)$$

Where $\ln(\text{consumptio}_{i,t})$ represents household consumption (log), using total and disaggregated variables in the regressions, respectively; insured i,t represents insured status, using 0 – 1 dummy variables for participation or not and multicategory dummy variables for type of endowment insurance in the regressions; $\ln(\text{payment}_{i,t})$ represents pension (log); $X_{i,t}$ includes a series

Table 1. Variables

Variable type	Variable name	Variable description
Explained variable	Household consumption (yuan)	Household consumption expenditure excluding commercial insurance expenditure
Explanatory variables	Participation in endowment insurance	1- The householder participates in endowment insurance 0- The householder does not participate in endowment insurance
	Types of endowment insurance	1- Pension received from the institution where he or she used to work after retirement 2- Basic endowment insurance 3- Enterprise supplementary endowment insurance 4- Commercial endowment insurance 5- Old rural endowment insurance 6- New rural social endowment insurance 7- Urban and rural resident endowment insurance
	Pension (yuan)	Amount of pensions received from endowment insurance
Control variables	Income of household head (yuan)	Including post-tax monetary salary, post-tax bonus income, and post-tax subsidy income
	Value of financial assets (yuan)	The value of financial assets refers to the total value of cash, deposits, stocks, bonds, funds, and other financial products
	Net property value (yuan)	The difference between household property value and mortgage
	Non-mortgage liabilities (yuan)	Non-mortgage liabilities include bank borrowings and private borrowings pending loan repayment
	Commercial insurance expenditure (yuan)	Premiums paid for commercial insurance
	Risk preference	Whether the household holds risky financial assets such as stocks and funds: 1- Household holds risky financial assets 0- Household does not hold risky financial assets
	Gender of household head	1- Male 0- Female
	Age of household head (year)	Actual age of household head
	Household registration type	1- Urban 0- Rural
	Marital status	1- Married 0- Unmarried
	Education level	1- College and above 0- Below college
	Health status	1- Fair or good 0- Poor
	Employment status of household head	1- With a job 0- No job
	Number of family members (unit)	Number of family members
	Old-age dependency ratio (%)	Family demographics: Ratio of the number of people aged 65 years old and above to the number of working people aged 16 – 64

of control variables; λ_t represents household fixed effects; δ_t represents year fixed effects;and $\varepsilon_{i,t}$ is the unobserved disturbance term in the household and year dimensions.

3. Results

3.1. Descriptive statistics

Table 2 presents the descriptive statistics for household consumption, revealing considerable variability across different expenditure categories. The mean total household consumption stands at 44417 yuan, with a substantial standard deviation of 44815 yuan, indicating significant heterogeneity in consumption patterns. Food expenditure averages 15121 yuan, while expenditures on clothing and housing are notably lower, at 4391 yuan and 3063 yuan, respectively. Spending on household equipment, healthcare, and transportation shows considerable variation, with standard deviations exceeding 13000 yuan in certain categories. Education and entertainment expenses average 4354 yuan, accompanied by a high degree of variation (standard deviation of 7491 yuan). In addition, expenditures on other consumption items, such as commercial insurance, exhibit even greater disparities. These

Table 2. Descriptive statistics (*n*=35872)

Variables	Average value	Standard deviation	Minimum value	Maximum value
Household consumption (yuan)	44,417	44,815	2,660	2,66,100
Food expenditure (yuan)	15,121	13,220	0	64,125
Clothing expenditure (yuan)	4,391	10,033	0	76,911
Housing expenditure (yuan)	3,063	5,290	0	38,986
Household equipment and daily necessities expenditure (yuan)	6,082	17,321	0	1,28,562
Health care expenditure (yuan)	4,354	8,360	0	55,433
Transportation and communication expenditure (yuan)	3,750	4,499	0	25,650
Education and entertainment expenditure (yuan)	4,354	7,491	0	39,542
Other consumption expenditures (yuan)	824.8	2,071	0	14,400
Participated in endowment insurance (dichotomous variable)	0.399	0.490	0	1
Receiving a pension from the institution where he or she used to work after retirement (dichotomous variable)	0.029	0.169	0	1
Having a basic endowment insurance (dichotomous variable)	0.101	0.302	0	1
Having a supplementary enterprise endowment insurance (dichotomous variable)	0.014	0.116	0	1
Having a commercial endowment insurance (dichotomous variable)	0.014	0.117	0	1
Having an old rural endowment insurance (dichotomous variable)	0.035	0.182	0	1
Having a new rural social endowment insurance (dichotomous variable)	0.225	0.418	0	1
Having an urban and rural residents endowment insurance (dichotomous variable)	0.026	0.159	0	1
Monthly pension (yuan)	736.6	3,393	0	25,200
Mean income of household head (yuan)	33,159	38,158	0	1,87,031
Value of financial assets (yuan)	40,540	89,948	0	5,73,329
Net property value (yuan)	4,01,809	38,67,000	0	7,00,000,000
Total mortgage (yuan)	20,347	96,635	0	46,19,000
Non-mortgage liabilities (yuan)	8,923	28,586	0	1,87,031
Commercial insurance expenditure (yuan)	995.700	2,939	0	18,478
Risk preference (dichotomous variable)	0.054	0.226	0	1
Men (dichotomous variable)	0.518	0.500	0	1
Mean age (year)	50.250	14.100	18	95
Urban household registration type (dichotomous variable)	0.274	0.446	0	1
Married (dichotomous variable)	0.861	0.346	0	1
Receiving a tertiary education (dichotomous variable)	0.074	0.261	0	1
Good health (dichotomous variable)	0.811	0.391	0	1
Employed (dichotomous variable)	0.751	0.432	0	1
Number of family members (unit)	3.808	1.855	1	21
% Old-age dependency ratio	0.620	1.406	0	7

Notes: The old-age dependency ratio tends to be infinite for households with no working people, so we adjusted the value. Since the highest old-age dependency ratio for an average household is 3, the number of household members over 65 (1, 2, 3, 4) is assigned a value of (4, 5, 6, 7) to reflect the old-age dependency burden of the household.

statistics underscore the uneven distribution of household consumption, which is likely influenced by factors such as income, asset levels, and individual preferences, highlighting the complex nature of household spending behavior.

To address large standard deviations, this study applied logarithmic transformations to certain variables. This reduces scale differences and extreme values, creating a more suitable data distribution for analysis.

3.2. Impact of endowment insurance on household consumption levels

The impact of participation in endowment insurance and receiving a pension on household consumption levels was analyzed using a benchmark regression. The results in Table 3 show three models: (1), (2), and (3).

The regression results provide valuable insights into the relationship between endowment insurance participation and household consumption, both statistically and economically. In Model (1), the statistically significant coefficient for the insurance participation dummy variable indicates that involvement in endowment insurance significantly affects household consumption levels. This finding suggests that households with endowment insurance exhibit distinct consumption patterns compared to those without such coverage. However, it is important to note that this result solely reflects the effect of participation in the insurance scheme, without accounting for the actual pension income received.

In Model (2), where the continuous variable representing the amount of pension income is introduced, the lack of statistical significance in its coefficient suggests that the amount of pension income alone does not substantially influence household consumption. This implies that while the mere presence of endowment insurance has an impact on consumption behavior, the specific pension amount may not directly affect consumption decisions. Model (3) offers a more nuanced perspective by including both the insurance participation dummy variable and the pension income variable. The highly significant coefficients for both variables suggest that both participation in endowment insurance and the amount of pension income play vital roles in shaping household consumption. This finding

Table 3. Two-way fixed effects regression

Independent variable	Models		
	(1)	(2)	(3)
	Dependent variable: Household consumption (log)		
Participated in endowment insurance (dichotomous variable)	0.12***		0.13***
Pension (log)		0.00	0.00**
Income of household head (log)	0.01***	0.01***	0.01***
Value of financial assets (log)	0.01***	0.01***	0.01***
Net property value (log)	0.01***	0.01***	0.01***
Non-mortgage liabilities (log)	0.02***	0.02***	0.02***
Commercial insurance expenses (log)	0.05***	0.05***	0.05***
Risk preference (dichotomous variable)	0.08***	0.09***	0.08***
Gender of household head (dichotomous variable)	0.02*	0.02*	0.02*
Age of household head (year)	-0.00***	-0.00***	-0.00***
Household registration type (dichotomous variable)	0.07***	0.07***	0.07***
Marital status (dichotomous variable)	0.13***	0.14***	0.13***
Education level (dichotomous variable)	0.13***	0.16***	0.13***
Health status (dichotomous variable)	−0.01	−0.01	−0.01
Employment status of household head (dichotomous variable)	−0.03**	−0.01	−0.03*
Number of family members (unit)	0.03***	0.02***	0.03***
% Old-age dependency ratio	0.01	0.01	0.01
Constant	9.84***	9.87***	9.85***
Household fixed effects	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes
Fixed effects F test	2.83 (p=0.000)	2.81 (p=0.000)	2.81 (p=0.000)
Model significance test	151.56 (p=0.000)	151.52 (p=0.000)	143.99 (p=0.000)
Within R^2	0.11	0.11	0.11
Sample size	35872	35872	35872

Notes: *P<0.1; **P<0.05; ***P<0.01.

implies that households with endowment insurance not only display distinct consumption patterns compared to those without coverage, but the actual pension income further influences consumption decisions.

3.3. Impact of endowment insurance on household consumption structure

Table 4 presents the regression results that explore the impact of endowment insurance on various categories of household consumption expenditures. This analysis aims to assess whether participation in endowment insurance influences the magnitude of household spending across different expenditure categories.

The regression results reveal significant effects of both insurance participation and pension receipt on various categories of household consumption expenditures. Insurance participation is positively associated with all consumption categories, underscoring its role in enhancing overall household consumption. Specifically, expenditures on clothing, transportation and communication, education and entertainment, and other goods are notably influenced by insurance participation. This suggests that insured households allocate a larger share of their budget to these categories compared to uninsured households.

In contrast, the receipt of a pension exhibits a more nuanced effect on consumption. While it significantly increases expenditures on clothing and healthcare, it also leads to substantial reductions in housing and other categories. This pattern suggests that pension-receiving households may prioritize spending on clothing and healthcare, likely due to the financial security afforded by pension income. However, they may reduce expenditures on housing and other items, potentially as a means of compensating for the fixed nature of pension benefits.

In the following analysis (Table 5), we utilized the relative value of various consumption expenditures as the dependent variable in the regression. This approach allowed us to investigate the impact of endowment insurance on the evolution of household consumption structure.

The regression results presented in Table 5 offer valuable insights into the relationship between endowment insurance participation and household expenditure patterns. Participation in endowment insurance is found to significantly influence consumption behavior across various expenditure categories. Specifically, insured households tend to allocate a smaller proportion of their total consumption to food expenditures, indicating a decrease in food spending. This suggests that endowment insurance alleviates financial pressure on essential needs, allowing households to reallocate resources to other areas of consumption.

Table 4. Two-way fixed effects regression results of endowment insurance on different types of consumption expenditure

	Models							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Food	Clothing	Housing	Household equipment and daily necessities	Health care	Transportation communication	Education and entertainment	Other
Participation in endowment insurance (dichotomous variable)	0.18***	0.50***	0.15***	0.3***	0.15***	0.27***	0.36***	1.01***
	0.01	0.08***	−0.06***	0.00	0.02**	0.01	0.01	−0.03***
Pension (log)	8.23***	5.92***	6.55***	6.60***	5.66***	6.79***	3.88***	2.27***
Constant	Join	Join	Join	Join	Join	Join	Join	Join
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Household fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	1.52 (p=0.000)	1.49 (p=0.000)	1.38 (p=0.000)	1.48 (p=0.000)	1.92 (p=0.000)	1.92 (p=0.000)	3.38 (p=0.000)	1.68 (p=0.000)
Fixed effects F test	41.79 (p=0.000)	226.70 (p=0.000)	81.56 (p=0.000)	67.77 (p=0.000)	28.54 (p=0.000)	69.76 (p=0.000)	62.27 (p=0.000)	175.47 (p=0.000)
Model significance test	0.04	0.17	0.07	0.06	0.02	0.06	0.05	0.16
Within R^2	35872	35872	35872	35872	35872	35872	35872	35872
Sample size								

Notes: *P<0.1; **P<0.05; ***P<0.01.

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Table 5. Two-way fixed effects regression results of endowment insurance on consumption structure

	Models							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Food	Clothing	Housing	Household equipment and daily necessities	Health care	Transportation and communication	Education and entertainment	Other
Participating in endowment insurance	−0.04***	0.03***	0.01***	0.00	0.00	0.01***	0.01***	−0.01***
Pension (log)	−0.00	0.00***	−0.00***	0.00	0.00*	−0.00	−0.00	0.00***
Constant	0.43***	0.06***	0.11***	0.09***	0.13***	0.09***	0.06***	0.03***
Control variables	Join	Join	Join	Join	Join	Join	Join	Join
Household fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fixed effects F test	1.71 (p=0.000)	1.15 (p=0.000)	1.15 (p=0.000)	1.18 (p=0.000)	1.91 (p=0.000)	1.77 (p=0.000)	2.85 (p=0.000)	1.14 (p=0.000)
Model significance test	42.81 (p=0.000)	202.57 (p=0.000)	146.18 (p=0.000)	17.94 (p=0.000)	23.04 (p=0.000)	10.59 (p=0.000)	7.89 (p=0.000)	28.66 (p=0.000)
Within R^2	0.04	0.15	0.15	0.02	0.02	0.01	0.01	0.04
Sample size	35872	35872	35872	35872	35872	35872	35872	35872

Notes: *P<0.1; **P<0.05; ***P<0.01.

Conversely, participation in endowment insurance is positively associated with increased expenditures on clothing, transportation and communication, education and entertainment, and housing. This implies that insured households devote a larger share of their consumption budget to these categories compared to uninsured households. The positive effects on these expenditure categories suggest that endowment insurance enhances households' ability to afford and prioritize spending on comfort, mobility, education, entertainment, and housing, thereby contributing to overall well-being and quality of life.

3.4. Heterogeneity analysis

To explore the disparities between urban and rural households, we conducted a heterogeneity analysis based on household registration status. The analysis focused on households with unchanged registration status over a 4-year period, resulting in a final sample of 7224 urban households and 23008 rural households.

The regression results in Table 6 reveal distinct consumption behaviors across these groups. Urban households with endowment insurance demonstrate higher overall consumption levels; however, the impact of pension receipt on their consumption is not statistically significant. In contrast, rural households with endowment insurance and pensions exhibit a substantial increase in consumption, with a notable positive correlation between pension receipt and higher consumption levels—approximately 0.8% more than households without pensions. Furthermore, the analysis indicates that rural households experience a faster rate of consumption growth compared to urban households with similar income increases. This suggests that rural endowment insurance plays a more pronounced role in stimulating consumption than its urban counterpart.

The analysis presented in Table 7 examines household consumption across different regional development levels in China—Eastern, Central, Western, and Northeast. The results indicate that endowment insurance significantly boosts consumption in all regions. However, pensions only show a positive effect on consumption in the central region, highlighting the region-specific role of pensions. Income increases have the most significant impact in the central region, followed by the western, northeastern, and eastern regions.

In terms of age groups in Table 8, households with members under 60 show a 9.9% increase in consumption when insured. Conversely, for households with members aged 60 and above, pensions are associated with a decrease in consumption. These findings underscore the positive

influence of endowment insurance on younger individuals while suggesting potential downsides for older recipients.

3.5. Robustness check

3.5.1. The impact of participating in different types of endowment insurance on household consumption levels

Table 9 illustrates the distribution of participants across various types of endowment insurance, showing how many are exclusively involved in each type versus those who might have multiple types of coverage. Of the 35872 households in the sample, 14225 participate in endowment insurance, with the majority engaged in a single type.

Table 6. Regression results of consumption of households with different household registration

Independent variable	Models	
	(1)	(2)
	Urban household registration	Rural household registration
	Dependent variable: Household consumption	
Participation in endowment insurance	0.116*** (4.891)	0.127*** (10.835)
Pension (log)	0.002 (0.731)	0.008** (2.438)
Constant	9.893*** (94.387)	9.763*** (190.600)
Control variables	Join	Join
Household fixed effects	Yes	Yes
Year fixed effects	Yes	Yes
Fixed effects F test	2.980 (p=0.000)	2.620 (p=0.000)
Model significance test	46.350 (p=0.0000)	86.750 (p=0.0000)
Within R^2	0.162	0.101
Sample size	7224	23008

Notes: *p<0.1; **p<0.05; ***p<0.01.

The results shown in Table 10 reveal that pensions from previous institutions do not have a statistically significant effect on household consumption. In contrast, basic endowment insurance for urban employees is associated with an 11.1% increase in consumption, indicating a strong positive impact. Similarly, supplementary enterprise endowment insurance leads to a 6.7% increase in consumption, underscoring its role in enhancing household spending.

Conversely, commercial endowment insurance appears to have a slight negative effect, although this result is not statistically significant, suggesting that further investigation may be necessary to understand this trend more comprehensively. Old rural endowment insurance, new rural social pension insurance, and urban and rural residents endowment insurance are all positively and statistically significantly associated with increased household consumption, with coefficients of 0.141, 0.106, and 0.088, respectively ($p < 0.01$).

3.5.2. Breakpoint regression

The breakpoint regression analysis examines the impact of pension receipt on household consumption, with particular attention to retirement age eligibility in China. Specifically, men are eligible for pensions at age 60, while women qualify at ages 50 and 55. In rural areas, individuals become eligible for pensions at age 60. To ensure

Table 7. Regression results of household consumption in different development regions

Independent variable	Models			
	(1)	(2)	(3)	(4)
	Eastern Region	Central Region	Western Region	Northeast Region
	Dependent variable: Household consumption			
Participation in endowment insurance	0.104*** (5.790)	0.183*** (9.502)	0.107*** (6.030)	0.079*** (3.222)
Pension (log)	0.004 (1.252)	0.008** (1.976)	0.003 (0.774)	0.005 (1.555)
Constant	9.841*** (113.538)	9.781*** (108.041)	9.730*** (144.461)	10.037*** (86.392)
Control variables	Join	Join	Join	Join
Household fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Fixed effects F test	3.080 (p=0.000)	2.780 (p=0.000)	2.330 (p=0.000)	3.040 (p=0.000)
Model significance test	52.220 (p=0.000)	53.560 (p=0.000)	35.750 (p=0.000)	15.420 (p=0.000)
Within R^2	0.127	0.154	0.097	0.075
Sample size	11328	8872	9944	5728

Notes: *p<0.1; **p<0.05; ***p<0.01.

Table 8. Regression results of household consumption for different ages

Independent variable	Type I households (under 60 years old)	Type II households (60 years old and above)
	Dependent variable: Household consumption	
Participation in endowment insurance	0.099*** (9.104)	
Pensions (log)		−0.008** (−2.356)
Constant	9.808*** (195.646)	9.931*** (58.019)
Control variables	Join	Join
Household fixed effects	Yes	Yes
Year fixed effects	Yes	Yes
Fixed effects F test	2.820 (p=0.000)	2.870 (p=0.000)
Model significance test	103.400 (p=0.000)	17.070 (p=0.000)
Within R^2	0.112	0.116
Sample size	22440	4484

Notes: *p<0.1; **p<0.05; ***p<0.01.

consistency, the analysis focuses on households with male heads and employs a fuzzy breakpoint regression approach to account for variations in pension receipt relative to the retirement age.

Figures 1 and 2 reveal distinct jump points near the retirement age, indicating a relationship between pension receipt and household consumption. The fuzzy breakpoint regression results presented in Table 11, utilizing the IV-2SLS method, isolates the effect of pension receipt by using age 60 as an instrumental variable.

The results demonstrate a significant negative effect of pension receipt on household consumption, suggesting that receiving a pension leads to a reduction in spending. Table 12 demonstrates a significant negative effect of pension receipt on household consumption, suggesting that receiving a pension leads to a reduction in spending. Furthermore, the analysis in Figure 3 confirms that the conditional densities of covariates remain continuous at the breakpoints, showing no significant jumps. This reinforces the validity of the fuzzy breakpoint regression model and supports the conclusion that receiving a pension may have an adverse effect on household consumption.

3.5.3. Placebo test

The placebo test was conducted to evaluate the robustness of the breakpoint regression results by introducing alternative breakpoints at ages 55 and 65. This involved assessing the impact of these new breakpoints on pension receipt and household consumption.

Table 9. Number of participants in different endowment insurance

Types of pension insurance	Sample number of participants	Sample size for this type of insurance only
Pension received from the institution where he or she used to work after retirement	1051	556
Basic endowment insurance	3634	2610
Supplementary enterprise endowment insurance	493	195
Commercial endowment insurance	498	173
Old rural endowment insurance	1236	1045
New rural social endowment insurance	8070	7543
Urban and rural residents' endowment insurance	935	594

Initially, we selected ages 55 and 65 as alternative breakpoints. Table 13 presents the results, revealing that age effects on pension receipt are generally not statistically significant at these breakpoints, except for a few marginal cases. Similarly, the impact of pension receipt on consumption remains mostly insignificant across different age ranges. These findings indicate that the treatment effect is specific to age 60, thereby confirming the robustness of the original breakpoint regression results.

Subsequently, we excluded 302 samples near the original breakpoint of age 60 to address potential manipulation concerns. Table 14 shows that even after this exclusion, the effects of being over 60 on pension receipt remain statistically significant at the 1% level. In addition, the impact of pension receipt on consumption continues to be significant across various age ranges, suggesting that the causal relationship persists despite the removal of samples near the breakpoints.

Finally, we performed a placebo test by omitting all control variables to determine if the observed effects were driven by covariates. The results in Table 15 demonstrate that the effects of age over 60 on pension receipt and the subsequent impact on household consumption remain statistically significant at the 1% level. This confirms that the consumption jump at the breakpoint is not attributable to the inclusion of control variables, thereby supporting a causal relationship between pension receipt and household consumption.

Overall, the placebo tests validate the robustness of the breakpoint regression findings, indicating that the significant increase in consumption at age 60 is not influenced by alternative breakpoints, sample exclusion, or

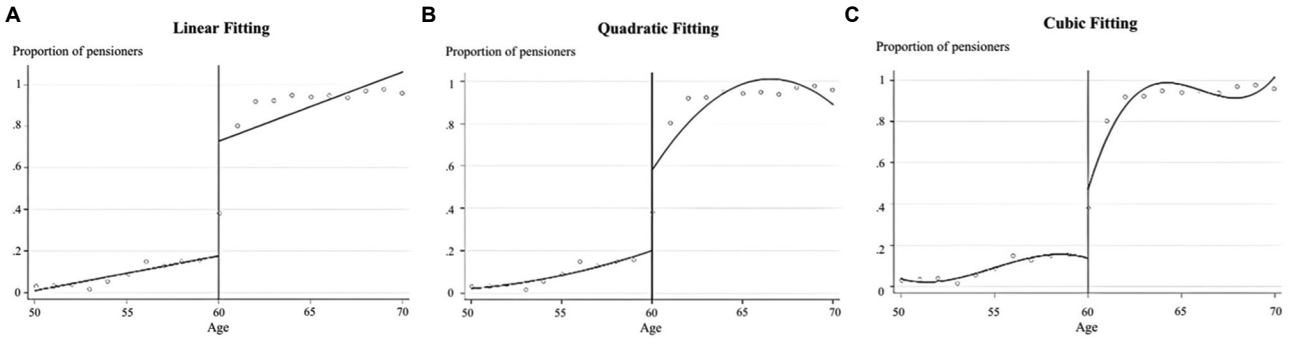

Figure 1. Proportion of the population receiving pensions by age. (A) Linear fitting; (B) Quadratic fitting; (C) Cubic fitting.

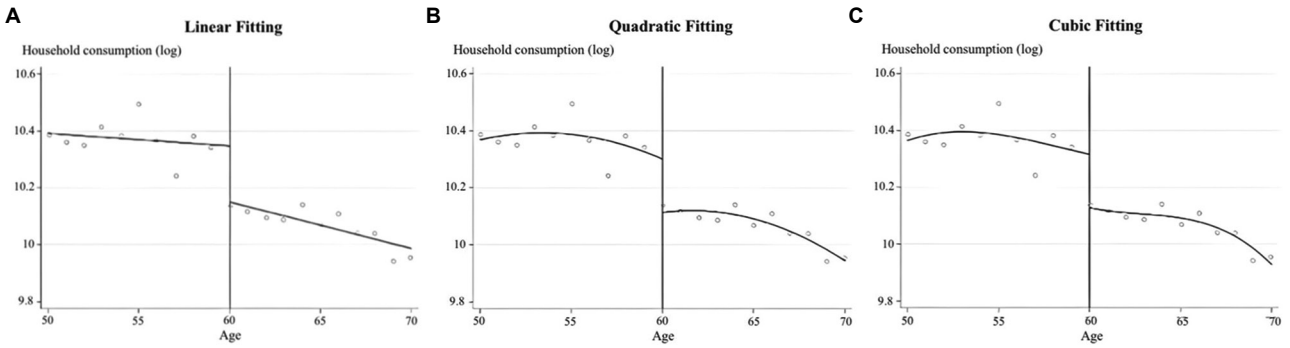

Figure 2. Household consumption (log) of the population by age. (A) Linear fitting; (B) Quadratic fitting; (C) Cubic fitting.

Table 10. Regression results of endowment insurance type on household consumption

Independent variable	Dependent variable: Household consumption
Pension received from the institution where he or she used to work after retirement	0.017 (0.677)
Basic endowment insurance	0.111*** (7.340)
Supplementary enterprise endowment insurance	0.067** (2.022)
Commercial endowment insurance	−0.013 (−0.369)
Old rural endowment insurance	0.141*** (5.946)
New rural social pension insurance	0.106*** (9.576)
Urban and rural residents' endowment insurance	0.088*** (3.638)
Pension (log)	0.004** (2.043)
Constant	9.852*** (240.242)
Control variables	Join
Household fixed effects	Yes
Year fixed effects	Yes
Fixed effects F test	2.79 (p=0.0000)
Model significance test	111.68 (p=0.0000)
Within R^2	0.1129
Sample size	35872

Notes: *p<0.1; **p<0.05; ***p<0.01.

control variables, thereby affirming a causal link between pension receipt and household consumption.

4. Discussion

The findings of this study provide significant insights into the intricate relationship between pension insurance and household consumption, underscoring the pivotal role that endowment insurance plays in shaping household economic behavior. Specifically, the substantial increase in household consumption associated with pension participation illustrates the asset substitution effect, which suggests that the availability of a stable and predictable income stream from pensions alleviates the need for precautionary savings. This shift enables households to reallocate more of their current income toward consumption, thereby stimulating economic activity (Feldstein, 1974; Hubbard *et al.*, 1995).

The asset substitution effect is instrumental in explaining why households exhibit a greater propensity to increase consumption when they receive guaranteed pension income. With the security of stable pensions, households feel less compelled to save for an uncertain future, allowing them to direct more resources toward immediate consumption. This behavioral pattern aligns with the Permanent Income Hypothesis (Friedman, 1957), which posits that individuals base their consumption

Table 11. Age, pension receipt, and household consumption

	Age range			
	±1	±2	±3	±4
Impact of age >60 on receiving pension	0.451*** (0.031)	0.566*** (0.022)	0.617*** (0.017)	0.649*** (0.015)
Impact of receiving pension on household consumption	−0.374*** (0.125)	−0.271*** (0.075)	−0.193*** (0.058)	−0.187*** (0.048)
Sample size	972	1626	2224	2834

Notes: *p<0.1; **p<0.05; ***p<0.01.

Table 12. Covariate test

Covariates	Age range			
	±1	±2	±3	±4
Income of household head (log)	−0.406 (0.389)	−0.176 (0.675)	−0.034 (0.662)	−0.130 (0.498)
Net property value (log)	0.246 (0.242)	0.102 (0.475)	0.040 (0.469)	−0.042 (0.347)
Non-mortgage liabilities (log)	−0.185 (0.331)	−0.376 (0.587)	−0.383 (0.575)	−0.237 (0.431)
Commercial insurance expenditure (log)	−0.232 (0.256)	0.006 (0.468)	0.006 (0.460)	−0.198 (0.339)
Risk preference	0.009 (0.018)	0.028 (0.033)	0.025 (0.032)	0.032 (0.024)
Household registration type	−0.013 (0.039)	0.016 (0.069)	0.006 (0.068)	−0.037 (0.051)
Marital status	−0.007 (0.022)	−0.008 (0.039)	−0.005 (0.039)	0.006 (0.028)
Education level	0.024 (0.016)	0.042 (0.027)	0.036 (0.027)	0.023 (0.019)
Health status	−0.047 (0.033)	−0.041 (0.057)	−0.039 (0.055)	−0.051 (0.042)
Employment status of household head	−0.039 (0.031)	−0.052 (0.054)	−0.055 (0.053)	−0.036 (0.040)
Number of family members	−0.023 (0.172)	0.241 (0.307)	0.253 (0.300)	0.079 (0.219)
Old-age dependency ratio	0.007 (0.024)	−0.005 (0.035)	−0.014 (0.034)	0.000 (0.029)

Table 13. Placebo test - change breakpoint location

	Age range			
	±1	±2	±3	±4
Impact of age >55 on receiving pension	0.063 (0.023)	0.086 (0.016)	0.092* (0.013)	0.099** (0.012)
Impact of receiving pension on household consumption	0.767 (1.116)	−0.335 (0.594)	−0.084 (0.453)	−0.096 (0.371)
Sample size	744	1245	1808	2358
	±1	±2	±3	±4
Impact of age >65 on receiving pension	−0.005 (0.014)	0.006 (0.011)	0.018* (0.010)	0.055*** (0.009)
Impact of receiving pension on household consumption	10.196 (30.595)	−7.030 (16.007)	−2.344 (2.535)	−1.156* (0.649)
Sample size	1124	1806	2503	3167

Notes: *p<0.1; **p<0.05; ***p<0.01.

Table 14. Results of placebo test after excluding samples near breakpoints

	Age range			
	±1	±2	±3	±4
Impact of age >60 on receiving pension	0.646*** (0.030)	0.709*** (0.020)	0.736*** (0.016)	0.752*** (0.013)
Impact of receiving pension on household consumption	−0.349*** (0.118)	−0.361*** (0.075)	−0.306*** (0.061)	−0.299*** (0.052)
Sample size	670	1324	1922	2532

Notes: *p<0.1; **p<0.05; ***p<0.01.

Table 15. Results of placebo test after excluding control variables

	Age range			
	±1	±2	±3	±4
Impact of age >60 on receiving pension	0.463*** (0.032)	0.576*** (0.022)	0.632*** (0.018)	0.666*** (0.015)
Impact of receiving pension on household consumption	−0.467*** (0.149)	−0.429*** (0.088)	−0.343*** (0.067)	−0.330*** (0.056)
Sample size	972	1626	2224	2834

Notes: *p<0.1; **p<0.05; ***p<0.01.

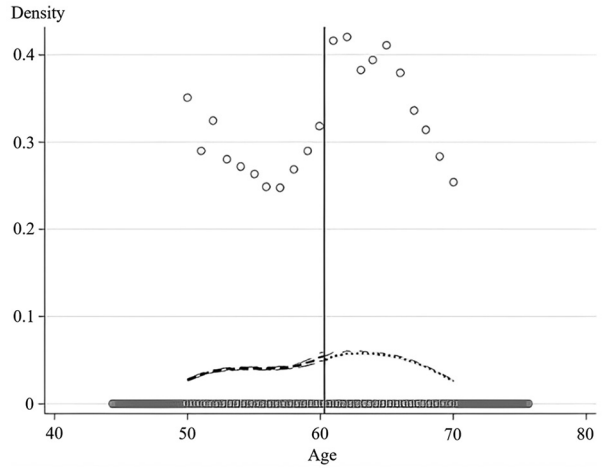

Figure 3. Density function of grouping variables

decisions not solely on current income but also on expectations of lifetime income. Households with pension plans view future benefits as integral components of their financial portfolios, prompting them to adjust their consumption patterns accordingly.

Further analysis reveals the complex mechanisms that underlie household consumption patterns across different pension schemes. Government endowment insurance emerges as a prominent driver of increased consumption, suggesting that the predictability and stability of such benefits encourage discretionary spending (Blake, 2003). In contrast, the limited or even negative impact of commercial insurance raises concerns regarding its perceived value. This reflects consumer confidence theories, which contend that households may regard commercial insurance as less reliable, thereby leading to hesitancy in altering consumption behavior (Barro & MacDonald, 1979).

The varying effects of different pension schemes—particularly the strong influence of institutional endowment insurance compared to the limited or negative effects of commercial insurance—highlight the critical role of consumer confidence. Households tend to perceive institutional pensions as more reliable due to their government backing and predictability. In contrast, commercial insurance products may be perceived as riskier or less beneficial, a discrepancy that underscores the importance of perceived value in shaping consumer attitudes and consumption behavior (Thaler, 1991).

Moreover, the effects of pension receipt are not uniform across different demographic groups or regions. For instance, rural households may experience a more pronounced increase in consumption from pensions due to their relatively lower baseline economic resources. This disparity can be explained by the Relative Income Hypothesis, which suggests that individuals' consumption decisions are influenced by their income relative to others within their community (Yi *et al*., 2008). In less affluent areas, the additional pension income can lead to more significant changes in consumption behavior as families prioritize immediate needs.

In addition to these immediate shifts, the transformative effects of endowment insurance can be observed across several broader dimensions. First, endowment insurance contributes to a fundamental shift in household financial strategies. By providing a predictable future income stream, it alleviates households' need for precautionary savings, which are traditionally driven by uncertainty about future income. As a result, households may increase their current consumption, particularly in discretionary areas such as entertainment and leisure, which have historically been constrained by concerns over future financial insecurity (Feldstein, 1974; Hubbard *et al*., 1995). This shift marks a crucial change in household financial planning, allowing for greater current spending and investment in immediate needs.

The long-term impact of endowment insurance on household welfare is also noteworthy. Over time, as individuals accumulate pension entitlements, they may increasingly prioritize current consumption, thus altering their life-cycle consumption patterns. This shift is particularly transformative for households that previously lacked access to reliable savings vehicles or government-provided safety nets (Modigliani & Brumberg, 1954). The availability of stable, predictable income not only supports increased consumption in the present but also enhances long-term financial security. As households gain confidence in their financial future, they are able to make better decisions, plan more effectively, and invest in their overall welfare.

Endowment insurance also plays a critical role in risk mitigation and consumption smoothing. By guaranteeing a future income stream, it allows households to allocate resources more efficiently, thus reducing consumption volatility during economic downturns or personal financial distress (Deaton, 1991). This ensures that households can maintain a stable standard of living even in the face of unforeseen circumstances such as illness, job loss, or other disruptions. As such, endowment insurance serves as a vital financial tool for households seeking stability in the face of uncertainty, fostering greater resilience in household financial behavior.

While this study provides valuable insights into the effects of endowment insurance on household consumption in China, several limitations must be acknowledged. First, the use of fixed effects models enables the control of unobserved individual-level heterogeneity through within-unit variation; however, this approach excludes time-invariant factors. Although these factors are undoubtedly significant, they remain unaccounted for in the model, potentially limiting the depth and comprehensiveness of our findings. Furthermore, the presence of missing data and follow-up attrition may introduce biases that affect the results. To mitigate these concerns, sample selection methods and winsorization of continuous variables were employed to address outliers, and multiple imputation techniques were applied to handle missing values. These strategies are designed to minimize bias and ensure the integrity of the dataset. It is also important to note that this study did not examine the potential effects of the COVID-19 pandemic on consumption patterns and pension participation. The release of updated data will provide an opportunity to explore these dynamics, offering deeper insights into how household financial behavior has evolved in response to the crisis. Future research could benefit from comparative studies across different countries and longitudinal investigations, which would enrich our understanding of the global implications of pension systems on consumption behavior. Such studies could facilitate the identification of cross-national patterns and trends, thus contributing to the broader literature on pension systems and their impact on household economic decision-making.

This study carries important implications for policymakers, particularly in the context of China's aging population and the rapid economic transformations it is undergoing. The findings suggest that enhancing the predictability and reliability of pension systems could significantly increase household consumption, a critical factor for sustaining economic growth. Policymakers may therefore consider strengthening institutional pension frameworks and bolstering public confidence in pension systems as a means of stimulating greater consumer spending. The broader, transformative effects of endowment insurance—including behavioral shifts in savings and consumption, long-term improvements in household welfare, and its role in risk mitigation—offer valuable lessons for other countries as well.

5. Conclusion

This study revealed a robust positive correlation between participation in endowment insurance and household consumption levels. Specifically, households with insurance experience a 12.5% increase in consumption, with a 1% rise in pension income correlating with a 0.4% increase in consumption. Further analysis underscores that these effects are consistent across various demographic factors, including household registration type, regional development, and age. In particular, rural households, residents of central regions, and individuals over 60 benefit most from pension income. Robustness tests confirm that participation in endowment insurance not only enhances overall spending but also drives increased expenditures in key categories such as clothing, transportation, education, and entertainment, signaling a shift toward higher consumption standards. However, while pension receipts tend to increase spending on clothing and healthcare, they are associated with reduced expenditures on housing and other categories, suggesting a complex shift in consumption patterns.

In addition, the study highlights that institutional insurance is linked to a 1.7% increase in consumption, while commercial insurance, though associated with a 1.3% decrease, lacks statistical significance. Finally, breakpoint regression analysis shows a reduction in consumption at the pension age, likely due to the recalculation of pensions based on previous earnings, which leads individuals to adjust their consumption downward.

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Conflict of interest

The authors declare they have no competing interests.

Author contributions

Conceptualization: Lili Zheng
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Investigation: Lili Zheng, Ya Su
Methodology: Lili Zheng, Ya Su
Writing–original draft: Ya Su
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Ethics approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

Availability of data

The data used in this study can be obtained from the Peking University Open Research Data Platform (https://opendata.pku.edu.cn/dataverse/CFPS?language=en).

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ACCSCIENCE PUBLISHING

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RESEARCH ARTICLE

The effects of economic development and regional disparity on fertility rates in South Korea, 2000 – 2020

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Abstract

The declining total fertility rate in South Korea is a pressing issue, prompting numerous studies aimed at identifying the factors affecting fertility rates. However, limited empirical research has focused on investigating the relationship between regional economic disparity and fertility. This study examines the effects of economic development and regional economic disparity on fertility rates. Employing bivariate models, spatial panel models, and time series models, data on the total fertility rate across 16 metropolitan areas over a 20-year period from 2000 were analyzed. The findings indicate that economic development, as observed in the spatial panel model, has a positive effect on childbirth, although it does not reach statistical significance in the nationwide time series model when accounting for the regional disparity. Conversely, the study reveals a negative impact of Gross Regional Domestic Product disparity among regions on the total fertility rate. Consequently, this research underscores the importance of balanced national development in improving fertility rates, highlighting the detrimental consequences of widening regional disparity on low fertility. In addition, the study offers policy measures to address the challenge of local extinction.

Keywords: Total fertility rate; Economic development; Regional economic disparity; Spatial panel model; Time series model

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1. Introduction

The low fertility rate in South Korea (hereafter Korea) is at an unprecedentedly low level compared to global trends. Due to the significant decline in fertility rates, the Korean government has implemented various policies aimed at increasing fertility rates. However, as of 2023, the total fertility rate has reached a historical low of 0.72 births per woman (Statistics Korea, 2024), placing Korea among the lowest-ranking Organization for Economic Co-operation and Development (OECD) countries. Persistent low fertility raises concerns about the country's long-term sustainability, and criticism regarding the effectiveness of existing birth policies has been voiced (Jung & Kim, 2022; Park, 2022; Seo, 2019).

This decline in fertility rates has been observed alongside Korea's rapid economic growth. Since its industrialization in the 1960s, Korea has transformed from a low-income economy into one of the world's leading industrialized nations. Despite sustained economic expansion, fertility rates have continued to decline, highlighting the need to examine whether this trend is directly linked to economic growth. The relationship between economic growth and fertility is complex and has been widely debated in demographic and economic research. While economic development generally leads to improved living standards, its effects on fertility can vary depending on structural economic changes, social norms, and policy interventions. In the early stages of economic growth, rising incomes and better healthcare often contribute to higher fertility rates. However, as economies advance, fertility rates tend to decline due to factors, such as increased female labor force participation, rising opportunity costs of child-rearing, and shifts in household preferences toward investment in child quality rather than quantity (Becker, 1960; Galor & Weil, 2000).

Meanwhile, economic growth has not been uniform across regions, leading to widening regional economic disparities. While prior studies have examined regional differences in fertility rates, the direct impact of economic disparities between regions on fertility decline remains understudied. Regional economic inequality can influence fertility decisions through multiple channels, including income stability, employment opportunities, housing affordability, and access to public services, such as childcare and education. Specifically, regional economic disparities can drive outmigration to more developed areas, exacerbating demographic imbalances and further weakening fertility rates in less developed regions (OECD, 2022). Despite the growing recognition of these dynamics, empirical research that integrates economic growth, regional economic disparities, and fertility outcomes within a single analytical framework remains limited.

This study aims to address this gap by examining the relationship between economic growth, regional economic disparities, and fertility rates. Using data on total fertility rates from 2000 to 2020 across 16 metropolitan regions in Korea, this study conducts a bivariate analysis, spatial panel analysis, and time series analysis to assess how economic growth and regional economic disparity affect fertility rates. By providing empirical evidence on the interplay between economic growth, regional economic disparities, and fertility outcomes, this study contributes to a deeper understanding of how structural economic factors shape demographic trends, offering valuable insights for policies aimed at regional economic balance and demographic sustainability.

1.1. Literature review

1.1.1. Economic development and fertility rates

The relationship between economic development and fertility rates remains a contentious topic in socioeconomic research. Various studies offer differing perspectives on how economic progress influences fertility decisions, reflecting the complexity of this issue across multiple disciplines – demography, economics, political science, sociology, and geography (Duan & Chen, 2022; Lee *et al.*, 2021; Park, 2018; Rosero-Bixby, 2024). Research efforts typically classify the study of this relationship into micro-level approaches, examining individual or household characteristics and macro-level approaches, exploring how national or regional economic variables impact fertility rates (Yoon, 2016). This study focuses on the macro-level analysis, seeking to understand how broader economic conditions relate to aggregated fertility rates, which are indicative of collective individual decisions (Kim *et al.*, 2006; Lee & Choi, 2012).

Traditional economic theories suggest that higher fertility rates are typically observed during the initial stages of a nation's economic development. However, as economic development progresses, a declining trend in fertility rates is often noted. Numerous international studies have argued that economic development is negatively associated with fertility rates (Campisi *et al.*, 2020; Doepke, 2004; Galor & Weil, 1996; Lieming *et al.*, 2022; Myrskylä *et al.*, 2009; Wu *et al.*, 2022), with this effect being more pronounced in advanced economies than developing countries (Li, 2015). Furthermore, longitudinal studies indicate a negative correlation between long-term population growth rates and per capita gross domestic product (GDP) growth rates (Barro & Becker 1989).

A comprehensive analysis of the longitudinal trends in Korea's per capita GDP and total fertility rate following the Korean War (1950 – 1953) reveals a significant pattern, in which the nation's economic development is consistently accompanied by a progressive decline in the fertility rate. Socially, as living standards improved and the importance of human capital increased, expectations regarding the residential environment and education for child-rearing also intensified (Galor & Weil, 2000; Sheppard, 2024). This increased the overall societal cost of childbirth, influenced by the trend of lower-income households striving to match the educational investment levels of higher-income households, a phenomenon known as the "neighborhood effect" (Ha, 2012).[1] Furthermore, several studies have

[1] According to the "exogenously determined habit formation" model in consumption theory, an individual's utility is influenced not only by their own consumption but also by the consumption levels of others (Pollak, 1970).

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indicated that as the overall income level of the population rises, individuals tend to prioritize consumption and embrace individualistic values, leading them to favor personal self-fulfillment and cultural pursuits over marriage and childbirth (Bertinelli & Black, 2004; Lee & Hwang, 2020; Lesthaeghe & Surkyn, 1988).

Moreover, the intensification of a competitive atmosphere and social pressures, particularly in Korea, while contributing to economic development by fostering innovation and productivity (Kim & Hlasny, 2024; Nickell, 1996; Porter, 1990), has further negatively affected fertility rates in Korea (Joo & Lim, 2022; Kim, 2022; Ko *et al.*, 2020; Sohn, 2005). Life history strategy theory, from ecological research, supports the idea that in competitive and resource-scarce environments, species tend to prioritize the quality of offspring over quantity (Pianka, 1970; Reznick *et al.*, 2002). Economic studies have revealed that in high-density and competitive societies, individuals delay marriage and childbirth to enhance and sustain their competitive advantage (Firebaugh, 1982; Ko *et al.*, 2020; Lutz *et al.*, 2006; Sng *et al.*, 2017). Higher competition and inequality levels increase the cost of investing in children's social status, leading to lower fertility rates (Shenk *et al.*, 2016).

Conversely, some studies suggest that economic growth can positively influence fertility rates by fostering optimism about future economic conditions (Kim & Cho, 2012). Notably, Doepke *et al.* (2023) highlighted that the historically negative relationship between economic development and fertility has weakened in high-income countries. Their findings indicated that factors such as improved compatibility between women's careers and family life, access to affordable childcare, cooperative partners, favorable social norms, and flexible labor markets have contributed to stabilizing or even increasing fertility rates in these nations. This suggests a nuanced interaction whereby economic prosperity, along with supportive social structures, can mitigate the decline in fertility rates traditionally associated with economic development. Korea's attainment of a population of 50 million and a GDP per capita of United States dollars 30,000 in 2018 exemplifies its advanced economic status. Consequently, it can be posited that economic development may positively influence fertility rates, suggesting that the observed decline in the fertility rate may be attributable to other underlying factors.

In summary, the impact of national and regional economic progress on the fertility rate yields contrasting results depending on the particular studies. This divergence in outcomes is attributable to the dual nature of economic development: while economic enhancement may alleviate the financial burden of child-rearing, it can simultaneously intensify socioeconomic disparities and enhance the utility of alternatives to childbirth, ultimately discouraging higher fertility rates. Given these diverse perspectives, this study aims to clarify the impact of economic development on fertility rates in Korea. By providing a comprehensive analysis, it seeks to resolve the existing debates in this particular context.

1.1.2. Regional disparity and fertility rates

Another inadvertent consequence of economic development is the widening of regional economic disparities. As economies grow, industrialization and urbanization tend to concentrate wealth and opportunities in major cities, often at the expense of rural and less-developed regions (Guo *et al.*, 2018). Korea has experienced rapid economic growth since the 1960s due to industrialization; however, regional disparities have also intensified (Heo & Ahn, 2008; Kim & Park, 2022). Manufacturing and service industries have been disproportionately concentrated in Seoul and other metropolitan areas, attracting investment and skilled labor while leaving many rural regions struggling with economic stagnation (Park & Kim, 2022). In 2019, Korea ranked second among OECD countries in terms of regional disparities in gross regional domestic product (GRDP) (Kim *et al.*, 2022).

The expansion of regional disparity is closely linked to income and opportunity inequality (Jeong, 2021), which can discourage childbirth (Bhattacharyya, 1975; Castro Torres *et al.*, 2022; Flegg, 1979; Guest & Swift, 2008). In addition, regional economic disparities often lead to the outmigration of younger populations to more economically developed areas, further reducing the number of individuals of reproductive age in less developed regions and worsening demographic imbalances (Rees *et al.,* 2012).

Research analyzing the relationship between various factors, such as economic development and childbirth, continues to be actively pursued. In addition, numerous studies have revealed spatial correlations or gaps in regional fertility rates (Brée & Doignon, 2022; Campisi *et al.*, 2020; Jung *et al.*, 2019; Kato, 2021; Kim & Jun, 2021; Lamonica *et al.*, 2022; Lieming *et al.*, 2022; Vitali & Billari, 2015). However, studies specifically examining the impact of economic disparities on regional fertility rates remain limited. The study by Kim *et al.* (2024) is one of the few addressing this gap by analyzing the effects of economic development and regional disparities on fertility rates in Korea. Using data from 229 municipal districts and 16 metropolitan areas between 2010 and 2019, the study finds that while economic development positively affects fertility rates at the district level, widening regional

disparities – measured by GRDP inequality and property value gaps – exert a significant negative influence. Nevertheless, the study does not explore how regional economic development influences the nationwide total fertility rate, leaving room for further investigation into the broader implications of regional disparities.

Consequently, this study not only analyzes the impact of economic development at the national and regional levels on fertility rates but also conducts empirical analyses on the influence of regional disparities. To address these research questions empirically, the study is grounded in theoretical frameworks and prior empirical research, leading to the formulation of the following two research questions.

(a) Research question 1: Economic development and fertility rates
Economic development is positively correlated with household income levels, and an increase in income levels has a positive impact on fertility rates. However, economic development and the subsequent rise in income levels may also negatively correlate with fertility rates due to increased opportunities beyond childbirth and intensified competition. "If all other conditions being equal," what is the effect of rising income levels due to economic growth on childbirth?

(b) Research question 2: Regional disparity and fertility rates
Economic development is positively correlated with household income levels, and increased income levels generally have a positive impact on fertility rates. However, economic development may also be associated with greater regional disparities, which have a negative impact on fertility rates. "If all other conditions being equal," what is the effect of regional disparities resulting from economic growth on fertility rates?

2. Data and methods

2.1. Data and measurements

The analyses in this study involve examining the correlation between fertility rates, economic growth, and regional disparities; analyzing the determinants of fertility at the regional level using various spatial panel models; and investigating the impact of macroeconomic growth and regional disparities on fertility using time series models. Consequently, the variables employed in each model exhibit heterogeneity.

To analyze the correlation between the total fertility rate, economic growth, and regional disparities, data from 2000 to 2020 provided by Statistics Korea were utilized. This includes the total fertility rates at the metropolitan level and GRDP data. Two representative indices, the Gini coefficient and the Theil coefficient, were used to measure annual regional disparities in fertility rates and economic growth. The Gini coefficient has the advantage of not being affected by differences in population size across regions. However, as it is based on the overall distribution of variables, different patterns of inequality can produce the same Gini value. The Theil coefficient, on the other hand, can distinguish between within-region and between-region inequality but is less effective when comparing two regions of differing population sizes (Trapeznikova, 2019). Both coefficients range from 0 to 1, with values closer to 1 indicating greater regional disparities. The specific formulas for calculating the regional disparity using these two indices are presented in Equations I and II below.

$$GINI = \frac{1}{2n^2\mu_t}\sum_{i=1}^{n}\sum_{j=1}^{n}\left|y_i - y_j\right| \quad \text{(I)}$$

$$THEIL = \frac{1}{n}\sum_{i=1}^{n}\left(\frac{y_i}{\mu_t}\right)log\left(\frac{y_i}{\mu_t}\right) \quad \text{(II)}$$

In the above equations, μ_t represents the average value of GRDP at time t, while y_i denotes the GRDP for region i, and n is the number of regions (16[2]).

Table 1 provides descriptions of the controlled independent variables used in the spatial panel model constructed to analyze the determinants of regional total fertility rates. The dependent variable is the log-transformed total fertility rate by metropolitan level. The controlled independent variables include GRDP, population density (as a measure of competition level), population size (representing opportunities beyond childbirth), the proportion of the population of childbearing age (as an indicator of potential fertility), and the unemployment rate (as a proxy for labor market stability). By controlling for these factors, the net effect of economic growth on fertility can be estimated, thus answering research question 1.

The primary objective of this study was to examine the effects of economic growth and regional disparities on fertility rates, rather than to identify all potential determinants of fertility. Therefore, rather than including an extensive set of control variables, the study focused on key macroeconomic indicators that capture the economic and spatial dimensions relevant to fertility decisions. This approach helped maintain alignment with the core research question, avoiding overfitting and unnecessary complexity.

[2] Throughout the entire period, Sejong was considered part of the Chungcheongnam-do region.

Table 2 describes the variables used in the time series model constructed to analyze the impact of regional disparities on fertility rates. The dependent variable was the national total fertility rate for the corresponding year, as provided by Statistics Korea. To assess the influence of economic growth on the fertility rate, the GRDP growth rate for the respective year was utilized as a common independent variable. The Gini coefficient and Theil coefficient served as indicators of inequality. To balance the strengths and weaknesses of these two indices, the Gini coefficient of GRDP was used in Models 2 and 4, while the Theil coefficient of GRDP was applied in Models 3 and 5. By employing these coefficients, the net effect of regional disparities on the fertility rate can be estimated, thus answering research question 2. In addition, in Models 4 and 5, the previous year's total fertility rate was included as an independent variable to examine its relationship with fertility rates in subsequent years.

2.2. Analytical models

2.2.1. Bivariate model

The primary objective of this study was to investigate the relationship between economic growth, regional disparities, and fertility rates. Before conducting multiple regression analyses, a correlation analysis was performed to examine the relationships among key variables. In this study, Pearson's correlation coefficients, which are widely used as statistical measures of correlation, were applied to assess the relationships between regional fertility rates, regional GRDP, and regional disparities in individual variables.

2.2.2. Spatial panel model

The spatial dependence of fertility rates across various regions has been highlighted in multiple studies (Brée & Doignon, 2022; Campisi *et al.*, 2020; Kim & Jun, 2021; Vitali & Billari, 2018). This study investigated macro-level factors that influence the total fertility rate across different regions, not only through correlation analysis but also from a spatial perspective. To this end, a panel dataset combining cross-sectional and time-series data, along with spatial panel models, was utilized with regions as the spatial units.

The panel model improves estimation efficiency by increasing degrees of freedom through sample augmentation and mitigating multicollinearity among

Table 1. Variables used in the spatial panel model

Variables	Description	Model 1	Model 2
Dependent variable			
Log (total fertility rate)	Log (regional fertility rate)	☐	☐
Independent variables			
GRDP	GRDP (unit: trillion won)	☐	☐
Density	Population density (unit: 1,000 people/km^2)		☐
Population	Total population (unit: million people)		☐
Youth	Population of 25 – 34 years old (unit: 10,000 people)		☐
Unemployment	Unemployment rate (unit: %)		☐

Source: Statistics Korea.
Abbreviation: GRDP: Gross regional domestic product.

Table 2. Variables used in the time series model

Variables	Description	Model 1	Model 2	Model 3	Model 4	Model 5
Dependent variable						
Fertility rate	National fertility rate	☐	☐	☐	☐	☐
Independent variables						
Growth rate	GDP growth rate	☐	☐	☐	☐	☐
Gini	Gini coefficient of GRDP		☐		☐	
Theil	Theil coefficient of GRDP			☐		☐
Fertility rate_1	Fertility rate of the previous year				☐	☐

Source: Statistics Korea, author calculations.
Abbreviations: GDP: Gross domestic product; GRDP: Gross regional domestic product.

independent variables. In addition, it enables the identification of variations over time (Hsiao, 2014; Lee & Noh, 2012). Applying traditional econometric models that do not consider spatial dependency or spatial autocorrelation in regional studies may have a negative impact on the efficiency of the analysis (LeSage & Pace, 2009). In contrast, spatial panel models address statistical issues that arise from spatial dependency (Anselin *et al.*, 2008). In this study, various spatial panel models were employed, including the spatial autoregressive model (SAR), the spatial error model (SEM), the spatial autoregressive confused model (SAC), and the spatial Durbin model (SDM). These models incorporate random effects, assuming the individual and time-specific characteristics of the error term as random disturbances.

To apply spatial econometric models, it is necessary to construct a spatial weight matrix that reflects interactions among regions (Anselin *et al.*, 2008; Elhorst, 2014; LeSage & Pace, 2009). A spatial weight matrix assigns weights between regions based on physical distance, temporal proximity, or traffic flow, indicating higher weights for stronger spatial dependencies. Among the various types, the most common are the adjacency matrix, which assigns weights based on geographic boundaries, and the inverse distance matrix, which assigns weights inversely proportional to the distance between regions. In this study, various weight matrices were applied; the model's explanatory power was highest when using the adjacency matrix. Unlike the inverse distance matrix, which assumes that all regions exert influence over one another based on distance, the adjacency matrix restricts interactions to geographically neighboring regions, making it more suitable for capturing spatial dependence in this context. Moreover, the adjacency matrix effectively reflects spatial autocorrelation. Therefore, a Queen-type adjacency matrix was adopted as the spatial weight matrix, providing a comprehensive representation of spatial relationships (Lee *et al.*, 2006, p. 175).

Equation III represents the SAR model, which assumes spatial lag in the dependent variable. ρ represents the spatial autocorrelation coefficient, indicating the spatial autocorrelation among the dependent variables. In this equation, y_{it} represents the total fertility rate of region i in year t, w_{ij} represents the spatial weight of region j for region i, x_{it} denotes the explanatory variables, β represents the model's estimated parameters, and indicates the error term. α_i denotes the individual effect.

$$y_{it} = \rho \sum_{i \neq j} w_{ij} y_{jt} + x_{it}\beta + u_{it}$$

$$u_{it} = \alpha_i + \varepsilon_{it} \quad \text{(III)}$$

$$\varepsilon_{it} \sim N(0,\sigma^2)$$

The SEM, unlike the SAR model, assumes the presence of spatial dependence in the error term rather than in the dependent variable. represents the spatial autocorrelation coefficient, indicating spatial autocorrelation among the error terms.

$$y_{it} = x_{it}\beta + u_{it}$$

$$u_{it} = \alpha_i + \lambda \sum_{i \neq j} w_{ij} u_{jt} + \varepsilon_{it} \quad \text{(IV)}$$

$$\varepsilon_{it} \sim N(0,\sigma^2)$$

The SAC model assumes spatial dependence in both the dependent variable and the error term. Therefore, in Equation V, both the spatial correlation of the dependent variable (ρ) and the spatial correlation of the error term (λ) are included:

$$y_{it} = \rho \sum_{i \neq j} w_{ij} y_{jt} + x_{it}\beta + u_{it}$$

$$u_{it} = \alpha_i + \lambda \sum_{i \neq j} w_{ij} u_{jt} + \varepsilon_{it} \quad \text{(V)}$$

$$\varepsilon_{it} \sim N(0,\sigma^2)$$

Finally, the SDM assumes spatial dependence in both the dependent variable and the explanatory variables. Here, x_{jt} represents the explanatory variables of neighboring regions j for region i, and θ indicates the magnitude of the influence of neighboring regions' characteristics on the regional fertility rate. By employing the SDM, it is possible to incorporate the characteristics of the focal region while also assessing the influence of neighboring regions' characteristics. This facilitates a more comprehensive examination of the complex determinants impacting fertility rates, thereby enhancing the sophistication of the analysis.

$$y_{it} = \rho \sum_{i \neq j} w_{ij} y_{jt} + x_{it}\beta + \sum_{i \neq j} w_{ij} x_{jt}\theta + u_{it}$$

$$u_{it} = \alpha_i + \varepsilon_{it} \quad \text{(VI)}$$

$$\varepsilon_{it} \sim N(0,\sigma^2)$$

2.2.3. Time series model

To analyze the impact of regional disparities resulting from economic growth on the fertility rate, a time series model was employed as the primary methodology in this study. Time series models offer the advantage of providing efficient estimates even when applied to small datasets and can reveal long-term trends (Box & Jenkins, 1976; Greenberg, 2001). These models have been widely used in various fields of social science for both analytical and predictive purposes. In this study, the time series model

was expected to identify not only the influence of widening regional disparities on the fertility rate over time but also to forecast future fertility rate trends.

Two types of time series models were utilized. First, Equation VII represents a model that incorporates temporal dependence among the error terms, where y_t denotes the national total fertility rate in year t.

$$y_t = x_t \beta + u_t$$
$$u_t = \psi_1 u_{t-1} + \psi_2 u_{t2} + \cdots + \psi_m u_{t-m} + \varepsilon_t \quad \text{(VII)}$$
$$\varepsilon_t \sim N(0,\sigma^2)$$

To verify the suitability of the model, it is necessary to conduct the Durbin–Watson (DW) test. The DW test examines autocorrelation among the error terms, and the test statistic is calculated as shown in Equation VIII. Generally, a DW statistic close to 0 indicates positive autocorrelation, while a value near 4 suggests negative autocorrelation. A value close to 2 implies no significant autocorrelation.

$$DW = \frac{\sum_{t=2}^{T}(\varepsilon_t - \varepsilon_{t-1})^2}{\sum_{t=1}^{T}\varepsilon_t^2} \quad \text{(VIII)}$$

In addition to the commonly applied time series model in Equation VII, this study also employed a more robust statistical model to enhance the reliability of the results. Specifically, Equation IX includes the previous year's total fertility rate (y_{t-1}). This inclusion accounts for the lagged correlation of the dependent variable and addresses uncontrolled socioeconomic and cultural factors that may influence fertility. This approach, known as a "dynamic solution," improves model robustness (SAS, 1996).

$$y_t = \phi y_{t-1} + x_t \beta + \varepsilon_t$$
$$\varepsilon_t \sim N(0,\sigma^2) \quad \text{(IX)}$$

According to Park (1975), when the explanatory variables in a model include lagged dependent variables, the DW statistic is no longer appropriate. Instead, the model's goodness of fit should be assessed using the Durbin h test. The Durbin h statistic is defined by Equation X, where T represents the number of observations and $var(\varphi)$ denotes the variance of the estimated lagged values of the dependent variable. The null hypothesis of this test is "no serial correlation." A statistically significant test statistic indicates rejection of the null hypothesis, suggesting the presence of temporal dependence among the error terms.

$$h = \left(\frac{1-DW}{2}\right)\sqrt{\frac{T}{1-T(var(\phi))}} \quad \text{(X)}$$

3. Results

3.1. Bivariate model

Figure 1 depicts an analysis of the annual correlation between regional GRDP and the total fertility rate from 2000 to 2020. Over the entire period, the two variables demonstrated a negative correlation. In particular, this negative correlation was statistically significant at the $p<0.10$ level from 2013 to 2020. This suggests that regional economic growth is associated with a decline in fertility rates. However, further analysis using regression modeling, controlling for potential confounding variables, is necessary to determine whether economic growth has a significant direct causal effect on fertility.

Figure 2 illustrates the correlation between Korea's total fertility rate from 2000 to 2020 and regional economic inequality, as measured by the Gini and Theil coefficients. Table 3 presents the Pearson correlation coefficients and their statistical significance. Both the Gini and Theil coefficients, which reflect disparities in GRDP among regions, exhibit a strong negative correlation (−0.83 or

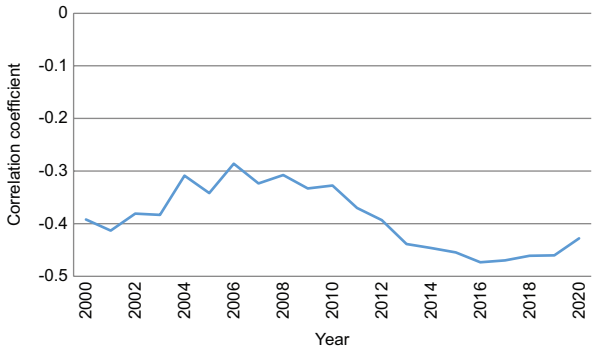

Figure 1. Correlation between gross regional domestic product and fertility rate by region, 2000 – 2020

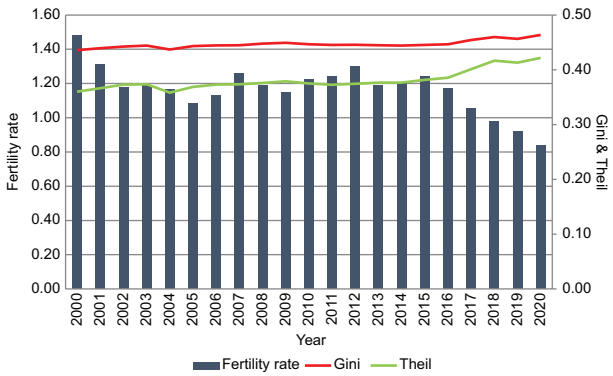

Figure 2. Fertility rate and gross regional domestic product inequality indices, 2000 – 2020
Abbreviation: ppl: People.

Table 3. Correlation between fertility rate and gross regional domestic product (GRDP) inequality indices

Inequality index	GRDP Gini	GRDP Theil
Fertility rate	−0.8455***	−0.8329***

Note: ***p<0.01.

greater) with the total fertility rate. These correlations are statistically significant at the p<0.01 level. These findings indicate a significant association between regional economic inequality and declining fertility rates. Nonetheless, it is important to note that these results do not establish a causal relationship but rather provide limited insight into the potential impact of regional economic disparities on fertility rates. In the following section, the impact of economic growth and regional inequality on fertility will be further analyzed using appropriate regression models that control for changes in various independent variables and incorporate relevant data.

3.2. Spatial panel model

The analysis of the spatial panel model investigating the factors influencing the total fertility rate across 16 regional local governments over a 20-year period is presented in Tables 4 and 5. In the panel model analysis, the results of the pooled ordinary least squares (OLS) model, which disregards time-specific and individual-specific effects, are included in Model 1 (Table 4) and Model 2 (Table 5). These results are compared with four different spatial econometric panel models: The SAR panel, SEM panel, SAC panel, and SDM panel.

Table 4 displays the results of Model 1, which includes only GRDP as an independent variable. All five models demonstrate explanatory power, with R^2 values ranging from 12.5% to 14.7%, though the spatial interaction values indicating the statistical significance of spatial dependence differ across models. The spatial lag coefficient (ρ), which represents spatial autocorrelation of the dependent variable, is statistically significant at p<0.01 in the SAR and SDM models but not in the SAC model. The spatial error coefficient (λ), which captures spatial autocorrelation in the residuals, is statistically significant at p<0.01 in both the SEM and SAC models.

In all models, GRDP shows a negative association with the regional total fertility rate, which is statistically significant at p<0.01. This result is consistent with previous research suggesting that economic growth leads individuals to prioritize their own labor participation and economic stability through continuous income generation, often leading to delayed or forgone childbirth (McDonald, 2006). These findings align with the earlier bivariate analysis (Figure 1), although Model 1 is limited in that it does not account for the net effects of other important determinants.

Table 5 presents the analysis results of Model 2, which adds population density, total population, the proportion of the population of reproductive age, and the unemployment rate as additional independent variables. The R^2 values for all five models more than double compared to those in Model 1, indicating that the additional independent variables in Model 2 provide substantial explanatory power for the dependent variable. The coefficients of the independent variables calculated in the pooled OLS are approximately two to four times larger than those estimated in the spatial panel models, suggesting a potential overestimation error when spatial autocorrelation is not considered. The spatial lag coefficient (ρ) and spatial error coefficient (λ) – representing spatial autocorrelation in the dependent variable and residuals, respectively – remain consistent with those in Model 1.

Gross regional domestic product is statistically significant and positively associated with the regional total fertility rate in all models except the SDM Panel. This contradicts the results of Model 1, suggesting that the initially observed negative relationship may have been influenced by omitted variable bias. In Model 1, where no covariates were included, the effect of GRDP on fertility rates may have been confounded by unobserved factors that simultaneously affect both economic growth and fertility decisions. Omitting relevant explanatory variables can lead to biased and inconsistent estimates, distorting the true effect of the independent variable on the dependent variable (Angrist & Pischke, 2009). However, as additional control variables were introduced in subsequent models, these confounding effects were mitigated, revealing the true positive association between GRDP and fertility rates. This finding aligns with previous research suggesting that the relationship between economic growth and fertility is not fixed but evolves as economies develop (Doepke *et al.*, 2023). In the early stages of economic growth, rising opportunity costs, such as increased female labor force participation and higher educational levels, may contribute to fertility decline. Yet, as economies continue to develop, labor market stability, improvements in gender equality, and the expansion of family-supportive policies can help reverse this trend by creating an environment more conducive to childbearing. These findings indicate that, once key covariates are accounted for, the net effect of GRDP on fertility becomes positive. This interpretation addresses research question 1, which suggests that an increase in income levels due to economic growth has a positive effect on the total fertility rate when other conditions are held constant.

Table 4. Regression results of spatial panel models (Model 1), 2000 – 2019

Parameter	Pooled OLS[3]	SAR panel	SEM panel	SAC panel	SDM panel
Intercept	0.2698***	0.0569#	0.2427***	0.2489***	0.0559#
GRDP	−0.0006***	−0.0003***	−0.0003***	−0.0003***	−0.0003***
W_GRDP	-	-	-	-	0.0000#
F-statistics	15.21***	-	-	-	-
r	-	0.8224***	-	−0.2857#	0.8235***
l	-	-	0.8532***	0.8526***	-
R^2	0.1472	0.1258	0.1472	0.1472	0.1252
LL	-	-	476.9922	476.7526	477.0485
No. of groups	16	16	16	16	16
Time period (years)	20	20	20	20	20
N	320	320	320	320	320

Notes: The values represent the coefficients; Significance levels: *p<0.1, **p<0.05, ***p<0.01, #p>0.05. λ: Spatial error coefficient; *r*: Spatial lag coefficient. Abbreviations: LL: Log-likelihood; OLS: Ordinary least squares; SAC: Spatial autoregressive confused; SAR: Spatial autoregressive; SDM: Spatial Durbin model; SEM: Spatial error model; W_GRDP: Spatial interaction coefficient for gross regional domestic product.

Table 5. Regression results of spatial panel models (Model 2), 2000 – 2019

Parameter	Pooled OLS	SAR panel	SEM panel	SAC panel	SDM panel
Intercept	0.4022***	0.0508#	0.2403***	0.2443***	0.0461#
GRDP	0.0013***	0.0004*	0.0005***	0.0005**	0.0003#
Density	−0.0361***	−0.0334***	−0.0350***	−0.0355***	−0.0339***
Population	−0.1874***	−0.0558***	−0.0609***	−0.0587***	−0.0451**
Youth	0.0096***	0.0033***	0.0037***	0.0035***	0.0032***
Unemployment	−0.0271***	0.0105**	0.0101**	0.0104**	0.0103**
W_GRDP	-	-	-	-	−0.0011***
W_Density	-	-	-	-	0.0243#
W_Population	-	-	-	-	0.9700***
W_Youth	-	-	-	-	−0.0050***
W_Unemployment	-	-	-	-	−0.0055#
F-statistics	6.66***	-	-	-	-
r	-	0.8301***	-	−0.2779#	0.8335***
λ	-	-	0.8620***	0.8615***	-
R^2	0.5313	0.2333	0.3740	0.3785	0.2366
Log-likelihood	-	489.6565	498.4088	498.6600	497.9861
No. of groups	16	16	16	16	16
Time period (years)	20	20	20	20	20
N	320	320	320	320	320

Notes: The values represent the coefficients; Significance levels: *p<0.1, **p<0.05, ***p<0.01, #p>0.05. λ: Spatial error coefficient; *r*: Spatial lag coefficient. Abbreviations: OLS: Ordinary least squares; SAC: Spatial autoregressive confused; SAR: Spatial autoregressive; SDM: Spatial Durbin model; SEM: Spatial error model; W_Density: Spatial lag coefficient for population density; W_GRDP: Spatial interaction coefficient for gross regional domestic product; W_Population: Spatial lag coefficient for population size; W_Unemployment: Spatial lag coefficient for the unemployment rate; W_Youth: Spatial lag coefficient for the proportion of the reproductive-age population.

[3] The formula for pooled OLS regression is as follows:

$$y_{it} = x_{it}\beta + \varepsilon_{it}$$

$$\varepsilon_{it} \sim N\left(0, \sigma^2\right)$$

Population density shows a negative effect at p<0.01 in all five models. This suggests that as competition for resources and opportunities intensifies, difficulties in child-rearing lead to a reluctance to have children (Ko *et al.*, 2020; Lutz,

2006). Population size has a negative effect in all models, with statistical significance at $p<0.01$ in all but the SDM Panel, where it is significant at $p<0.05$. This implies that in regions with larger populations, individuals are more likely to pursue personal career goals, cultural activities, and other values rather than focusing on family (Kulu *et al.*, 2009), as these regions tend to have more cultural facilities and job opportunities. The proportion of the population of reproductive age, which represents the potential fertility of a region, is found to have a positive impact on the regional total fertility rate ($p<0.01$), and this result is consistent across all models. The unemployment rate, reflecting labor market instability, has a negative impact on the regional total fertility rate in the pooled model that disregards the spatial and temporal characteristics of the data. However, it shows a positive impact in the spatial panel models. This aligns with Schultz's (1973) rational choice theory, which suggests that labor market participation can be considered an opportunity cost of childbirth. In fact, some studies conducted in advanced countries have shown that an increase in the unemployment rate can have a positive impact on the total fertility rate (Schmitt, 2008).

Analyzing the results of the SDM panel model provides insights into how independent variables in neighboring regions influence the total fertility rate of a specific region. The spatial interaction coefficient for GRDP (W_GRDP) shows a significant negative impact at $p<0.01$, indicating that as the economic level of neighboring regions increases, the total fertility rate in the specific region decreases. This suggests that when neighboring regions have higher economic levels, various factors – such as the outmigration of reproductive-age populations – come into play, contributing to lower fertility rates in adjacent areas. Although the spatial lag coefficient for population density (W_Density) has a positive value, it is not statistically significant. The spatial lag coefficient for population size (W_Population) is statistically significant at $p<0.01$ and shows a positive impact. This finding implies that as the population size of neighboring regions increases, the likelihood of marriage and childbirth among reproductive-age groups in the specific region increases. Conversely, a high proportion of the reproductive-age population in neighboring regions may lead to the outmigration of youth from the focal region, which can contribute to a decline its fertility rate. This inference is supported by the significant negative spatial lag coefficient for the proportion of the reproductive-age population (W_Youth; $p<0.01$). The spatial lag coefficient for the unemployment rate (W_Unemployment), representing the labor market conditions in neighboring regions, shows a negative effect but does not reach statistical significance.

3.3. Time series model

To investigate the impact of regional disparities resulting from economic growth on fertility rates, this study collected data spanning 20 years, from 2000 to 2019, for time series analysis. As mentioned earlier, the time series model employed in this study includes the lagged total fertility rate as a controlled variable. Therefore, regression analysis was conducted using data starting from 2001.

Table 6 presents the results of the time series analysis. The DW statistic, which indicates autocorrelation in error terms, shows values close to 1, suggesting the presence of positive autocorrelation. Regarding model goodness-of-fit, the models that control for the Theil coefficient demonstrate higher explanatory power than those that control for the Gini coefficient. Among them, Model 5, which includes lagged variables and controls for the Theil coefficient, exhibits the highest explanatory power at 69.76%. The Durbin *h* statistic, which evaluates model fitness when controlling for a lagged dependent variable in the time series model, varies depending on whether the GINI and THEIL coefficient is used. In Model 4, which controls for regional inequality using the Gini coefficient, the Durbin *h* statistic is statistically significant at the $p<0.01$ level, indicating the presence of serial autocorrelation. In contrast, Model 5, which controls for regional disparities using the Theil coefficient, shows no statistically significant Durbin *h* value, suggesting the absence of serial autocorrelation. Therefore, the final interpretation of the regression results is based on Model 5, which includes lagged variables and controls for the Theil coefficient.

Model 1, which only includes the economic growth rate as a predictor, shows a statistically significant positive effect on the total fertility rate at the $p<0.05$ level. However, in Models 2 through 5, which additionally account for regional disparities, the impact of economic growth on fertility is no longer statistically significant. In Models 4 and 5, which control for the lagged total fertility rate, the lagged term exerts a statistically significant positive influence on the present year's total fertility rate at the $p<0.10$ and $p<0.05$ levels, respectively. Considering that the lagged total fertility rate reflects unobserved socioeconomic and cultural factors influencing fertility, the estimated effects of economic growth and regional disparities on fertility – when this variable is controlled for – carry significant explanatory power.

Models 2 and 4, which use the Gini coefficient control to capture regional disparities, reveal a statistically significant negative impact on the total fertility rate at the $p<0.01$ and $p<0.05$ levels, respectively. Similarly, Models 3 and 5, which control for regional disparities using the Theil coefficient, also exhibit a negative effect, with all

Table 6. Regression results of time series models, 2000 – 2019

Parameter	Model 1	Model 2	Model 3	Model 4	Model 5
Intercept	1.0576***	7.4712***	3.3723***	4.8166**	2.1635***
Growth rate	0.0303**	−0.0069#	0.0025#	−0.0029#	−0.0030#
Gini	-	−14.0627***	-	−9.1997**	-
Theil	-	-	−5.8202***	-	−3.7763***
Fertility rate_1	-	-	-	0.3917*	0.3752**
R^2	0.2610	0.6933	0.6831	0.6406	0.6976
DW statistics	0.8649	1.0282	0.9256	-	-
Durbin *h*	-	-	-	2.1841**	1.1868#
Time period (years)	19	19	19	19	19

Notes: The values represent the coefficients; Significance levels: *p<0.1, **p<0.05, ***p<0.01, #p>0.05.
Abbreviation: DW: Durbin–Watson.

coefficients statistically significant at the p<0.01 level. Although the precise mechanism through which regional inequality affects fertility cannot be fully identified from these results, it can be inferred that widening disparities may drive population shifts toward economically dominant areas (Rees *et al.,* 2012), resulting in increased population density and intensified competition, which may discourage childbearing (Firebaugh, 1982; Ko *et al.*, 2020; Lutz *et al.*, 2006). In summary, the findings address Research Question 2, indicating that widening regional disparities have a significant negative effect on fertility rates, holding other conditions constant.

4. Conclusion

Korea's low fertility problem, exacerbated by widening regional disparities, represents a critical demographic challenge that accelerates both population and regional decline. Despite the implementation of various policies by the central and local governments to increase the fertility rates, the decline persists. To effectively address this issue, a comprehensive national-level discussion on solving the low fertility problem, integrated with alternative approaches at the regional level, is necessary.

This study formulated two research questions regarding the relationships between economic growth, regional economic disparities, and fertility rates. Using data on the total fertility rates from 2000 to 2020 across 16 metropolitan regions in Korea, bivariate models, spatial panel models, and time-series models were applied to address these research questions. The main findings of this study are as follows.

First, the bivariate analysis confirmed that the total fertility rate showed an overall declining trend over the past 20 years, while regional disparities in fertility rates widened. During the same period, quantitative economic growth exhibited a continuous upward trend, while regional disparities in GRDP also increased. Strong negative correlations between regional disparities and fertility rates were observed, with both Gini and Theil coefficients showing statistical significance, suggesting that regional economic imbalances are associated with a decline in fertility rates.

Second, the spatial panel model analysis revealed that when controlling for other factors, the net effect of the regional economic level, represented by GRDP, on fertility was positive and statistically significant at the p<0.01 level. This result was consistent across all four models applied, excluding the SDM, which is necessary for estimating spatial diffusion effects. This addresses research question 1, which states that "Under constant conditions, an increase in income level due to economic growth has a positive impact on fertility."

Third, the time-series analysis showed that the expansion of regional disparities negatively impacts fertility. When both regional disparities and economic growth were simultaneously controlled, the effect of economic growth on fertility was not statistically significant, whereas regional disparities had a statistically significant negative effect on fertility. This result answers research question 2, which posits that "Under constant conditions, the widening of regional disparities due to economic growth negatively affects fertility."

The key policy implications based on the main findings of this study are as follows. Efforts to mitigate regional economic disparities are essential for addressing fertility decline and ensuring balanced national development. Policies should focus on reducing economic inequalities across regions by promoting balanced growth, improving resource distribution, and fostering local economic development. Large-scale infrastructure projects, such as transportation and social overhead capital (SOC)

investments, should be designed to prevent further regional imbalances and support sustainable population distribution. In addition, measures that improve access to employment, housing, and public services in underdeveloped areas can help create an environment more conducive to family formation. A comprehensive policy framework that prioritizes regional equity and inclusive economic growth is necessary to ensure that development benefits all regions and contributes to long-term demographic stability.

Despite the scholarly and policy contributions of the primary research findings, several limitations should be acknowledged. While this study examined the relationship between economic growth, regional disparities, and fertility rates, it did not fully account for the mechanisms through which these factors influence fertility. Future research should explore mediating factors such as income effects, housing affordability, labor market stability, and childcare policies. Another limitation is the spatial unit of analysis, as this study focuses on metropolitan-level disparities, while previous research suggests that municipal-level differences may be more significant. Prior studies indicate that GRDP disparities are more pronounced at the municipal level than at the metropolitan level (Kim, 2021). Therefore, conducting the analysis at the municipal level could provide a more detailed understanding of the relationship between fertility rates, economic growth, and regional disparities. Furthermore, methodologically, establishing a causal link between economic growth and fertility remains challenging. Although spatial panel models were used, potential endogeneity issues persist, including the possibility of reverse causality. Addressing these limitations would enhance the understanding of the complex dynamics between economic conditions and fertility trends.

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Conflict of interest

The authors declare that they have no competing interests.

Author contributions

Conceptualization: Seongwoo Lee
Formal analysis: Kyungjae Lee
Investigation: Kyungjae Lee
Methodology: All authors
Writing – original draft: Kyungjae Lee
Writing – review & editing: Seongwoo Lee

Ethics approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

Availability of data

Data supporting this study are available from the corresponding author upon reasonable request.

Further disclosure

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RESEARCH ARTICLE

Determinants of the desire to limit childbearing among married women in sub-Saharan African countries

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Abstract

Most sub-Saharan African countries have experienced high total fertility rates, leading to rapid population growth and policy concerns. This study examined the determinants of the desire to limit childbearing among married women in four high-fertility sub-Saharan African countries using the most recent demographic and health survey data: Gabon (2019), Mali (2018), Tanzania (2022), and Zambia (2018). The analysis included married women desiring to limit childbearing, with sample sizes of 3,664 (Gabon), 6,782 (Mali), 6,946 (Tanzania), and 6,674 (Zambia). Multivariate binary logistic regression was performed, and the results were reported with 95% confidence intervals (CIs). Zambia recorded the highest proportion of married women desiring to limit childbearing (47%), whereas Mali had the lowest (23.9%). Older women (35 – 49 years) were more likely to express this desire than younger women (15 – 19 years) in Gabon (adjusted odds ratio [aOR] = 3.02; CI: 1.60 – 5.70), Mali (aOR = 44.28; CI: 26.19 – 74.89), Tanzania (aOR = 8.85; CI: 5.81 – 13.49), and Zambia (aOR = 6.74; CI: 4.61 – 9.86). Increasing parity was also a significant predictor. Women with one to two children had lower odds of wanting to limit childbearing compared to those with five or more children: (aOR = 0.05; CI: 0.03 – 0.08) in Gabon, (aOR = 0.10, CI: 0.06 – 0.15) in Mali, (aOR = 0.03; CI: 0.02 – 0.04) in Tanzania, and (aOR = 0.04; CI: 0.03 – 0.06) in Zambia. Across all countries, the age of a woman, parity, and decision-making were significant determinants of the desire to limit childbearing among married women. The study highlights the need to intensify reproductive health education and family planning services, particularly for younger women. In addition, empowering marginalized women can help them make informed reproductive choices, thus increasing their desire to limit childbearing.

Keywords: Women; Reproductive health; Fertility desire; Family planning; Sub-Saharan Africa

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1. Introduction

Sub-Saharan Africa (SSA) is a part of the world where total fertility has been constantly high for a long time. The region's population growth rate has been, for a long time,

higher than that of other regions of the world (Bongaarts, 2020). It is evident that population growth rates have significantly declined in developed regions due to a drastic fertility transition, which has reduced the total fertility rate to below the replacement level (Cheng *et al*., 2022). The United Nations Population Fund (UNFPA) estimates showed that in 2024, the world population was eight billion people (UNFPA, 2024), in which SSA accounted for approximately 1.2 billion with an average total fertility rate of four children per woman (Tesfa *et al*., 2023). SSA has the highest total fertility rate in the world, with a population growth 7 times higher than that of more developed regions (Tesfa *et al*., 2023; UNFPA, 2022). This situation has led to a dramatic increase in the population of developing countries, primarily caused by an increase in the number of women reaching reproductive age and slow changes in fertility rates (UNFPA, 2022; UNPD, 2019).

Evidence shows that although fertility decline has begun in nearly all parts of SSA, the pace of decline has been slower than in other parts of the world (Bongaarts, 2016; Bongaarts & Casterline, 2013). Given the high levels of fertility in SSA, significant health policies and programming have been devoted to improving women's access to and use of modern contraceptives (Emeh *et al*., 2023). These family planning initiatives are intended to enhance women's sexual and reproductive health rights to enable them to make informed reproductive decisions to space or limit childbearing, so that they can meet their desired reproductive goals (Ezeanolue *et al*., 2015; Oronje *et al*., 2011). Various initiatives aimed at promoting contraception use have been discussed at the continental level. One such example includes the 2006 Maputo Program of Action, signed by 48 African Union member countries. The plan called for enhancing universal access to reproductive health services among women by 2015 (African Union, 2006).

High fertility in SSA is largely attributed to cultural norms favoring large families, limited access to contraception, and lower levels of female education and employment opportunities (Mwaisaka *et al*., 2020). Recent trends indicate that fertility decline has occurred in most SSA countries, although the fertility rates remain higher compared to other regions of the world. The average total fertility rate in East Africa dropped to 3.9 children per woman in 2023, whereas West Africa remains high at 5.1 children per woman (Tesfa *et al*., 2023). National initiatives, such as expanded family planning programs in Kenya and Rwanda, have contributed to observed declines in East African countries. On the other hand, Southern Africa has the most advanced fertility transition, characterized by early childbearing peaks and negative correlations between fertility levels and both age at first marriage and contraceptive prevalence (Ojakaa, 2022). Limiting childbirth is crucial for women and their families in SSA as it significantly enhances maternal and child health. Frequent pregnancies increase the risk of maternal mortality and complications such as anemia, pre-eclampsia, and obstetric fistula. By spacing births and limiting the number of children, women can recover fully between pregnancies, reducing health risks and leading to better overall well-being.

On a broader scale, reducing high fertility rates in SSA is vital for economic and social development. Lower fertility rates can contribute to a demographic dividend. Moreover, smaller family sizes enable households to save more and invest in their futures, enhancing overall economic stability (Ahinkorah *et al*., 2021). For SSA countries, managing population growth is essential for sustainable development, as it helps reduce the strain on natural resources, public services, and infrastructure, paving the way for a more resilient and prosperous society (Bongaarts, 2009). Studies across SSA and elsewhere have identified various demographic factors, such as age, parity, ideal number of children, and socioeconomic factors, such as educational level, religious beliefs, current contraceptive use, and decision-making autonomy, as key drivers influencing women's desire to limit childbearing (Ahinkorah *et al*., 2020; Bolarinwa *et al*., 2022; Matovu *et al*., 2017; Muluneh & Moyehodie, 2021).

The timing of key reproductive events, such as the age of first sexual activity and the age of first marriage, significantly influences a woman's fertility preferences and her eventual desire to limit childbearing. Studies indicate that women who engage in sexual activity at an early age are more likely to experience early marriage and prolonged reproductive spans, which increase their total fertility rates and delay their inclination to limit childbearing (Ahinkorah *et al*., 2021; Kidie *et al*., 2024). Early marriage is often associated with limited access to education and economic opportunities, reinforcing traditional gender roles and higher fertility expectations, particularly in SSA (Bongaarts, 2020; Namukoko *et al*., 2022). Conversely, women who delay their first sexual activity and marriage tend to have better access to education, reproductive health services, and contraceptive methods, enabling them to make informed decisions regarding their fertility preferences (Adhikari, 2010; Muhoza, 2019). Understanding the interplay between these factors is essential for shaping policies that promote delayed marriage, comprehensive reproductive health education, and access to modern contraceptive methods to help women achieve their reproductive goals.

Most studies on fertility preference in SSA have focused on examining determinants of the desire for more children in countries such as Nigeria, Niger, Ghana, and Uganda (Babalola *et al*., 2017; Mardi *et al*., 2018; Naghibi *et al*., 2019). Others have examined broader regions such as SSA and East Africa (Ahinkorah *et al*., 2021; Casterline & El-Zeini, 2007; Cleland *et al*., 2020). These studies are important because they provide useful information to understand the causes of high fertility in SSA. Despite this extensive research, there is also a need to understand the profiles and factors that are associated with the desire to limit childbearing among women of reproductive age, especially in high-fertility countries. This study examines fertility behavior in high-fertility countries in SSA (Gabon, Mali, Tanzania, and Zambia) using the most recent demographic and health survey data, offering a comparative perspective on regional reproductive behaviors. Unlike many studies focused on single countries, this study addresses the lack of research on factors influencing married women's desire to limit childbearing. Understanding these factors is essential for shaping effective reproductive health policies, improving access to family planning, and promoting gender equality. Beyond academic contributions, this research has key policy implications, emphasizing targeted interventions to support younger, less-educated women and enhance women's autonomy through economic empowerment.

1.1. Theoretical framework

The decision to limit childbearing can be analyzed through an expanded theoretical lens that integrates Easterlin's demand–supply framework of fertility, the Gender and Development (GAD) framework, and the Social Influence Theory. This multitheory approach provides a comprehensive understanding of the interplay between economic, sociocultural, and structural factors shaping reproductive behavior. Easterlin's demand–supply framework posits that fertility outcomes are shaped by the balance between the demand for children, the supply of children, and the costs associated with fertility regulation (Bongaarts, 1993; Easterlin, 1975; Qamar, 2022). The demand for children reflects socioeconomic and cultural influences on desired family size, while supply refers to the biological capacity for childbearing, influenced by health and mortality rates (Bongaarts, 2020). Couples regulate fertility through contraception when the cost of having additional children outweighs the perceived benefits (Bwalya *et al*., 2023). Economic development, increased female education, and urbanization have been associated with reduced fertility desires, as women weigh career opportunities and financial stability against childbearing (Muhoza, 2019).

The GAD framework emphasizes the role of gender power dynamics in shaping access to reproductive health services and decision-making autonomy. Patriarchal structures in many SSA societies restrict women's agency in determining their reproductive choices, including contraception use and fertility preferences (Ahinkorah *et al*., 2021; Kidie *et al*., 2024). Women with limited autonomy often face barriers to negotiating contraceptive use or limiting childbearing, as male partners, extended family, or cultural norms may dictate reproductive decisions (Oronje *et al*., 2011). Empowering women through education, economic independence, and policy interventions that promote gender equality can enhance their ability to act on fertility preferences and make informed reproductive health decisions (Atake & Gnakou Ali, 2019).

On the other hand, the Social Influence Theory highlights how societal norms, peer expectations, and religious beliefs shape individual fertility decisions. In SSA, fertility is often tied to social status, with large families symbolizing wealth, lineage continuity, and social security (Hoyweghen *et al*., 2022; Qamar, 2022). Religious doctrines, community leaders, and peer networks influence perceptions of ideal family size and contraceptive use (Ahinkorah *et al*., 2021; Muluneh & Moyehodie, 2021). In contexts where high fertility is culturally reinforced, women may feel pressured to have more children despite personal preferences to limit births. Understanding these social pressures is crucial for designing culturally sensitive family planning programs that address communal attitudes while promoting reproductive autonomy (Church *et al*., 2023).

By combining Easterlin's demand–supply framework with the GAD framework and the Social Influence Theory, this study provides a more holistic analysis of the determinants of the desire to limit childbearing among married women in SSA. Easterlin's model explains the economic and demographic drivers of fertility decisions, whereas the GAD framework highlights gender-based constraints, and the Social Influence Theory contextualizes fertility choices within broader social and cultural expectations. This integrated approach offers critical insights for policymakers and reproductive health practitioners, emphasizing the need for multi-faceted interventions that address economic constraints, gender inequalities, and sociocultural norms influencing fertility behavior in SSA.

2. Data and methods

2.1. Data source and sample size

"The data for this study were drawn from the latest Demographic and Health Surveys (DHS) conducted in four SSA nations: Gabon (2019 DHS), Mali (2018 DHS), Tanzania

(2022 DHS), and Zambia (2018 DHS). The DHS program, which provides nationally representative household data, is carried out by national statistics agencies in many developing countries, with support from international partners such as Inner City Fund International and the United States Agency for International Development. The DHSs employed a stratified two-stage sampling approach. In the first stage, enumeration areas were selected with a probability based on the size of each stratum. In the second stage, households are systematically selected with equal probability in each enumeration area. All women aged 15 – 49 years and men aged 15 – 59 years who had stayed overnight in the selected household preceding the interview date were eligible for inclusion in the survey. The DHS utilizes standardized questionnaires to gather data, including the Household Questionnaire, Woman's Questionnaire, Man's Questionnaire, and Biomarker Questionnaire (Croft *et al*., 2018). Each country's survey report provides a detailed explanation of the methodologies used in these surveys (Croft *et al*., 2018). Our study used the module on Contraceptive Use and Fertility Preferences, which is included in the individual women's recode file. The DHS datasets are publicly available from the DHS website (https://dhsprogram.com/; Croft *et al*., 2018). The samples of women interviewed in each country were as follows: Gabon (n = 11,043), Mali (n = 10,519), Tanzania (n = 13,266), and Zambia (n = 13,683). These samples translated into overall response rates of 96%, 95%, 97%, and 97%, respectively. However, in this analysis, we restricted the samples to married women who had the desire to limit childbearing. This resulted in the following study sample (n = 3,664) for Gabon, (n = 6,782) for Mali, (n = 6,946) for Tanzania, and (n = 6,674) for Zambia.

2.2. Measurement of study variables

2.2.1. Outcome variable

The outcome variable for this study is the desire to limit childbearing. For this analysis, the desire to limit childbearing refers to an individual woman's preference to control the number of children she wants to have. In the DHS, all women who had given birth were asked a question: "Would you like to have another child, or would you prefer not to have any more children?" To facilitate our analysis, we restricted the analysis to married women who indicated that they desired to have another child or wanted no more children. Women whose responses were coded as undecided were removed from the analysis sample. A binary variable was created to facilitate binary logistic regression. The outcome variable was coded "1," representing women who indicated that they wanted no more children, and "0," representing women who wanted to have another child in the future.

2.2.2. Independent variables

Explanatory factors were chosen based on the body of existing literature (Adilo & Wordofa, 2017; Ahinkorah *et al*., 2020; Casterline & Agyei-Mensah, 2017; Phiri *et al*., 2023a; 2023b; Shiferaw *et al*., 2019). The following variables were included: a woman's age, place of residence, educational attainment, partner's educational attainment, parity, living children, household's wealth status, employment status, decision-making about health, informed about family planning at a health facility, and exposure to media family planning information. These variables were divided into two groups: Variables at the individual and contextual levels. The variables were categorized as age (15 – 24 years, 25 – 34 years, and 35 – 49 years), education attainment (no education, primary level, secondary level, and tertiary level), partners' education (no education, primary level, secondary level, and tertiary level), employment status (working or not working), parity (1 – 2, 3 – 4, and 5+), and other individual variables (yes or no), such as was informed about family planning at health facilities, visited a health facility in last the 12 months, and exposure to mass-media family planning information. Contextual level variables included residence (urban or rural) and household wealth status (poor, middle, or rich).

The initial analysis included the following variables: Contraceptive use, ideal number of children, age at first sexual activity, and age at first marriage. However, after a thorough review of the literature, these variables were removed from the analysis due to ambiguity in their relationship significance to explain the desire to limit childbearing among women. Contraceptive use may not directly indicate a desire to limit childbearing, as it could also reflect spacing intentions. The ideal number of children is often influenced by cultural and social desirability biases, making it unreliable as a predictor of limiting behavior. Furthermore, age at first sexual activity and age at first marriage may have no direct influence on the desire to limit childbearing, as reproductive intentions are shaped more by factors such as socioeconomic status, health concerns, and access to family planning rather than the timing of these life events. Their exclusion ensured a more consistent analysis of the true drivers of the desire to limit childbearing among women.

2.3. Statistical analysis

"Statistical analysis was performed using Stata version 17 software with a 95% confidence interval (CI). The analysis considered survey design, cluster effect, and post-stratification weights in the DHS datasets. Statistical analysis was conducted in three stages. In the first stage, a univariate analysis was conducted to describe

variations in the prevalence of desire to limit childbearing among married women in SSA countries with a series of frequencies and percentage distributions. Bivariate analysis was then performed through cross-tabulation of the independent variable with the outcome variable using Pearson's Chi-square test. Finally, a multivariate binary logistic regression analysis was performed between the dependent variable and various independent variables. Adjusted odds ratios (AORs) with corresponding *p*-values were calculated. Multivariate logistic regression models were performed for each country. Multicollinearity was assessed for all the predictor variables to separate the independent effects of the interrelated variables. Below is the binary logistic regression equation presented in Equation I,

$$\text{Logit}\,[P\,(y = 1)|Xi\ldots Xk] = \beta o + \beta 1X1 + \beta 2X2.....\beta kXk \quad (I)$$

where βo is the intercept, β1 is the regression coefficient, and Xi…Xk are the independent variables (Warner, 2008).

2.4. Ethical approval

Permission to access the datasets for Gabon, Mali, Tanzania, and Zambia was requested from the DHS Program. Since all ethical protocols were adhered to by Inner City Fund International and the respective national statistical agencies during the original data collection process, no additional ethical approval was required for the secondary analysis (DHS Program, 2021). The dataset that was analyzed is publicly available and may be found on the website (https://dhsprogram.com/).

3. Results

3.1. Description of sample characteristics

Table 1 shows the background characteristics of women included in the study. The majority of the married women in the three countries lived in rural areas: Tanzania (77%), Zambia (59%), and Mali (78%). In Gabon, a greater proportion (69%) of the married women resided in urban areas. With regard to women's education, the highest proportion of women without formal education was in Mali (72.6%), followed by Tanzania with 19.4%. In Zambia and Gabon, married women without education were 9.3% and 8.2%, respectively. The percentage of married women who had higher education was highest in Gabon (14.9%) and lowest in Tanzania (1.1%), whereas the majority of married women in Tanzania and Zambia had primary education (66.1% and 50.7%, respectively).

Results for wealth status show that in all four countries, the majority of married women were from rich households, in Gabon (46.2%), Mali (40.8%), Tanzania (41.4%), and Zambia (41.0%). On the other hand, the lowest proportion of married women was from the middle-income level households in all the countries, in Gabon (21.8%), Mali (20.8%), Tanzania (19.0%), and Zambia (19.0%). A greater proportion of the women in Gabon (52.9%), Mali (58.7%), Tanzania (78.9%), and Zambia (51.7%) were working at the time of the survey.

Figure 1 shows the proportion of married women who desired to limit childbearing in SSA countries. In terms of country-based analysis, Zambia had the highest proportion of married women who desired to limit childbearing, 40.7% (95% CI: 39.3 – 42.1), whereas Mali had the lowest, 23.9% (95% CI: 22.7 – 25.2).

3.2. Distribution of married women who desire to limit childbearing by background characteristics

Table 2 shows the bivariate analysis of the association between the independent variables and the desire to limit childbearing among married women in the four countries included in the study. In all four countries, the age of a woman was significantly associated with the desire to limit childbearing. The desire to limit childbearing was highest among older women aged 35 – 49 in all the countries, Gabon (48.3%), Mali (60.1%), Tanzania (59.6%), and Zambia (74.3%). However, the desire to limit childbearing was lowest among married women aged 15 – 24 years in all the countries, with 13.9%, 1.2%, 4.0%, and 9.4% for Gabon, Mali, Tanzania, and Zambia, respectively.

In Zambia, living in urban areas was significantly associated with a high desire to limit childbearing (43.2% in urban vs. 39% in rural). Contrary to Zambia, in Gabon, women living in rural areas were more likely to have the desire to limit childbearing compared to those living in urban areas (39% in rural vs. 31.2% in urban).

Women's level of education was significantly associated with the desire to limit childbearing in all countries. Women who had a secondary education level had lower reports of desire to limit childbearing in Mali (10.8%), Tanzania (20.9%), and Zambia (31.9%). In Gabon and Tanzania, women with primary education (40.5% in Gabon and 32.2%

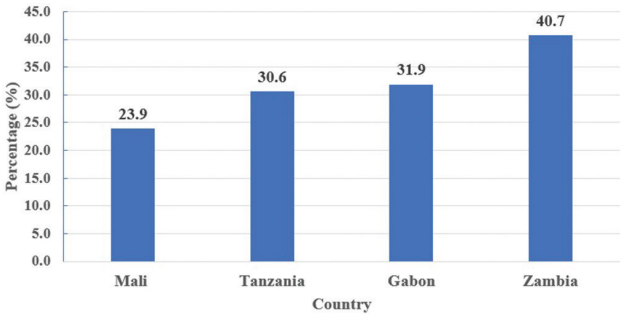

Figure 1. Distribution of married women who desired to limit childbearing in sub-Saharan African countries

Table 1. Distribution of background characteristics of married women (15 – 49 years)

Background characteristics	Gabon (*n*=3,664)	Mali (*n*=6,782)	Tanzania (*n*=6,946)	Zambia (*n*=6,674)
Age (%)				
15 – 24	13.0	26.3	24.1	23.9
25 – 34	42.8	43.1	39.9	40.0
35 – 49	44.2	30.6	36.0	36.1
Residence (%)				
Urban	68.6	22.3	30.3	40.8
Rural	31.4	77.7	69.7	59.2
Women's education (%)				
None	8.2	72.6	19.4	9.3
Primary	16.0	12.1	66.1	50.7
Secondary	60.9	13.8	13.4	34.9
Tertiary	14.9	1.5	1.1	5.1
Partners' education (%)				
None	10.8	73.5	12.3	5.7
Primary	7.3	9.4	69.0	36.7
Secondary	54.3	12.6	15.7	48.3
Tertiary	27.6	4.5	3.0	9.3
Wealth status (%)				
Poor	32.0	38.3	39.6	40.0
Middle	21.8	20.8	19.0	19.0
Rich	46.2	40.8	41.4	41.0
Working status (%)				
Not working	47.1	41.3	21.1	48.3
Working	52.9	58.7	78.9	51.7
Parity (%)				
1 – 2	41.8	31.8	38.8	35.2
3 – 4	34.7	28.2	29.3	30.0
5+	23.5	40.0	31.9	34.8
Was informed about family planning at a health facility (%)				
No	80.8	66.4	60.7	50.1
Yes	19.2	33.6	39.3	49.9
Visited a health facility in the last 12 months (%)				
No	35.9	48.7	27.7	28.8
Yes	64.1	51.3	72.3	71.2
Exposure to media family planning messages (%)				
No	73.7	59.5	32.7	76.3
Yes	26.3	40.5	67.3	23.7

in Tanzania) had the highest desire to limit childbearing. However, in Mali and Zambia, married women with no education had the highest desire to limit childbearing (27.3% and 52.6% in Mali and Zambia, respectively).

As expected, in all four countries, working status was significantly associated with a higher desire to limit childbearing. Women who reported working at the time of the survey were more likely to have the desire to limit childbearing: Gabon (35.6%), Mali (26.6%), Tanzania (32.3%), and Zambia (44.1%)

Household wealth status was also significantly associated with the desire to limit childbearing in Tanzania

Table 2. Distribution of married women who desire to limit childbearing by background characteristics

Background characteristics	Gabon (*n*=3,664)	Mali (*n*=6,782)	Tanzania (*n*=6,946)	Zambia (*n*=6,674)
Age	***	***	***	***
15 – 24	68 (13.9)	23 (1.2)	66 (4.0)	152 (9.4)
25 – 34	331 (20.4)	374 (12.1)	567 (20.6)	785 (29.1)
35 – 49	812 (48.3)	1,318 (60.1)	1,477 (59.6)	1,806 (74.3)
Residence	***	ns	ns	***
Urban	1,087 (31.2)	374 (23.4)	675 (32.4)	1,188 (43.2)
Rural	125 (39.0)	1,342 (24.1)	1,435 (29.9)	1,555 (39.0)
Women's education	***	***	***	***
None	109 (34.7)	1,419 (27.3)	413 (30.8)	331 (52.6)
Primary	246 (40.5)	178 (20.5)	1,465 (32.2)	1,525 (44.6)
Secondary	740 (32.0)	107 (10.8)	192 (20.9)	752 (31.9)
Tertiary	117 (20.7)	12 (11.0)	40 (51.9)	136 (40.0)
Partner's education	*	***	*	***
None	91 (26.4)	1,298 (25.6)	242 (28.6)	169 (45.4)
Primary	94 (40.5)	138 (21.4)	1,523 (32.1)	1,085 (45.5)
Secondary	544 (31.5)	183 (21.0)	280 (26.0)	1,126 (35.9)
Tertiary	261 (29.8)	42 (13.3)	65 (31.2)	248 (40.9)
Working status	***	***	***	***
Not working	496 (27.7)	595 (20.0)	354 (24.4)	1,204 (37.0)
Working	716 (35.6)	1,121 (26.6)	1,756 (32.3)	1,540 (44.1)
Parity	***	***	***	***
1 – 2	185 (11.7)	75 (3.3)	176 (6.6)	262 (11.0)
3 – 4	426 (32.3)	259 (12.9)	602 (29.8)	739 (36.7)
5+	601 (67.1)	1,381 (48.1)	1,332 (60.6)	1,742 (74.2)
Wealth status	ns	ns	***	***
Poor	432 (35.6)	702 (25.5)	761 (27.9)	995 (36.9)
Middle	244 (29.4)	348 (23.3)	430 (32.9)	554 (43.3)
Rich	536 (30.5)	666 (22.7)	919 (32.2)	1,195 (43.2)
Husband's desire for children	***	**	***	***
Both want the same	318 (32.5)	238 (20.5)	851 (30.1)	1,051 (37.9)
Husband wants more	276 (28.2)	854 (25.4)	669 (37.0)	746 (45.9)
Husband wants a few	57 (17.8)	74 (28.3)	129 (30.4)	242 (40.9)
Decision-making about own health	ns	***	***	***
Woman	340 (31.4)	176 (32.9)	444 (40.4)	1,198 (43.1)
Woman and husband/partner	543 (31.6)	267 (30.1)	1,177 (30.2)	1,077 (40.0)
Husband/partner alone	326 (33.2)	1,253 (22.3)	484 (25.9)	467 (37.1)
Exposure to media family planning messages	*	ns	**	ns
No	928 (33.1)	1,021 (23.9)	644 (28.5)	2,088 (40.2)
Yes	284 (28.4)	695 (23.9)	1,466 (31.7)	675 (42.2)

Note: Data presented as *n* (%) unless stated otherwise; Statistical significance determined at *p<0.05, **p<0.01, and ***p<0.001.
Abbreviation: ns: Non-significant.

and Zambia. Women from poor households (27.9% in Tanzania and 36.9% in Zambia) had lower reports of desire to limit childbearing compared to those from middle and rich households. Regarding contraceptive

use, in Tanzania, women who were using contraceptives had higher reports of desire to limit childbearing (34.5%). Women who indicated having six or more living children were more likely to have the desire to limit childbearing in all the countries: Gabon (80.2%), Mali (65.1%), Tanzania (71.8%), and Zambia (86.8%).

3.3. Determinants of desire to limit childbearing

Table 3 shows the AORs of the multivariable logistic regression examining the association between independent correlates and desire to limit childbearing in the four SSA countries (Gabon, Mali, Tanzania, and Zambia). Results show that in all four countries, as the age of a woman increased, the likelihood of the desire to limit childbearing increased. Women in the age group 35 – 49 years in Gabon (aOR = 2.24; 95% CI: 1.80 – 3.60), in Mali (aOR = 17.97; 95% CI: 12.28 – 26.30), Tanzania (aOR = 7.19; 95% CI: 5.25 – 9.83), and Zambia (aOR = 5.84; 95% CI: 4.51 – 7.56) were more likely to have the desire to limit childbearing compared to those in the age group 15 – 19 years.

In Zambia, women who were residing in rural areas (aOR = 0.73; 95% CI: 0.58 – 0.92) had lower odds of the desire to limit childbearing than their counterparts living in urban areas. As expected, increasing parity was significantly associated with a high likelihood of the desire to limit childbearing in all four countries. Women with parity 1 – 2, in Gabon (aOR = 0.10; 95% CI: 0.08 – 0.14), in Mali (aOR = 0.15, 95% CI: 0.11 – 0.19), in Tanzania (aOR = 0.08; 95% CI: 0.06 – 0.10), and in Zambia (aOR = 0.07; 95% CI: 0.06 – 0.09), had lower odds of the desire to limit childbearing compared to those with parity of five or more.

Regarding household wealth status, married women in Zambia who belonged to households classified as rich were significantly more likely to limit childbearing compared to those who belonged to poor households (aOR = 1.62; 95% CI: 1.28 – 2.05). Similarly, women who were working in Gabon (aOR = 1.06; 95% CI: 0.89 – 1.28) had higher odds of the desire to limit childbearing compared to those not working.

In Mali and Tanzania, married women who had access to family planning information were significantly associated with the desire to limit childbearing (aOR = 0.76; 95% CI: 0.60 – 0.95 and aOR = 1.29; 95% CI: 1.12 – 1.48, respectively). In regard to the husband's desire for children, in Tanzania (aOR = 0.68; 95% CI: 0.51 – 0.90), women who had husbands wanting a few children had lower odds of the desire to limit childbearing compared to those who reported having husbands who wanted more children.

4. Discussion

This study sought to examine determinants of the desire to limit childbearing among married women in SSA countries. Many prior studies on fertility preferences in SSA focused on examining factors that influence the desire to have additional children among married women. The study found differing results in terms of the prevalence and drivers of the desire to limit childbearing across different countries examined. Mali had the lowest proportion of women willing to limit childbearing, whereas Zambia had the highest. These differences could be explained by heterogeneity in social, economic, and cultural norms across SSA countries (Adhikari, 2010; Muhoza, 2019; Nibaruta *et al*., 2023; Wildeman *et al*., 2023). In Mali, traditional views often emphasize large families, with children seen as a source of social and economic support. Understanding the factors that explain women's desire to limit childbearing is crucial for designing effective family planning programs and policies that address women's reproductive health needs, promote autonomy, and support informed decision-making on high fertility levels in SSA. To achieve this, we examined four countries that have been reported to have high fertility rates in SSA (Bongaarts, 2020; Casterline & Agyei-Mensah, 2017; Tesfa *et al*., 2023).

Results show that older married women were more likely to limit childbearing in Gabon, Tanzania, Zambia, and Mali compared to young women. Similar findings have been reported in prior studies conducted in Ethiopia, Ghana, Cameroon, Nigeria, and Mozambique (Babalola *et al*., 2017). These findings align with broader demographic trends where age plays a significant role in reproductive choices (Teshale *et al*., 2022). As women age, they are more likely to have achieved their desired family size and may prioritize economic stability, health, and child-rearing responsibilities over further childbearing (Casterline, 2017). In contrast, another study in SSA has reviewed that young women often intend to limit their births, contrary to the assumption that only older women do (Van Lith *et al*., 2013). In addition, older women may have greater access to family planning information and services, enabling them to make informed decisions about limiting fertility (Casterline, 2017). The findings suggest the need to strengthen access to and utilization of family planning services in SSA countries with high fertility, especially among older women, to enable them to attain their reproductive health goals.

Our study found that married women in Mali who were living in rural areas were highly likely to limit childbearing compared to those living in urban areas. Married women living in rural areas in Mali may be more inclined to limit childbearing due to the economic pressures and resource constraints typically associated with rural living. Larger families can pose a challenge in rural settings where access

Table 3. Association between background characteristics and women's desire to limit childbearing

Background characteristics	Gabon (*n*=3,664) Pseudo R^2=0.2149		Mali (*n*=6,782) Pseudo R^2=0.3236		Tanzania (*n*=6,946) Pseudo R^2=0.2879		Zambia (*n*=6,674) Pseudo R^2=0. 3256	
	AOR	95% CI	AOR	95% CI	AOR	95% CI	AOR	95% CI
Age								
15 – 24	Ref		Ref		Ref		Ref	
25 – 34	1.02	(0.72 – 1.43)	2.59***	(1.77 – 3.78)	2.16***	(1.59 – 2.23)	1.37***	(1.08 – 1.74)
35 – 49	2.54***	(1.80 – 3.60)	17.97***	(12.19 – 26.30)	7.19***	(5.25 – 9.83)	5.84***	(4.51 – 7.56)
Parity								
1 – 2	0.10***	(0.08 – 0.14)	0.15***	(0.11 – 0.19)	0.09***	(0.06 – 0.10)	0.07***	(0.06 – 0.09)
3 – 4	0.32***	(0.26 – 0.39)	0.32***	(0.27 – 0.39)	0.38***	(0.33 – 0.45)	0.27***	(0.23 – 0.89)
5+	Ref		Ref		Ref		Ref	
Residence								
Urban	Ref		Ref		Ref		Ref	
Rural	1.03	(0.83 – 1.27)	0.84*	(0.68 – 1.04)	0.74	(0.62 – 0.88)	0.74***	(0.61 – 0.89)
Women's education								
No education	Ref		Ref		Ref		Ref	
Primary	1.20	(0.82 – 1.76)	1.12	(0.88 – 1.43)	1.26***	(1.06 – 1.48)	0.88	(0.71 – 1.09)
Secondary	1.04	(0.72 – 1.50)	0.89	(0.66 – 1.21)	0.90	(0.70 – 1.17)	0.83	(0.64 – 1.08)
Tertiary	0.74	(0.44 – 1.24)	0.73	(0.34 – 1.57)	1.59	(0.75 – 3.36)	0.95	(0.63 – 1.44)
Wealth status								
Poor	Ref		Ref		Ref		Ref	
Middle	0.87	(0.66 – 1.14)	1.02	(0.84 – 1.24)	1.02	(0.92 – 1.30)	1.24*	(1.04 – 1.49)
Rich	1.20	(0.94 – 1.50)	1.13	(0.91 – 1.40)	1.11	(0.94 – 1.35)	1.62***	(1.28 – 2.05)
Working status								
No	Ref		Ref		Ref		Ref	
Yes	1.04	(0.89 – 1.28)	0.92	(0.79 – 1.07)	1.23	(0.95 – 1.33)	0.89*	(0.78 – 1.01)
Husband's education								
No education	Ref		Ref		Ref		Ref	
Primary	1.12	(0.77 – 2.50)	0.89	(0.68 – 1.15)	1.14	(0.94 – 1.39)	1.19	(0.90 – 1.56)
Secondary	0.90	(0.65 – 1.25)	1.38**	(1.07 – 1.79)	1.04	(0.80 – 1.36)	1.19	(0.89 – 1.58)
Tertiary	0.92	(0.61 – 1,38)	1.02	(0.63 – 1.66)	1.81**	(1.13 – 2.93)	1.34	(0.91 – 1.98)
Husband's desire for children								
Both want the same	Ref		Ref		Ref		Ref	
Husband wants more	0.73***	(0.57 – 0.93)	1.16	(0.93 – 1.44)	0.85*	(0.73 – 1.00)	1.04	(0.88 – 1.22)
Husband wants a few	0.63***	(0.44 – 0.92)	1.67	(1.10 – 2.53)	0.68**	(0.51 – 0.90)	0.88	(0.69 – 1.13)
Do not know	1.00	(0.80 – 1.27)	1.09	(0.87 – 1.36)	0.61***	(0.52 – 0.72)	0.92	(0.78 – 1.08)
Decision-making								
Woman	1.05	(0.82 – 1.35)	1.46	(1.13 – 1.09)	1.57***	(1.29 – 1.91)	1.24**	(1.03 – 1.48)
Woman/partner	0.92	(0.74 – 1.24)	1.30**	(1.06 – 1.59)	1.13	(0.97 – 1.31)	1.17	(0.97 – 1.41)
Others	0501*	(0.12 – 1.208)	1.32	(0.68 – 2.55)	1.31	(0.38 – 4.51)	1.39	(0.41 – 4.72)
Husband/partner alone	Ref		Ref		Ref		Ref	
Exposure to media family planning information								
No	Ref		Ref		Ref		Ref	
Yes	0.76**	(0.001 – 0.95)	0.96	(0.82 – 1.11)	1.29	(1.12 – 1.48)	1.04	(0.88 – 1.22)

Notes: Do not know is referring to a category of an independent variable (Husband's desire for children) ; Statistical significance determined at *p<0.05, **p<0.01, and ***p<0.001.
Abbreviations: AOR: Adjusted odds ratio; CI: Confidence interval; Ref: Reference.

to health care, education, and financial resources may be limited, making it difficult for families to adequately support more children. On the contrary, in Zambia, married women who were living in rural areas were less likely to limit childbearing compared to those living in urban areas. Compared to Mali, Zambia has experienced economic transitions that influence family planning decisions. In urban areas with higher living costs and greater access to education and employment opportunities, women may choose to delay marriage and childbearing, leading to a reduced desire to limit fertility later. Conversely, in rural settings where economic benefits are tied to larger families, early marriage and higher fertility may remain prevalent (Teshale *et al*., 2022). Other studies in SSA have also reported similar results (Ahinkorah *et al*., 2021). This is an expected result and reflects rural-urban disparities in socioeconomic conditions among women. Women living in urban areas are likely to be more educated and increasingly exercise autonomy over their reproductive health (Samuel *et al*., 2021). On the other hand, women living in rural areas often face challenges with access to reproductive health services. However, these trends may vary across countries in SSA. This particular finding could highlight the need for improved reproductive health-care access delivery, especially in rural areas where women usually walk long distances to access maternal health care.

In all the countries analyzed, we found that married women with lower parity were less likely to limit childbearing compared to those with higher parity. Women with fewer children are often influenced by societal expectations, economic considerations, and partner or family pressures to continue childbearing until they reach what is considered an acceptable family size (Tufa *et al*., 2023). In contrast, those with higher parity may feel they have fulfilled these expectations, making them more willing to consider limiting childbearing due to health, economic, and personal reasons. In addition, lower parity women may have been less likely to receive education or counseling on family planning after a few births, especially in settings where maternal health services are not fully provided during antenatal care (Ahinkorah *et al*., 2021). Furthermore, married women with fewer children often have less knowledge or access to contraception, particularly in rural or underserved areas, such as Mali and Zambia, where lower contraceptive awareness can prevent them from even contemplating limiting childbearing due to a lack of means (Gilda & Ashford, 2016; Namukoko *et al*., 2022). Similar dynamics may be observed in other countries where religious influences shape family-size decisions (Ahinkorah *et al*., 2021). This finding suggests the need to provide comprehensive reproductive health education to women, especially during their early years of childbearing, which could help them make informed decisions about family size.

The findings of this study pose the need for strengthening family planning initiatives in SSA countries to enable women to achieve their desired family size. Educational campaigns that highlight the health, economic, and social benefits of smaller family sizes can help balance the traditional values of large families while offering alternatives. The desire to limit childbearing is associated with contraceptive use. Women who are often exposed to family planning information through health services, outreach programs, or community education are more aware of the options available to control the number and timing of their children (Bwalya *et al*., 2023; Teshale *et al*., 2022). This knowledge influences their decision to limit childbearing. This study is an eye-opener to expanding access to a wide range of contraceptive methods, particularly in rural and underserved areas, which can empower more women to control their fertility and limit childbearing.

Our study found that in Mali, Tanzania, and Zambia, married women who participated in household decision-making were more likely to limit childbearing compared to those who did not. Women involved in household decision-making often have greater autonomy over key aspects of their lives, including reproductive choices, which allows them to make informed decisions about the number of children they want (Demissie *et al*., 2022). In addition, women who participate in household decisions tend to have better communication and negotiation power with their partners regarding family size, enabling couples to discuss and agree on limiting childbearing after reaching a mutually desired number of children. In societies where women's access to education and employment is limited, early marriage and higher fertility are often normative, as seen in Mali. Enhancing women's socioeconomic status through education and workforce participation can shift these norms, empowering women to make informed reproductive choices and potentially leading to a preference for smaller families. A similar study done in Nigeria found that those women who participated in household decisions had a higher desire to limit childbearing than those who did not participate (Atake & Gnakou Ali, 2019). This study's findings catalyze the need for empowerment programs to enhance women's participation in household decision-making by promoting gender equality in the family.

This study applied Easterlin's demand–supply framework, the GAD framework, and the Social Influence Theory, which provide a more holistic analysis of the determinants of the desire to limit childbearing among married women in SSA. Easterlin's model explains the

economic and demographic drivers of fertility decisions, which offers an integrated framework that combines economic factors and sociological perspectives to explain variations in fertility rates, while the GAD framework highlights gender-based constraints, and the Social Influence Theory contextualizes fertility choices within broader social and cultural expectations. This integrated approach offers critical insights for policymakers and reproductive health practitioners, emphasizing the need for multi-faceted interventions that address economic constraints, gender inequalities, and sociocultural norms influencing fertility behavior in SSA. By accounting for economic, sociocultural, and structural factors, the theories provide a comprehensive understanding of decisions regarding fertility desire.

While the study offers valuable insights that could enhance existing family planning initiatives aimed at reducing high fertility among married women in SSA, the development of targeted interventions will require a more nuanced approach. Conducting a detailed decomposition analysis of both individual and community-level factors is essential to uncover the drivers of variability in the desire to limit childbearing across different countries in SSA. For countries with a lower prevalence of this desire, adopting and adapting successful family planning strategies from nations where the issue is less pronounced could prove effective.

4.1. Policy implications of the study findings

This study has several policy implications for the SSA region. The results highlight that older women and those with higher parity are more likely to have a desire to limit childbearing, underscoring the importance of promoting modern contraceptive use. Health policy initiatives should prioritize expanding access to reproductive health education and family planning services to increase women's ability to make informed reproductive choices, particularly in rural and underserved areas where accessibility remains a challenge. Results also reveal that women exposed to mass media on family planning information in Tanzania had higher odds of the desire to limit childbearing than their counterparts. Therefore, nationwide mass media campaigns should be launched using television, radio, and social platforms to promote modern contraceptive methods. Collaborating with local community leaders will further help dispel myths such as the use of contraceptives, especially among young or unmarried women, encourage promiscuity and immoral behavior, and increase informed decision-making. Women's participation in household decision-making is associated with a higher likelihood of limiting childbearing. Therefore, initiatives that promote women's empowerment and reproductive decision-making autonomy should be prioritized in SSA countries. This is because such interventions have the potential to enhance education and economic opportunities for women. Furthermore, the initiatives help women to achieve reproductive autonomy, enabling them to make informed choices about family planning and childbearing.

4.2. Strengths and limitations

The results of this analysis can be generalized to the total population of married women of childbearing age in the countries where the study was conducted. This is because the study included a nationally representative sample of women who had given birth. The DHS dataset's standard methodology made it possible to compare the findings across countries. However, because the DHS applied a cross-sectional study design, causality cannot be inferred in this study. Further, due to the respondents being asked to report prior occurrences, there is also a chance of recall bias. This can result in underreporting or overreporting of events, affecting the reliability and validity of the results.

5. Conclusion

This study highlights significant differences in the desire to limit childbearing among married women in four SSA countries, with Zambia having the highest prevalence and Mali the lowest. These differences underscore the need for context-specific interventions to address high fertility rates. Key determinants include age, parity, decision-making autonomy about a woman's health, and ideal number of children, with additional factors such as contraceptive use, education, and wealth status varying across countries. Policymakers should expand educational opportunities, improve contraceptive access, and empower women in marginalized communities. Beyond the four African countries analyzed, these findings have broader implications for global fertility trends. Fertility rates are declining worldwide due to economic conditions, cultural shifts, and evolving personal aspirations. The study underscores the relationship between women's ideal number of children and their desire to limit childbearing, emphasizing the need to integrate fertility preferences into reproductive health policies. In regions where large families are preferred, such as parts of the Middle East, South Asia, and Latin America, fertility rates may remain above replacement levels, impacting population growth. Conversely, in European and East Asian nations, sub-replacement fertility presents workforce shortages and aging populations. To address these trends, policymakers must tailor family planning initiatives to local contexts. High-fertility regions need better education, contraception access, and economic opportunities, while low-fertility countries may benefit from childcare subsidies and

parental leave policies. Understanding fertility motivations is crucial for designing effective interventions. These insights contribute to discussions on demographic change and reproductive behavior. Addressing both high and low fertility challenges through evidence-based, culturally sensitive strategies can promote sustainable population dynamics and economic stability.

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Conflict of interest

The authors declare no competing interests.

Author contributions

Conceptualization: Robert Zulu, Million Phiri
Investigation: Robert Zulu, Emmanuel Musonda
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Writing-original draft: Robert Zulu, Million Phiri, Emmanuel Musonda
Writing-review & editing: All authors

Ethics approval and consent to participate

"Since the data for this analysis were obtained from publicly available secondary sources, there was no need for approval from an ethics committee. However, all required procedures and guidelines were observed to access the DHS datasets through the DHS program. The DHS protocols ensured that ethical standards were met before data collection in Zambia. For participants over the age of 18, consent was obtained during the survey process, whereas parents or guardians provided consent for participants aged 15 to 17, who also gave their own consent as minors.

Consent for publication

Not applicable.

Availability of data

The data utilized in this study can be accessed publicly through the IPUMS DHS or DHS Program websites: https://www.idhsdata.org/idhs/, https://dhsprogram.com/.

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ACCSCIENCE PUBLISHING

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RESEARCH ARTICLE

The association between contraceptive use transition and fertility dynamics in Zambia

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Abstract

The Zambian government has recognized family planning (FP) as a key strategy to reduce high fertility and teenage pregnancy rates. Over the years, contraceptive use has been increasing steadily in the country; however, the effects of increased contraceptive use on fertility dynamics have rarely been explored in Zambia. In this study, we examined the relationship between contraceptive transition and fertility dynamics using the Zambia Demographic and Health Surveys conducted from 1992 to 2018. We applied a Blinder–Oaxaca multivariable decomposition analysis technique to quantify the contribution of contraceptive transition to the observed reduction in fertility and teenage pregnancy rates. About 69% of the reduction in total fertility rate and 64% of the decline in teenage pregnancy rate were due to shifts in women's sociodemographic characteristics. Specifically, the increase in contraceptive use rates from 14.2% to 45.0% accounted for 17.7% of the reduction in total fertility rate. Furthermore, 54.8% of teenage pregnancies were averted due to increased contraceptive use among teenagers in Zambia. The study establishes that contraceptive use significantly reduced fertility and teenage pregnancy rates. These trends can be predominantly attributed to an escalation in the proportion of females achieving secondary education, along with delays in age at first marriage and sexual initiation. This necessitates the enhancement of current sexual and reproductive health, and FP approaches to uphold the escalating levels of contraceptive utilization to further increase the impact on fertility dynamics in the country.

Keywords: Women's health; Contraceptive behavior; Fertility; Reproductive health; Zambia

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1. Introduction

The average total fertility rate in Sub-Saharan Africa (SSA) continues to exceed the average total fertility rate observed across all developing nations (Bongaarts, 2017; Mback, 2017; Zulu *et al.*, 2025). This may suggest the need for better integrated sexual and reproductive health (SRH) policies and programs to strengthen family planning (FP) access and utilization. Governments in SSA countries recognize that promoting FP is crucial for accelerating the reduction of fertility rates, as well as teenage pregnancy and maternal deaths. Many governments are making significant efforts to promote

and legitimize the provision and utilization of FP and reproductive healthcare services, which aim to enhance the adoption of various contraceptive modalities, including oral contraceptives, implants, injectables, intrauterine devices, and condoms (Karra *et al.*, 2017; Lenze & Klasen, 2017; Odimegwu *et al.*, 2023).

In the context of SSA, the implications of fertility patterns on developmental processes and the strategic decisions concerning interventions to counter adverse population trends have consistently garnered significant attention within the realm of demographic scholarship (Mberu & Ezeh, 2017). Hence, there has been a notable focus on SRH policies and initiatives to bolster FP efforts in SSA. An exemplary instance of this is the endorsement of the 2006 Maputo Program of Action by 48 member states of the African Union. This strategic framework aimed to advance the widespread availability of reproductive health services across African nations by 2015.

The 2006 Maputo Program of Action introduced a range of measures aimed at improving SRH across Africa, including expanding access to FP services, reducing maternal and child mortality, and addressing unsafe abortions. These measures focused on strengthening each country's healthcare systems through increasing funding for reproductive health programs and fostering partnerships among governments, civil society, and international organizations. The intended impacts of such interventions were to enhance health outcomes, promote gender equality, and accelerate progress toward achieving the Millennium Development Goals related to health and development in the region (The African Union Commission, 2016; United Nations, 2022).

Existing studies show that contraceptive transition, which is defined as changes in the prevalence of contraceptive methods used among women over time, has occurred in most countries in SSA (Beguy *et al.*, 2017; Kalinda *et al.*, 2022; Phiri *et al.*, 2024; Yussuf *et al.*, 2020). Furthermore, studies have documented the effect of contraceptive transition on fertility decline in SSA and elsewhere, revealing that increased contraceptive use has positively contributed to fertility reduction (Ariho & Kabagenyi, 2020; Bongaarts, 2017; Bongaarts, 2020; Garenne, 2018; May, 2017; Sarnak *et al.*, 2021). Literature suggests that women who have access to and utilize contraception have more control over their reproductive options. Contraceptives have made it easy for women or couples to delay or plan their pregnancies to reduce family sizes by preventing unplanned pregnancies (Bongaarts, 2017; Masiano *et al.*, 2019; Nanvubya *et al.*, 2022). Contraceptives have also given women more freedom by enabling them to further their education, enter the workforce, and make educated choices regarding their reproductive health rights (Ahmed *et al.*, 2019; Anderson & Leah, 2019).

To mitigate the negative effects of rapid population increase, the government of Zambia and many other governments in SSA and international organizations have been actively supporting and pushing FP interventions to increase access to and utilization among women (Ahmed *et al.*, 2019; Ministry of National Development Planning, 2019). Various efforts have been made to implement FP programs. These include major public campaigns to promote FP, improve service quality, and increase access to FP services. Population growth rates that have been declining in most SSA counties over the past few decades (Mberu & Ezeh, 2017) could be attributed to the successful investment in FP programs, which contributed to improved access to contraceptive services, hence reducing total fertility rates.

Between 1992 and 2018, Zambia consistently recorded a steady increase in contraceptive usage, surging from 14.2% to 49.6% (Zambia Statistics Agency *et al.*, 2019). Concurrently, there was a decrease in the total fertility rate from 6.2 offspring per female to 4.7 offspring per female of reproductive age (Zambia Statistics Agency *et al.*, 2019). Furthermore, teenage pregnancy rates declined from 33.8% in 1992 to 29.2% in 2018 (Phiri *et al.*, 2023; Zambia Statistics Agency *et al.*, 2019).

Despite this evidence, studies of fertility in Zambia have paid less attention to examining the contribution of contraceptive use to fertility dynamics. This is in contrast to empirical evidence from other SSA countries and beyond, where increased contraceptive use has been shown to significantly contribute to fertility decline. Our study, therefore, examined the association between contraceptive transition and fertility dynamics in Zambia. The results of this study provide insights that can guide the development of reproductive health initiatives and interventions for sustainable management of the country's population and contribute to ongoing efforts to address high fertility rates in SSA countries.

1.1. Theoretical framework

In theory, the effect of contraceptive utilization transition on the dynamics of fertility can be comprehended through the theoretical foundations of the classical demographic transition theory and Easterlin's economic framework of fertility. These two theories provide valuable insights for understanding the intricate factors that influence fertility dynamics in SSA. The classical demographic transition theory was first put forth by Warren Thompson in 1929, and Frank W. Notestein later made improvements in

the mid-20th century (Szreter, 1993). This theory posits that as countries evolve economically and socially, they undergo a predictable series of demographic transitions (Bongaarts, 2009; Galor, 2012; Szreter, 1993). The central idea is that birth rates fall as societies become modern and experience economic growth (Bongaarts, 2009; Galor, 2012). Increased urbanization, greater education for women, wider contraception access, and shifts in cultural and social norms are often contributing factors (Akwara *et al.*, 2023; Götmark & Andersson, 2020).

The demographic transition model provides valuable insights into historical population changes and can help predict future demographic shifts in countries undergoing socioeconomic transformation. In Zambia, increasing contraceptive use can be seen as a driver of fertility decline, moving the country toward the later stages of the demographic transition. This theory posits that as access to FP improves and cultural attitudes shift, fertility rates decline, and families begin to prioritize quality of life over large family sizes, reflecting broader socioeconomic development.

Easterlin's economic framework of fertility is an economic theory that integrates economic and social factors to explain fertility decisions. It suggests that fertility levels are influenced by the balance between desired family size (based on sociocultural norms and economic conditions) and the costs of achieving that size, including the availability and use of contraception (Easterlin, 1975). In Zambia, the transition in contraceptive use reduces the costs (economic, health, and time related) associated with childbearing, leading to adjustments in fertility dynamics as individuals align their reproductive behavior with their socioeconomic aspirations. Both theories posit that social development factors, such as improved access to contraception, higher female educational attainment, and greater women's empowerment, play significant roles in shaping the fertility patterns of women in their reproductive years (Bongaarts, 2017; Dasgupta *et al.*, 2022; Macunovich, 1998). In accordance with the theoretical underpinning employed in this research, it is anticipated that when a country experiences a trend of increased contraceptive use over time, its fertility and teenage pregnancy rates are anticipated to decline. Therefore, examining the magnitude of the effect of contraceptive transition on fertility dynamics is key because such information provides critical insights for designing evidence-based reproductive health policies and programs aimed at achieving sustainable population growth.

2. Data and methods

2.1. Data sources

The study utilized data collected from six Zambia Demographic and Health Surveys (ZDHSs) conducted between 1992 and 2018. For the analysis, we used the women's datasets (IR recode) that contained data on reproductive-aged women (15 – 49 years old). The ZDHSs were surveys conducted nationwide and represented all regions. The DHS used a two-stage stratified cluster sampling approach to select households, dividing each region into rural and urban segments. The initial phase involved selecting enumeration areas based on proportional allocation to the region's size. During the second stage, household listing operations took place in all selected clusters. The DHS usually selects 20 – 25 households/cluster (Croft *et al.*, 2018; Zambia Statistics Agency *et al.*, 2019). The relevant variables for this study were extracted from the women's recode dataset. The study included six samples of sexually active, fecund women aged 15 – 49 years who were not pregnant. The analysis included 5,181 women in 1992, 5,938 in 1996, 5,844 in 2001, 5,347 in 2007, 12,653 in 2013, and 10,576 in 2018. The ZDHS report (Zambia Statistics Agency *et al.*, 2019) and other sources (Croft *et al.*, 2018) provided detailed explanations of the sampling procedures.

2.2. Data collection

The research utilized a cross-sectional approach to concurrently assess exposures and outcomes among participants at a distinct time juncture. Cross-sectional investigations are instrumental in ascertaining prevalence rates and exploring associations among diverse variables and outcomes through the analysis of either singular or longitudinal data. The ZDHS questionnaire was administered to all women aged 15 – 49 years who either spent a night in the household before the interview or were usual members in all selected households for the 1992 – 2018 DHSs. Questions about contraception, fertility, and reproductive health were asked of these women. Data were collected by well-trained enumerators who underwent intensive field training (Croft *et al.*, 2018; Zambia Statistics Agency *et al.*, 2019).

2.3. Variables and measurement

The outcome variables for this study are fertility rate and teenage pregnancy. The fertility rate was measured using the DHS variable, "children ever born to a woman at the time of the survey." This variable was collected as a count variable in the DHS. The second dependent variable is "teenage pregnancy." Experience of teenage pregnancy was measured as a binary outcome (yes/no). The variable was measured as a composite variable, which included teenage girls aged 15 – 19 years who were either currently pregnant or had ever been pregnant.

The study chose the independent variables based on their relevance in previous research as key determinants

of fertility dynamics in SSA (Ariho & Kabagenyi, 2020; Bietsch *et al.*, 2021; Phiri *et al.*, 2023; Wasswa *et al.*, 2021). The independent variables encompassed maternal age categories (15 – 24, 25 – 34, and 35 – 49 years old), adolescent ages (15 – 19 years old), residential setting classification (rural or urban), educational attainment levels (no formal education, primary education, secondary education, or tertiary education), and marital status classifications (single, married, or previously married), household wealth index (poor, moderate, or rich), religious denomination (Catholic, Protestant, or other), employment status (working or not working), age at first sexual debut (<15 years, 15 – 19 years, 20 or above), age at first marriage (<15 years, 15 – 19 years, 20 or above), ideal number of children (0 – 3, 4 – 5, 6+) and exposure to media FP messages (yes, no).

2.4. Statistical analysis

The analysis conducted in this research encompassed both descriptive and multivariable decomposition techniques to examine the shifting patterns in contraceptive utilization, fertility rates, and teenage pregnancies. The first stage analysis involved a trend analysis of contraceptive use, fertility rate, and teenage pregnancy rate for the six ZDHS datasets. This was performed to measure trend change for the three measures over time. The second level involved conducting a decomposition analysis to examine the effect of contraceptive transition and sociodemographic factors on fertility dynamics during the period 1992 – 2018.

The third level involved examining the effect of contraceptive transition and sociodemographic independent factors on the decline in teenage pregnancy rates. A two-component Blinder–Oaxaca multivariate decomposition analysis was employed to assess and quantify the impact of contraceptive transition on fertility dynamics in Zambia.

To examine the contribution of contraceptive transition to fertility rate reduction in Zambia, Poisson regression modeling was utilized. Fertility rate reduction was measured using trend reduction in children ever born between 1992 and 2018. Given that children ever born is a count variable and may exhibit some dependence, the single-level Poisson regression method was chosen as the primary analytical method. This model is typically utilized in situations in which the count data does not exhibit any dispersion, or when the mean value of the data is equivalent to the variance.

A multivariable decomposition analysis for the nonlinear outcome was used to decompose the effect of increased contraceptive use on teenage pregnancy decline, given that the outcome was a dichotomous variable. The change in fertility dynamics over time can be attributed to compositional differences between the surveys and varying effects of selected independent variables. Although trend analyses are often conducted from longitudinal studies, such studies are limited in many SSA countries. Decomposition methods have been developed to determine the contribution of factors to outcomes using cross-sectional data despite some limitations.

2.4.1. Decomposition analysis

The statistical tool, Blinder–Oaxaca decomposition analysis technique, was developed by Blinder Oaxaca in 1973 (Blinder, 1973) and was later generalized by Neumark in 1988 (Neumark, 1988). This approach allowed the outcome variables between the two groups to be broken down into components explained by observed characteristics and estimated coefficients while controlling for all confounding factors. The Blinder–Oaxaca decomposition technique has been utilized in multiple studies for the purpose of analyzing models with binary dependent variables (Sinning *et al.*, 2008). The decomposition formula to compute the mean difference in the binary outcome (Y) between two groups or periods was decomposed as in Equation I (Powers & Yoshioka, 2011).

$$\bar{Y}A - \bar{Y}B = (E\beta A(YiA|XiA) - E\beta B(YiB|XiB)) + (E\beta A(YiB|XiB) - E\beta B(YiB|XiB)) \quad (I)$$

In the decomposition formula, the recent ZDHS 2018 and reference ZDHS 1992 surveys are denoted by A and B, respectively. The component labeled "E" in the formula refers to the differential attributed to variations in endowments or characteristics of women, also known as the explained component or compositional characteristics effects. The "C" component represents the differential part related to coefficient or effect variations, commonly known as the unexplained component or coefficient effects. "A" denotes the time being compared, while "B" serves as the reference time. Therefore, "E" represented a hypothetical comparison of the outcome disparity from the viewpoint of the group "A." Group "B" viewed the outcomes of component "C" through a counterfactual comparison (de-Boer & Rodrigues, 2020; Powers & Yoshioka, 2011). The "mvdcmp" command in Stata software (version 17) was used to perform a multivariable decomposition analysis of trend change in fertility dynamics between the DHS data points in Zambia.

Blinder–Oaxaca decomposition analysis is unique in its ability to isolate and quantify the specific contribution of increased contraceptive use to changes in fertility dynamics, distinguishing it from other factors like socioeconomic or demographic influences. It allows the breakdown of fertility rate changes into direct and indirect effects, providing a

clearer understanding of the magnitude of contraceptive use alone in driving fertility decline. The method's advantages include its ability to identify contributing factors to inequality, providing detailed information for policymakers. However, the technique is limited by its reliance on linear assumptions, potential sensitivity to model specification, and inability to fully account for unobservable factors that may influence group differences (de-Boer & Rodrigues, 2020; Rahimi & Hashemi Nazari, 2021)

3. Results

3.1. Background characteristics of respondents

Table 1 presents the proportional distribution of demographic attributes within the sample population comprising individuals engaged in sexual activity across six DHSs. Most women surveyed from 1992 to 2018 fell within the age range of 25 – 34 years (34.4%, 33.3%, 33.7%, 36.5%, and 34.0%, respectively, across the 5 years). The distribution by place of residence shows that in all the survey years except for 1992, more women resided in rural than urban areas. When it comes to education level, the surveys consistently showed that most sampled women had a primary level of education, with percentages decreasing from 59.5% in 1992 to 43.3% in 2018. There was an apparent increase in women with tertiary education, from 2.1% in 1992 to 5.9% in 2018, and in secondary education, from 21.4% in 1992 to 40.5% in 2018.

In each of the survey years, more than 33% of the participants were from economically disadvantaged households, while the percentage of respondents from rich households rose from 44.1% in 1992 to 45.5% in 2018. With the exception of 1996, employed women outnumbered unemployed women in all the surveys. The proportion of women employed has varied from 50.0% in 1996 to 58.0% in 2001. Table 1 further reveals that the proportion of women who initiated their first sexual debut during the adolescence period increased from 41.6% in 1992 to 71.0% in 2018 but was stable, around 50%, between 1996 and 2013.

3.2. Trends in contraceptive use and fertility dynamics in Zambia

During the 26-year period, the country has recorded a steady and progressive rise in the contraceptive prevalence rate. The trend in utilization of contraceptive methods among sexually active, reproductive-aged women showed an increase from 14.2% in 1992 to 45.0% in 2018. A significant increase happened between 1992 and 2001 (14.2% – 31.6%) while the smallest increase occurred between 2013 and 2018 (44.8% – 45.0%) (Figure 1).

The results further show that although total fertility rates have been resilient in Zambia for a long period, a declining trend of almost two children was observed between 1992 and 2018 (from 6.5 children to 4.7 children/woman). Furthermore, the prevalence of teenage pregnancy in Zambia showed a reduction from 33.8% to 29.2% between 1992 and 2018 (Figure 1).

3.3. Changes in contraceptive use trends by sociodemographic characteristics

Contraceptive mutilation among sexually active women in Zambia showed different trends based on background from 1992 to 2018 (Table 2). The trend changes in contraceptive use occurred across all the DHS intervals. Overall, a change of 30.8% (14.2% – 45.0%) occurred among sexually active women during the analysis period. The largest change happened from 1992 to 1996 (12.3%), and the lowest was from 2013 to 2018 (0.2%). Contraceptive use increased by 7.8% between 2001 and 2007.

Zambia displayed regional differences in the transition of contraceptive use over time. Overall, rural areas recorded the largest increase (33.7%) compared to urban areas (28.1%) between 1992 and 2018. Urban areas recorded the largest increase (12.9%) between 1992 and 1996, and the lowest from 2013 to 2018 (−0.5%). Rural areas recorded the largest increase in prevalence of contraceptive use from 2001 to 2007 (10.8%), and the lowest was recorded from 2013 to 2018 (2.3%).

Results show that women aged 25 – 34 years recorded the highest improvement in contraceptive utilization between 1992 and 2018 (35.2%). The lowest increase in contraceptive use was recorded among adolescents aged 15 – 19 years (21.3%). The highest contraceptive use among women aged 25 – 34 years was recorded between 1992 and 1996 (10.9%), and the lowest from 2013 to 2018 (−0.3%). Among the women aged 35 – 49 years, the largest increase was recorded from 2007 to 2013 (9.7%).

In terms of marital status, women who were married recorded the highest improvement in utilization of contraceptives between 1992 and 2018 (39.4%). The highest increment was recorded between 1992 and 1996 (13.6%), and the lowest was recorded from 2013 to 2018 (0.5%). The lowest increase was recorded among women who were never married (16.7%). Among the women who were never married, the largest increase was recorded from 1992 to 1996 (8.2%), while the lowest was recorded from 2007 to 2013 (−0.1%) (Table 2).

3.4. Decomposition analysis of contraceptive transition on fertility rate

The results of the multivariable decomposition indicate that the fertility change in Zambian women from 1992 to 2018 can be attributed to changes in both women's compositional

Table 1. Percent distribution of sociodemographic and sexual behavior characteristics of participating women

Background characteristics	DHS 1992	DHS 1996	DHS 2001	DHS 2007	DHS 2013	DHS 2018
	n=5,181	*n*=5,938	*n*=5,844	*n*=5,347	*n*=12,653	*n*=10,576
Age						
15 – 19	1,001 (19.4)	975 (16.5)	886 (15.2)	627 (11.7)	1,535 (12.2)	1,280 (12.1)
15 – 24	1,112 (21.5)	1,428 (24.2)	1,332 (22.8)	1,071 (20.1)	2,361 (18.8)	2,168 (20.5)
25 – 34	1,726 (34.4)	1,967 (33.3)	1,971 (33.7)	2,047 (38.3)	4,594 (36.5)	3,594 (34.0)
35 – 49	1,330 (25.7)	1,542 (26.1)	1,656 (28.4)	1,595 (29.9)	4,088 (32.5)	3,524 (33.4)
Place of residence						
Rural	2,662 (51.5)	2,627 (44.4)	2,364 (40.4)	2,193 (41.1)	5,628 (44.7)	4,853 (45.9)
Urban	2,507 (48.5)	3,285 (55.6)	3,481 (59.6)	3,147 (58.9)	6,950 (55.3)	5,713 (54.1)
Education level						
No education	882 (17.1)	802 (13.6)	752 (12.9)	617 (11.6)	1,153 (9.2)	876 (8.3)
Primary	3,074 (59.5)	3,482 (58.9)	3,414 (58.4)	2,969 (55.6)	6,088 (49.2)	4,783 (45.3)
Secondary	1,104 (21.4)	1,439 (24.3)	1,487 (25.4)	1,443 (27.0)	4,554 (36.2)	4,281 (40.5)
Higher	107 (2.1)	188 (3.2)	192 (3.3)	310 (5.8)	674 (5.4)	627 (5.9)
Marital status						
Never married	869 (16.8)	1,022 (17.3)	916 (15.7)	834 (15.6)	2,216 (17.6)	2,293 (21.7)
Married	3,531 (68.3)	3,916 (66.2)	3,929 (67.2)	3,680 (68.9)	8,509 (67.6)	6,629 (62.7)
Formerly married	770 (14.9)	973 (16.5)	1,000 (17.1)	826 (15.5)	1,854 (14.7)	1,643 (15.6)
Wealth index						
Poor	–	2,264 (38.3)	2,136 (36.5)	1,939 (36.3)	4,566 (36.3)	3,803 (36.0)
moderate	–	1,040 (17.6)	1,162 (19.9)	966 (18.1)	2,458 (19.5)	1,951 (18.5)
Rich	–	2,608 (44.1)	2,546 (43.6)	2,435 (45.6)	5,554 (44.2)	4,811 (45.5)
Religion						
Catholic	1,421 (27.5)	1,420 (24.0)	1,330 (22.7)	1,087 (20.3)	2,229 (17.7)	1,817 (17.2)
Protestant	3,578 (69.2)	4,388 (74.2)	4,393 (75.2)	4,160 (77.9)	10,166 (80.8)	8,566 (81.2)
Other	170 (3.3)	104 (1.8)	122 (2.1)	93 (1.7)	182 (1.4)	183 (1.7)
Employment status						
Unemployed	2,434 (47.1)	2,955 (50.0)	2,452 (42.0)	2,491 (46.7)	5,636 (45.0)	5,191 (49.1)
Employed	2,734 (52.9)	2,952 (50.0)	3,389 (58.0)	2,842 (53.3)	6,889 (55.0)	5,375 (50.9)
Age at first sex						
<15 years	925 (17.9)	1,196 (20.2)	961 (16.4)	613 (11.5)	1,207 (9.6)	1,895 (17.9)
15 – 19 years	2,148 (41.6)	2,684 (45.4)	2,897 (49.6)	2,599 (48.7)	6,274 (49.8)	7,500 (71.0)
20+ years	2,096 (40.6)	2,031 (34.4)	1,987 (34.0)	2,128 (39.8)	5,096 (40.5)	1,171 (11.1)
Age at first marriage						
<15 years	738 (14.3)	737 (12.5)	663 (11.3)	558 (10.4)	1,030 (8.2)	834 (7.9)
15 – 19 years	2,767 (53.5)	3,104 (52.5)	3,222 (55.1)	2,804 (52.5)	6,489 (51.6)	4,788 (45.3)
20+ years	1,664 (32.2)	2,070 (35.0)	1,961 (33.5)	1,979 (37.0)	5,059 (40.2)	4,944 (46.8)

Notes: Data are presented as *n* (%); The symbol (–) signifies the absence of data pertaining to the variable in the corresponding DHS year.
Abbreviation: DHS: Demographic and Health Survey.

characteristics and fertility behavior. The results presented in Table 3 show that 68.98% of the reduction in fertility was due to changes in the characteristics of the women. However, the remaining 30.02% decline in fertility rate was linked to changes in women's fertility behavior caused by the change due to the effects of their characteristics. The

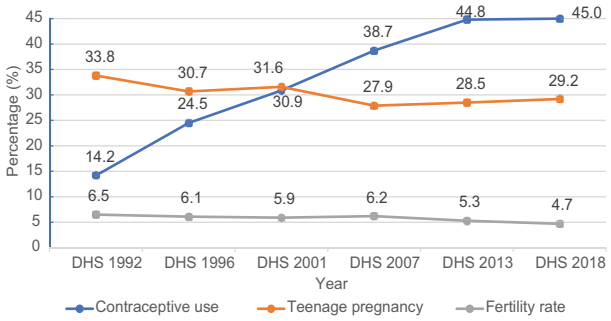

Figure 1. Trends in contraceptive use, fertility, and teenage pregnancy rates in Zambia in 1992 – 2018
Abbreviation: DHS: Demographic and health survey.

analysis shows that the observed increase in the utilization of contraceptive methods by women from 1992 to 2018 accounted for 17.67% of the reduction in the fertility rate in Zambia. In other words, the fertility rate would have increased by 17.67% if there had been no increase in the utilization of contraceptives.

Furthermore, an increase in the proportion of women with secondary education accounted for 33.80% of the observed reduction in fertility rate. This result indicates that the fertility rate would have increased by 33.80% if the proportion of women with a secondary level of education remained the same in 2018 as they were in 1992. Similarly, the rise in the proportion of women with tertiary education between 1992 and 2018 contributed 4.57% to the reduction in fertility. The reduction in the proportion of women who were married accounted for a reduction in the fertility rate by 15.95%.

In terms of fertility behavior, the coefficient shows that the positive fertility behavior of women with primary education contributed 22.43% to the reduction in the fertility rate in Zambia. The negative percentage indicates that the fertility rate would have been higher by 22.43% among women with primary-level education if the fertility behavior had not changed. Furthermore, changes in the fertility behavior of women who got married in the adolescent age group contributed to a 27.40% reduction in the country's fertility rate.

3.5. Decomposition analysis of contraceptive transition on teenage pregnancy rate

The results of the trend change in teenage pregnancy in Zambia between 1992 and 2018 are displayed in Table 4. The analysis presented examined the effect of contraceptive transition among teenagers and other predictors on the reduction of teenage pregnancy rates in Zambia. The results indicate that the decline in the incidence of adolescent pregnancy in Zambia can be primarily ascribed to shifts in the demographic attributes of adolescents rather than alterations in their reproductive practices. The results indicate that 64% of this variation is attributed to shifts in compositional elements, while the remaining 36% was linked to changes in reproductive behaviors.

In Zambia, the main factors that led to a decline in teenage pregnancy were secondary or tertiary level of education, contraceptive use, delayed age at first sexual encounter, and working status. Specifically, the increase in contraceptive use among teenagers significantly (p<0.001) contributed to the reduction in teenage pregnancy by 54.84%. The negative percentage indicates that if contraceptive use had not increased, the prevalence of teenage pregnancy would have been higher by 54.84%. The findings further indicate that the decrease in the incidence of adolescent pregnancy can be attributed to the shift in the percentage of adolescent girls achieving either secondary or tertiary educational attainment, which accounted for 87.15% of the variation observed. Similarly, the increase in the proportion of adolescents who were working significantly contributed 21.19% to the reduction in teenage pregnancy rates (Table 4). Furthermore, results show that teenage pregnancy among adolescents with primary education would have been higher by 25.67% if the proportion of adolescents who attained primary education had not changed between 1992 and 2018.

The increase in the percentage of teenagers who delayed the commencement of their sexual activity had a notable favorable impact of 30.08% on the decline in teenage pregnancies. Changes in the reproductive behavior of teenagers who were living in urban areas, had a primary level of education, and were exposed to mass-media FP messages positively contributed to the reduction in teenage pregnancies. In terms of percentage contributions, change in reproductive behavior among teenagers residing in urban areas contributed 21.44%, and those with primary education contributed 29.98% to the reduction in teenage pregnancy rates. Similarly, an increase in adolescents who received FP messages from the media contributed 7.69% (Table 4).

4. Discussion

The aim of this study was to examine the association between contraceptive transition and fertility dynamics in Zambia. Zambia, like many other countries in SSA, has undergone a fertility transition over the past four decades (1980 – 2020). The total fertility rate has exhibited a downward trend over the past decades, showing a reduction from an average of 7.2 children/woman in 1980 to an average of 4.7 children per woman in 2018 (Zambia Statistics Agency *et al.*, 2019). Additionally, teenage pregnancy rates reduced from 33.8% in 1992 to 29.2% in 2018 (Phiri *et al.*, 2023; Zambia Statistics

Table 2. Distribution of contraceptive prevalence rate trend changes in sexually active women by background characteristics

Background characteristics	ZDHS (1992 – 1996)	ZDHS 1996 – 2001	ZDHS (2001 – 2007)	ZDHS (2007 – 2013)	ZDHS (2013 – 2018)	ZDHS (1992 – 2018)
Age						
15 – 19	8.1	5.7	3.6	0.6	3.3	21.3
15 – 24	10.7	5.4	8.8	0.7	2.3	27.9
25 – 34	10.9	11.0	5.2	8.4	−0.3	35.2
35 – 49	8.8	1.9	8.2	9.7	−0.3	27.5
Residence						
Urban	12.9	6.7	3.5	7.5	−2.5	28.1
Rural	9.1	6.8	10.8	4.7	2.3	33.7
Education level						
No education	8.8	4.8	12.3	2.9	−0.9	27.9
Primary	10.3	6.2	10.2	6.2	1.9	34.8
Secondary	7.9	8.4	1.4	5.9	−0.7	22.9
Higher	6.4	−4.6	−7.1	8.1	−9.1	−6.3
Marital Status						
Never married	8.2	1.5	3.8	−0.1	3.3	16.7
Married	13.6	8.7	8.2	8.4	0.5	39.4
Formerly married	0.2	1.0	7.2	5.9	5.4	19.7
Wealth status						
Poor	–	2.5	15.9	1.3	2.9	22.3
Moderate	–	10.1	3.4	14.3	1.1	28.9
Rich	–	8.1	2.7	6.8	−2.6	15.0
Employment status						
Unemployed	12.5	7.4	8.8	5.9	−1.0	33.6
Employed	8.6	4.9	7.3	6.2	1.4	28.4
Religion						
Catholic	10.1	6.3	7.8	5.2	−1.0	28.4
Protestant	10.4	6.8	7.5	6.5	0.2	31.4
Other	9.3	−3.7	19.2	−5.3	14.2	33.7
Age at first sex						
<15 years	9.0	5.6	8.0	4.8	6.0	33.4
15 – 19 years	10.8	7.2	8.0	4.0	2.2	32.2
20 + years	10.9	5.1	6.9	8.8	−8.2	23.5
Ideal number of children						
0 – 3	6.7	4.8	6.4	3.5	−2.2	19.2
4 – 5	10.9	7.1	4.5	8.4	0.9	31.8
6+	9.6	5.0	12.8	4.6	0.7	32.7
Age at first marriage						
Below 15	10.0	2.6	12.8	9.3	−1.1	33.6
15 – 19	10.2	9.0	8.3	7.9	2.7	38.1
20+	10.7	1.2	8.4	3.7	−0.1	23.9
Exposure to media family planning messages						
No	7.6	6.5	10.2	5.6	1.9	31.8
Yes	8.5	5.5	2.1	7.9	−5.7	18.3
Total	12.3	6.4	7.8	6.1	0.2	30.8

Notes: Data are presented as %; The symbol (–) signifies the absence of data pertaining to the variable in the corresponding DHS year.
Abbreviation: ZDHS: Zambia's Demographic and Health Survey.

Table 3. Contribution of explanatory variables to fertility rate changes in Zambia

Background characteristics	Due to differences in characteristics (E)		Due to differences in coefficients (C)	
	Coefficients	Percent	Coefficients	Percent
Residence				
Rural	Ref		Ref	
Urban	0.0036 (−0.0078, 0.0149)	0.71	0.1199** (0.0487, 0.1912)	18.37
Contraceptive use				
No	Ref		Ref	
Yes	−0.1154** (−0.1985, −0.0323)	−17.67	0.1757*** (0.0555, 0.2407)	22.68
Woman's education level				
None	Ref		Ref	
Primary	−0.0706*** (−0.0885, −0.0527)	−10.82	−0.1510** (−0.2622, −0.0438)	−23.43
Secondary	0.2206*** (0.1721, 0.2692)	33.80	0.0191 (−0.0682, 0.1063)	2.92
Higher	0.0299** (0.0117, 0.0480)	4.57	0.0188 (−0.0051, 0.0426)	2.87
Marital status				
Never married	Ref		Ref	
Married	0.1042*** (0.0854, 0.1230)	15.95	0.5737*** (−0.2622, −0.0438)	67.87
Formerly married	−0.0607*** (−0.0737, −0.0476)	−9.29	0.1365** (−0.0682, 0.1063)	20.91
Age at first marriage				
<15 years	Ref		Ref	
15 – 19 years	−0.1789** (−0.0499, −0.0254)	−5.76	−0.1789** (−0.2962, −0.0616)	−27.40
20+ years	−0.1545** (0.1751, 0.2651)	33.72	−0.1546** (−0.2444, −0.0646)	−23.67
Age at first sex				
<15 years	Ref		Ref	
15 – 19 years	0.1295* (0.0294, 0.2296)	−9.84	0.1208 (−0.6954, 0.9371)	18.51
20+ years	0.2553*** (0.1565, 0.3541)	13.10	−0.0825 (−0.6180, 0.4530)	−12.64
Desired number of children				
0 – 3	Ref		Ref	
4 – 5	0.0093 (−0.0608, 0.0795)	1.43	−0.0900 (−0.2756, 0.0405)	−18.01
6+	0.2817*** (0.1896, 0.3738)	43.14	−0.1512* (−0.3051, −0.0454)	−26.84
Constant			0.4851* (0.0798, 0.8905)	74.31
Total	0.4452*** (0.3814, 0.5090)	68.98	0.2077 *** (0.1197, 0.2956)	30.02

Notes: Statistical significance determined at *p<0.05, **p<0.01, and ***p=0.001; Values in brackets represent confidence intervals.
Abbreviations: C: Coefficients; E: Endowments; Ref: Reference category.

Agency *et al.*, 2019). The shift in levels of fertility dynamics is typically associated with social, economic, reproductive health, and demographic changes that occurred in the country over the years (Ministry of National Development Planning, 2019; Munakampe *et al.*, 2021; Shumba *et al.*, 2024).

The period 1992 – 2018 presents a phase of nearly three decades in which Zambia's fertility has changed in observable ways, making it appropriate for analysis of fertility dynamics. This allowed the study to observe the changes in contraceptive use behavior and the population's demographic composition by examining fertility changes. The timeframe spanning from 1992 to 2018 witnessed significant alterations in population policy and FP programs in Zambia, which potentially influenced demographic transformations in the region. This era saw the evolution of Zambia's population policy, initially established in 1989 and subsequently revised in 2007. The updated population policy of 2019 underscored the critical need to enhance the provision of FP, sexual, and reproductive health services as a strategy to combat the enduringly high fertility rates in Zambia (Ministry of National Development Planning, 2019). These changes may have had some effects on the country's fertility dynamics.

The results of our study have shown that, in Zambia, the utilization of contraceptives among women engaging

Table 4. Contribution of explanatory variables to the difference in prevalence of teenage pregnancy among adolescent girls

Background characteristics	Due to differences in characteristics (E)		Due to differences in coefficients (C)	
	Coefficients	Percent	Coefficients	Percent
Contraceptive use				
No	Ref		Ref	
Yes	0.0248***	−54.84	0.0031	−6.83
Residence				
Rural	Ref		Ref	
Urban	0.0049**	−10.71	−0.0097	21.44
Region				
Lusaka	Ref		Ref	
Central	0.0018*	−3.91	0.0034	−7.39
Copperbelt	−0.0075*	16.56	0.0139	−30.75
Eastern	0.0010*	−2.29	0.0034	−7.60
Luapula	0.0009	−1.92	0.0010	−2.14
Northern	0.0025*	−5.52	0.0062	−13.59
North-western	0.0027*	−6.01	0.0017	−3.79
Southern	−0.0062**	13.71	0.0159*	−35.15
Western	0.0023***	−5.12	0.0057	−12.52
Religion				
Catholic	Ref		Ref	
Protestant	−0.0005	1.00	−0.0057	12.48
Other	−0.0001	0.02	−0.0005	1.04
Early sexual debut				
No	Ref		Ref	
Yes	−0.0136***	30.08	−0.0123	27.12
Woman's education level				
None	Ref		Ref	
Primary	0.0116	−25.67	−0.0136	29.98
Secondary/higher	−0.0395**	87.15	−0.0040	8.72
Employment status				
Not working	Ref		Ref	
Working	−0.0096***	21.19	0.0031	−6.74
Ideal number of children				
0 – 3	Ref		Ref	
4 – 5	0.00000	0.00	0.0007	−1.57
6+	−0.00121	2.67	0.0077	−16.90
Exposure to media family planning messages				
No	Ref		Ref	
Yes	−0.00346*	7.65	−0.0035	7.69
Constant			−0.0328	72.46
Total	−0.0290*	64.04	−0.0163	35.96

Note: Statistical significance determined at *p<0.05, **p<0.01, and ***p=0.001.
Abbreviations: C: Coefficients; E: Endowments; Ref: Reference category.

in sexual activity has experienced a notable rise during the analysis period. The observed increase in contraceptive use has resulted in a significant reduction in fertility and teenage pregnancy rates in Zambia. Several studies have documented a positive relationship between increased contraceptive use and fertility reduction in SSA countries (Ariho & Kabagenyi, 2020; Dasgupta *et al.*, 2022; Orwa *et al.*, 2023; Tetteh *et al.*, 2022). This is because contraceptive use directly enables women to manage the timing and number of their pregnancies. By offering reliable methods to prevent unintended pregnancies, space births, and limit family size, contraceptives support women in achieving their personal or FP objectives (Bietsch *et al.*, 2021; Bongaarts, 2017; Shasha *et al.*, 2023; Sikaluzwe *et al.*, 2024). This control over reproductive choices leads to a reduction in the overall number of births a woman is likely to have throughout her reproductive years. This implies that improving access to and utilization of contraceptive methods among reproductive-aged women has the potential to further reduce fertility levels in SSA countries.

Prior studies conducted in other countries have affirmed that increased contraceptive use among fecund women has a negative effect on fertility rate (Bongaarts, 2017; Garenne, 2018; Schoumaker, 2019). This study's findings corroborate previous findings on the positive effect of increased contraceptive use on fertility rate changes (Ariho & Kabagenyi, 2020; Garenne, 2018; Schoumaker, 2019). A study in Uganda found that increased contraceptive use contributed to an 8.2% reduction in fertility rate in 2006 – 2016 (Ariho & Kabagenyi, 2020). Another study in Ethiopia reported that an 18.6% increase in contraception use recorded in 2000 – 2011 contributed 30% to the decline in fertility rate during the same period (Wondimagegenhu, 2012). The finding of this current study implies that increasing contraceptive use further among Zambian women is key to the country's population policy's goal of fertility reduction.

Furthermore, prior studies have highlighted the significance of contraceptive use in reducing teenage pregnancy rates. A study conducted in Ghana by Tetteh *et al.* (2022) reported that not using contraceptives consistently and correctly, especially among adolescents, significantly increased the risk of pregnancy. Manlove (2015) found that changes in contraceptive methods, particularly an increase in condom use, contributed to a 48% decline in teen pregnancy rates between 2002 and 2010 in the United States of America. These findings suggest that proper and consistent contraceptive use among adolescents is crucial in reducing the risk of teenage pregnancies, indicating a direct link between increased contraceptive use and fertility reduction. This implies that addressing contraceptive behaviors among adolescents can play a significant role in reducing fertility rates and preventing unintended pregnancies.

To address reproductive health challenges relating to unintended pregnancies, SRH programs, such as comprehensive sexuality education, should be prioritized. Comprehensive sexuality education linked with accessible SRH services has shown promise in reducing early and unplanned pregnancies among adolescent girls who are still in school (Mbizvo *et al.*, 2023). These interventions should target multiple levels, including individual factors like contraceptive use and knowledge, interpersonal influences such as peer pressure and family dynamics, community-level socio-cultural norms, and policy environments affecting access to SRH information and services (Malunga *et al.*, 2023). Furthermore, improving access to FP services, particularly for women with low education levels, is crucial to further reduce unintended pregnancies in Zambia (Sikaluzwe *et al.*, 2024).

This study also highlights the importance of women's education, age at first marriage, and age at first sexual encounter in determining fertility reduction. The findings show that an increase in the proportion of women who attained secondary or tertiary education in Zambia significantly contributed to a reduction in fertility and teenage pregnancy rates. Existing literature shows that there is an association between women's education status and fertility dynamics (Alazbih *et al.*, 2021; Ariho & Kabagenyi, 2020; Olowolafe *et al.*, 2023; Tetteh *et al.*, 2022; Wasswa *et al.*, 2021), suggesting that increasing education levels lead to increased contraceptive use, delayed marriage, and a smaller family size desire. Women who have attained secondary or higher level education are more likely to delay marriage and desire small families (Bongaarts, 2020; Mapoma *et al.*, 2018; Okoli *et al.*, 2022). This signifies how education influences the reproductive behavior of women. Furthermore, scholarly investigations demonstrate a notable decrease in the occurrence of adolescent pregnancies among teenagers with elevated levels of educational attainment. This implies that education plays a crucial role in equipping young women with the knowledge to make well-informed choices regarding their reproductive health decisions. Therefore, increasing access to education can further contribute to reducing early pregnancy risk among teenagers.

Our study has also shown that age at first sexual experience and age at first marriage are key factors in determining fertility and teenage pregnancy rates. Hertrich (2017) and Casterline *et al.* (2017) examined the relationship between the age at first marriage and the beginning of the fertility transition and claim that the fertility transition is extremely improbable when women experience sexual debut or enter their first partnerships at very young ages. According to these scholars' findings, a change in the age at first marriage has served as a more significant indicator of early fertility decline than changes in contraceptive use across many countries in SSA (Casterline *et al.*, 2017; Hertrich, 2017).

This conclusion is supported by the findings of this current study, which has shown that an increase in the proportion of women who were married at the age of 20 years or later was one of the major contributors to fertility decline in Zambia. This trend was accompanied by an increase in the proportion of women attaining secondary education or an increase in those who initiated sexual debut at the age of 20 years or later. Furthermore, our study shows that a reduction in the proportion of women who desired six or more children had a significant effect in reducing the fertility rate in the country. This suggests that SRH interventions aimed at reducing fertility should also target women with high fertility preferences to create a greater impact.

The study has provided evidence that contraceptive transition among women of reproductive age has occurred in Zambia. Although the observed increase in contraceptive use has positively contributed to changing fertility dynamics, fertility and teenage pregnancy rates are still high compared to other countries in the region (Kalinda *et al.*, 2022; Yussuf *et al.*, 2020). This calls for actions to increase resources to FP programs in the country to enhance the benefits of contraceptive use. There is also a need for further research to critically examine other drivers of fertility dynamics in Zambia to design interventions that could help address high fertility. For sustained fertility decline, couples must be "ready, willing, and able" to use modern contraception, with readiness, willingness, and ability measured by a desire to limit births, approval of FP, and knowledge of contraceptive methods, respectively (Biney *et al.*, 2021; Muhoza *et al.*, 2018).

Our study results underscore the need for public health and FP policies to prioritize educational opportunities for girls and promote adolescent SRH initiatives such as comprehensive sexuality education that encourages delayed marriage and early sexual activity. Such measures can lead to more sustainable reductions in fertility and teenage pregnancy rates, ultimately improving health outcomes and socioeconomic development. Moreover, this research offers significant findings regarding how contraceptive transition has contributed to significant changes in fertility dynamics in Zambia. By demonstrating that the observed contraceptive transition accounted for a substantial reduction in the total fertility rate and prevented over half of teenage pregnancies, the findings underscore the need for health policymakers to lobby for increased financial investment in FP programs, especially adolescent reproductive health programs. This will help address the country's population growth challenges and high teenage pregnancies.

4.1. Strengths and limitations

The results of this analysis can be generalized to the total population of married women in Zambia, as it included a nationally representative sample of sexually active women of reproductive age in Zambia. The availability of multiple DHS datasets made it possible to investigate the long-term trends in contraceptive use and fertility dynamics. Furthermore, it was possible to examine the effects of contraceptive use on fertility dynamics in Zambia. However, causality cannot be inferred in this study due to the cross-sectional study design employed by the DHS.

5. Conclusion

This study found that although fertility rates remain high, contraceptive use significantly contributed to the shift in fertility dynamics in Zambia. Furthermore, there is evidence that contraceptive transition among adolescent girls has helped avert teenage pregnancies over time. This study also revealed that an increase in the proportion of women who attained secondary or tertiary education, delayed initiation of sexual debut, and delayed age at first marriage are the main drivers of changes in fertility dynamics in Zambia. There is a need to enhance access to education and contraceptive methods, especially among adolescent girls. Additionally, comprehensive sexuality education that promotes delay in initiating sexual debut and discourages early marriage should be promoted and prioritized, especially for adolescents and young women. Such health interventions have the potential to equip young women with accurate information about SRH.

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Conflict of interest

The authors declare that they have no competing interests.

Author contributions

Conceptualization: Million Phiri, Clifford Odimegwu
Formal analysis: Million Phiri
Investigation: Million Phiri
Methodology: Million Phiri, Tobias Chirwa
Writing – original draft: Million Phiri
Writing – review & editing: All authors

Ethics approval and consent to participate

In the study, secondary data sources were used. Permission to use DHS datasets was given by the DHS program. The DHS data does not contain any personal identification of survey

respondents. The Research Ethics Review Boards of The Tropical Disease and Research Centre (TDRC) in Zambia and the Centers for Disease Control and Prevention approved the 1992 – 2018 DHS Biomarker and survey protocols for Zambia. Therefore, all techniques used for gathering data were compliant with applicable guidelines and ethical standards. In accordance with the regulations of the DHS, all individuals participating in the survey who were above 18 years of age were required to provide explicit informed consent during the enumeration process. Additionally, prior to seeking assent from minors under the age of 18, informed consent was obtained from the parents or legal guardians of participants aged between 15 and 17 years.

Consent for publication

Not applicable.

Availability of data

The data utilized in this study can be accessed publicly through the IPUMS DHS or DHS Program websites: https://www.idhsdata.org/idhs/, https://dhsprogram.com

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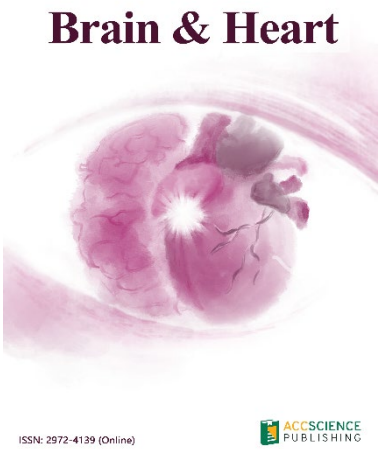
Heart-brain research on patients with syncope, autonomic dysfunction, cryptogenic stroke, and stroke with atrial fibrillation; research on the relationship between structural heart diseases and nervous system diseases, the correlation between cardiac electrophysiology and abnormal organizational structures and the pathogenesis of stroke, as well as new ways of diagnosis, treatment and prevention of unexplained stroke.



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