ACCSCIENCE PUBLISHING

ISSN: 2424-8150 (Print)
ISSN: 2424-8606 (Online)
Volume 9 · Issue 1
April 2023

INTERNATIONAL JOURNAL OF POPULATION STUDIES

International Journal of Population Studies

Print ISSN: 2424-8150

Online ISSN: 2424-8606

International Journal of Population Studies (IJPS) is an open access, multidisciplinary journal that publishes high quality original research and timely reviews of recent advances and emerging issues in population processes; dynamics of fertility, mortality, and migration; and linkages with socioeconomic and environmental change across times, spaces, and cultures. The journal aims to provide a platform for researchers worldwide to promote and share cutting-edge knowledge and advances in different areas of population research. Article formats include editorials, research articles, review articles, letters to editors, commentaries, perspectives, reports, and book reviews that address demography and population-related issues. The journal also offers special issues arising from conferences and other meetings.

About the Publisher

AccScience Publishing is a publishing company based in Singapore. We publish a range of high-quality, open-access, peer-reviewed journals and books from a broad spectrum of disciplines.

Contact Us

Managing Editor
ijps.office@accscience.sg

AccScience Publishing
9 Raffles Place, Republic Plaza 1 #06-00 Singapore 048619.

Volume 9 • Issue 1 • April 2023
ISSN 2424-8150 (print) ISSN 2424-8606 (online)

INTERNATIONAL JOURNAL OF POPULATION STUDIES

ACCSCIENCE PUBLISHING
Access Science Without Barriers

International Journal of Population Studies

ISSN: 2424-8150 (print)

ISSN: 2424-8606 (online)

Editorial and Production Credits

Publisher: AccScience Publishing
Managing Editor: Alicia Tian
Production Editor: Sharmila Velapasamy
Special Issue Commissioning Editors: Alicia Tian, Eva Liu
Article Layout and Typeset: Sinjore Technologies (India)
Cover Design: ProPub (China)

For all advertising queries, contact ijps.office@accscience.sg.

Supplementary file

Supplementary files of articles can be obtained at https://accscience.com/journal/IJPS/9/1.

Disclaimer

AccScience Publishing is not liable to the statements, perspectives, and opinions contained in the publications. The appearance of advertisements in the journal shall not be construed as a warranty, endorsement, or approval of the products or services advertised and/or the safety thereof. AccScience Publishing disclaims responsibility for any injury to persons or property resulting from any ideas or products referred to in the publications or advertisements. AccScience Publishing remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

International Journal of Population Studies

Editorial Board

ACCSCIENCE PUBLISHING

Volume 9 | Issue 1 | April 2023 | Page 1 – 88 |

International Journal of Population Studies

https://accscience.com/journal/IJPS

CONTENTS

ACCSCIENCE PUBLISHING

International Journal of Population Studies

RESEARCH ARTICLE

Local population changes as a spatial varying multiscale process: The Italian case

Federico Benassi[1]*, Massimo Mucciardi[2], and Gerardo Gallo[3]

[1]Department of Political Sciences, University of Naples Federico II, Via Leopoldo Rodinò 22, Naples, Italy

[2]Department of Cognitive Science, Education and Cultural Studies, University of Messina, Via Bivona Bernardi 3, Messina, Italy

[3]Department for Statistical Production, Directorate of Population Statistics, Social Surveys and Permanent Population Census, Italian National Institute of Statistics (ISTAT), P.zza Guglielmo Marconi 26/C, Rome, Italy

Abstract

The population dynamics in Italy show a strong spatial heterogeneity within a framework of persistent demographic territorial disparities. From a local point of view, it is necessary to understand what demographic determinants govern this process. In the paper, we model the population change according to a local (i.e., spatial varying coefficients) multiscale approach. To this aim, local demographic growth rates of each Italian municipality for the period 2011 – 2019 were estimated and modeled by means of a classic a-spatial global model (i.e., ordinary least-square), and a multiscale geographically weighted regression. The multiscale dimensions of local population changes are therefore analyzed by means of three sub-dimensions: Level of influence, scalability, and specificity. The results show that the determinants of local population changes are not spatially constant and that they vary in their effect at different geographical scales.

Keywords: Spatial demography; Local approach; Spatial varying coefficients; Multiscale geographically weighted regression model; Italy

***Corresponding author:**
Federico Benassi
(federico.benassi@unina.it)

Citation: Benassi, F., Mucciardi, M., & Gallo, G. (2023). Local population changes as a spatial varying multiscale process: The Italian case. *International Journal of Population Studies,* 9(1):1-10. https://doi.org/10.36922/ijps.393

Received: October 13, 2023

Accepted: February 8, 2023

Published Online: February 27, 2023

1. Introduction

In Italy, demographic changes present a strong spatial heterogeneity (Billari & Tomassini, 2021). Fertility and mortality, on the one hand, are affected by local and global spatial autocorrelation (Salvati *et al.*, 2020) and by spatial diffusion (Benassi & Carella, 2022; Vitali & Billari, 2017). On the other hand, migrations – internal and international – are affected by "classic" spatial variations, like the north–south divide, urban–rural divide, and new ones (for example the ones related to inner areas) (Benassi *et al.,* 2019; Bonifazi *et al.,* 2021; Lamonica & Zagaglia, 2013; Strozza *et al.*, 2016). The result of these processes is a dual demographic spatial landscape in which some spatial contexts grow, and some others shrink, with several (negative) effects on territorial cohesion and social sustainability (Reynaud *et al.,* 2020).

It is crucial to understand demographic components that act as drivers of that process considering spatial dependence and scale heterogeneity. Although studies that approach

the process of demographic change in Italy from a spatial perspective already exist, they usually address a rather large geographic scale. A few studies that have referred to a local scale (i.e., at municipality level) have used mainly explorative approaches. The rare cases that have used a regression approach are mainly based on a-spatial models or, at most, spatial global models (i.e., spatial autoregressive models). In other words, there is a lack of local multiscale approach in studying demographic changes in Italy.

To fill this gap, and based on these premises, this paper proposes a study on population change at the local level (municipality) using a multiscale approach: Multiscale geographically weighted regression (MGWR hereafter) recently proposed by Oshan *et al.* (2019). This class of model has been recently used in several studies regarding different issues like COVID-19 fully vaccinated rates (Yang *et al.*, 2022a), opioid use disorders in older populations (Yang *et al.*, 2022b), and mortality (Cupido *et al.,* 2021; Song *et al.*, 2021) and has proved to be extremely useful to grasp the multiscale nature of population spatial processes. However, quite surprisingly, to the best of our knowledge, no application to Italy has been made. This is paradoxical if we bear in mind that the demographic and socio-economic processes in Italy are deeply interested in spatial divides and spatial dependence processes (Benassi & Naccarato, 2017; Reynaud & Miccoli, 2018; Reynaud *et al.*, 2018; Caltabiano *et al.*, 2019; Zambon *et al.*, 2020). Indeed, on a local scale, the heterogeneity of demographic dynamics increases significantly, especially with regards to the drivers of changes. Migrations (both internal and international) play a key role in such changes since the natural growth is negative (or at most equal to zero) almost everywhere. The determinants of the capacity of a municipality to attract people (both from other Italian municipalities and/or abroad) are many: Spanning from the opportunity of finding a job, which is typically higher in urban areas located in the north and the center part of Italy, to the level of accessibility to services and infrastructures, which remains nowadays very low in many areas of the country, especially, mountainous and inland areas, and from many other factors related for example the presence of certain services (in particular primary school) that had proven to be crucial to counteract depopulation processes (Benassi *et al.*, 2021; 2023).

The main goals of the paper are straightforward: (i) Identifying what demographic determinants govern the process of local population change in Italy; (ii) verifying if these determinants are spatially constant or not; and (iii) if their effects vary at different geographical scale.

The paper is structured as follows: In the next section, data and methods are described, and then results are shown. The final section draws some conclusions and future developments.

2. Data and methods

In the paper, we modeled the yearly average total population growth rate (TOTPGR) by means of MGWR in function of a set of pure demographic determinants (independent variables).

These are:

- Yearly average natural population growth rate (NATPGR),
- Yearly average internal migratory population growth rate (MIGPGR),
- Yearly average international migratory population growth rate (INTPGR),
- Yearly average of Italian population growth rate (ITAPGR), and
- Yearly average of foreign population growth rate (FORPGR).

The variables refer to the Italian municipalities (7,904 cases) and cover the period 2011 – 2019. They have been standardized to a Z distribution so that their mean is equal to zero ($\mu = 0$) and their standard deviation is equal to one ($\sigma = 1$).

In the analysis and the interpretation of the multiscale regression results, we follow the approach of Yang *et al.* (2022a; 2022b) in which three multiscale dimensions of spatial process are defined:

- Level of influence, the percentage of population affected by a certain determinant across the entire area;
- Scalability, the spatial process of a determinant into global, regional, and local process; and
- Specificity, the determinant that has the strongest association with the yearly average total population growth rate.

These dimensions are evaluated in relation to each independent variable (Key findings section).

Population data used are based on the intercensal reconstruction of resident population and are provided by the Italian National Institute of Statistics (Istat). Basically, they refer to stocks (resident population at a given time) and flows (births, deaths, emigrations, and immigrations occurred in a given period) of resident population (Italians and foreigners). The period refers to 2011 – 2019.

The local dimension of the study lies both in the regression approach used (MGWR, that is a local regression approach) and, therefore, in the statistical units adopted. Indeed, our statistical units are the Italian municipalities. Municipalities, local administrative units

(LAUs) based on the Eurostat definition, are the basic spatial units adopted in this study. LAUs are defined with the aim to dividing the territory of the European Union for the purpose of providing statistics at local levels. They are low-level administrative divisions of a country below province, region, or state. LAUs may refer to a range of different administrative units, including municipalities, communes, parishes, or wards. In Italy, they correspond to municipalities.

For each municipality, we computed the rates following the approach proposed in Preston *et al.* (2001) and applied, among others, by Strozza *et al.* (2016). In such approach, the idea is that TOTPGR is the instantaneous growth rate (from one year to another) and can be expressed as the ratio between population change during time interval 0-*t* and the number of persons for that period *t* $(P_t - P_0)/ln\ (P_t/P_0)$ (Preston *et al.*, 2001). We computed all the other rates in the same way. These rates, standardized to a Z distribution, act as dependent (TOTPGR) and independent variables (NATPGR, MIGPGR, INTPGR, ITAPGR and FORPGR) in a MGWR model. As known, scale is a fundamental concept in spatial and regional demography (Howell *et al.,* 2016; Lloyd, 2016). This is currently discussed in the considerable and diverse literature that investigates the various roles that scale plays in different social processes (Fotheringham *et al.*, 2017). It is generally accepted that different processes can operate at different spatial scales, and we often make a distinction between micro and macro, or between local and global processes, but in real-world scenarios, data are often generated from spatial processes operating at different spatial scales (Wolf *et al.*, 2017). If we consider a less restrictive assumption that all spatially variable processes in a model operate at the same spatial scale, we can think of a more flexible model. Local models such as geographically weighted regression (GWR) (Fotheringham *et al.*, 2002) can capture process heterogeneities but do not adequately incorporate the multiscale properties of processes into modeling. Indeed, the bandwidth of the latter is closely related to the spatial scale of the processes examined, and bandwidths for each independent variable are assumed to be the same. In this respect, the semiparametric geographically weighted regression (SGWR) model (Nakaya, 2015; Nakaya *et al.*, 2005) provides, even if in a strictly rigid or extreme form, a first response to the multiscale problem by distinguishing between factors that play a role at a local and the global levels. Demographic research is often based on individual and contextual level data over a wide range of spatial scales, and therefore, the corresponding variables, which involve correlated social and economic aspects, require a deep understanding of the spatial context (Mucciardi, 2021). To overcome this problem, the development of the GWR/SGWR model, called MGWR, removes the single bandwidth assumption, and allows covariate-specific bandwidths to be optimized (Oshan *et al.*, 2019).

The scale of a spatial non-stationarity relationship may vary for each predictor variable. The MGWR model has the ability to differentiate local, regional, and global processes by optimizing a different bandwidth for each covariate (Li & Fotheringham, 2020). The following equation gives the specification of MGWR:

$$y_i = \sum_{j=0}^{m} \beta_{bwj}\left(u_i, u_j\right) x_{ij} + \varepsilon_i \quad (1)$$

Where β_{bwj} represents the coefficient of the bandwidth with the spatial weighting kernel used for estimating the *j*-th predictor variable x_{ij} at local site (i.e., municipality) *i*, ε_i is the error term, and y_i is the response variable. As pointed out by Oshan (Oshan *et al.,* 2019), MGWR provides an extension that allows each variable to be associated with a distinct bandwidth by recasting GWR as a generalized additive model such that:

$$y_i = \sum_{j=1}^{k} f_j + \varepsilon_i \quad (2)$$

Where f_j is a smoothing function applied to the *j*-th explanatory variable at location *i* that may be characterized by distinct bandwidth parameter and ε_i the error term of the model. Hence, a key advantage of MGWR over GWR is that it can more accurately capture the spatial heterogeneity within and across spatial processes, minimize overfitting, mitigate concurvity (i.e., collinearity due to similar functional transformations), and reduce bias in the parameter estimates (Oshan *et al.*, 2020). The MGWR model is calibrated using a "back-fitting" algorithm which maximizes the expected log likelihood, and the criteria for selecting the bandwidths are derived from the same procedure used in the conventional GWR framework using the corrected Akaike information criteria corrected (AICc) for finite samples (Burnham & Anderson, 2004). The calibration process concerns the method and the criterion of choosing the bandwidth. In our empirical estimation, we used an adaptive (bi-square) kernel because it is more favorable when dealing with non-uniform spatial distributions of observations (i.e., municipalities in our case) and it is also able to better handle irregularly shaped study areas. We recall that, although the fixed kernel could be used in the MGWR model, a limitation of this approach is that there may have calibration issues when there are sparsely populated regions of a study area (Oshan *et al.*, 2019). Furthermore, to compare each of the bandwidths obtained from an MGWR model, it is necessary to standardize the dependent and independent variables so that they are

zero-centered and based on the same range of variation. Consequently, the bandwidths are unconstrained from the scale and the variation of the explanatory variables, helping the relative comparison of bandwidths (Oshan *et al.*, 2020). In the first phase, we built a classic ordinary least square (OLS) model (which assumes processes to be constant across the study area) as a benchmark for evaluation of the MGWR model and report comparison. Before moving to the presentation of the results, it should be noted one limitation of the present study. The independent variables used (demographic rates obtained by a decomposition approach) can interact with each other. The estimation done cannot grasp this (possible) effect of interaction between independent variables. Nevertheless, our primary goal here is not to understand the "net" effect of the independent variables on the dependent one nor to explain the variance of this latter. Our primary goal is to prove that the local demographic change in Italy is a local multiscale process (i.e., it varies across spaces and across scales).

3. Key Findings

From 2011 (January 1) to 2019 (January 1), the resident population in Italy passed from 59,948,497 to 59,816,673 (a decline by −2.2‰). Those changes present a strong spatial variation as clearly shown in Figure 1. The right panel map clearly shows a sort of "broken" space that divides local contexts that recorded an increase of resident population during 2011 – 2019 from the other. The positive growth areas are most of the cases represented by urban areas and big cities mainly located in the center and northern Italy (like Milan, Bologna, Florence, Rome) while the negative growth areas are represented by inner contexts but also by some important medium and medium-large cities mainly located in the southern part of the country. It is important to underline that, if we refer to the Italian population only (i.e., people with Italian citizenship), the decrease was even sharper, from 55,847,162 million residents to 54,820,515 (a total decline by −18.3‰), proving the growth of the foreign population counterpart, from 4,101,335 to 4,966,158 (a total increase by +210.9‰).

The results of global (OLS) and local (MGWR) regression models are clear (Table 1). The first important finding is that, based on the Monte Carlo randomization significance test for spatial variability, all the variables introduced in the model are affected by spatial variability so that it would be misleading to treat them as constant in space (like in the OLS model). Moreover, they are supposed to be not correlated because the variance inflation factor (VIF) value is always lower than 10.

MGWR outperforms the OLS model: AICc is lower, Adj-R-square is higher, and the distribution of residuals is not spatially autocorrelated (see the not significant value of the $I_{\_MGWR\_res}$ respect to the significant value of the $I_{\_OLS\_res}$ in Table 1). OLS results tell us that all the independent variables are statistically significant. The net effect on the dependent variable is always positive. NATPGR has a higher net impact, followed by MIGPGR.

What is important, in our view, in addition to the spatial variability of the local coefficients, is the variation of the scale (i.e., the bandwidth) for each regression coefficient. In the case of adaptive kernel, the bandwidth represents the number of nearest neighbors from the regression point which receives a non-zero weight in the local regressions (i.e., the ones which are considered as neighbors to *i*). The selection of the optimal bandwidth parameters is based on statistical optimization criteria like Akaike Information

Table 1. OLS and MGWR models for the growth rate of the total population in 2011-2019 by municipality, Italy

Parameters	OLS	MGWR					
		Min	Median	Mean	Max	S.D.	Bandwidth[(b)]
Intercept [(a)]	0.000	-0.162	-0.007	-0.032	0.083	0.061	361
NATPGR [(a)]	0.477***	0.093	0.342	0.355	0.649	0.133	161
MIGPGR [(a)]	0.455***	0.082	0.323	0.327	0.668	0.120	170
INTPGR [(a)]	0.227***	0.025	0.171	0.165	0.343	0.057	105
ITAPGR [(a)]	0.281***	0.011	0.477	0.458	0.848	0.179	78
FORPGR [(a)]	0.099***	0.034	0.155	0.159	0.302	0.067	202

Note: **OLS model results:** AICc = -5691.82; Adj-R-square=0.972; Moran $I_{\_OLS\_res}$=0.034***
VIF: NATPGR=4.154; MIGPGR=4.165; INTPGR=1.800; ITAPGR=7.582; FORPGR=1.628
MGWR model results: AICc = -9779.45; Adj-R-square=0.985; Moran $I_{\_MGWR\_res}$ = -0.002 (n.s.)
Spatial kernel=adaptive bi-square
[(a)] Monte Carlo randomization significance test for spatial variability $p<0.001$ (Monte Carlo tests are based on 1,000 randomizations of the data)
[(b)] The bandwidth is determined with the number of nearest neighbors for each location
OLS: Ordinary least square. MGWR: Multiscale geographically weighted regression.
Dependent variable is TOTPGR 2011–2019.
*$p<0.05$; **$p<0.01$, ***$p<0.001$ n.s.: Not significant.

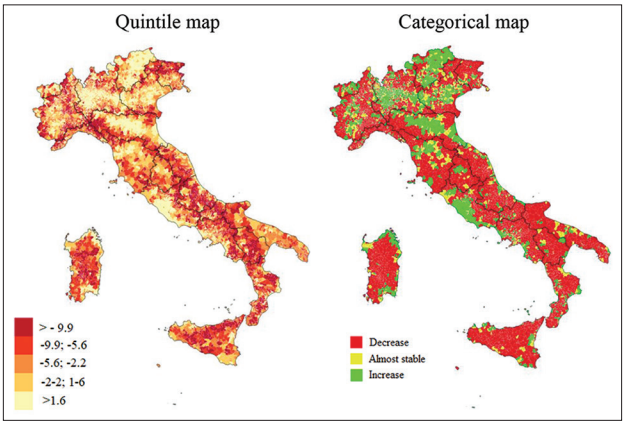


Figure 1. Yearly average total population growth rate per 1000 (TOTPGR) 2011 – 2019, Italian municipality
Note: TOTPGR: Yearly average total population growth rate.
Source: Author's elaboration on Istat data.

Criteria (Fotheringham *et al.*, 2002; Yu *et al.,* 2020). From a spatial perspective, the bandwidth is an indicator of the spatial scale over which the processes under observation operate. It is interesting to note that the higher bandwidth is recorded by FORPGR (202) while the lower one by ITAPGR (78). This means that the spatial scale over which the effect of FORPGR operates on the dependent variable (TOTPGR) is higher, although it is relatively small in geographical sense (the total bandwidth, i.e., the total number of municipalities is equal to 7904). Results of Table 1 provide evidence that the TOTPGR is greatly influenced by local determinants that have different effects at different scales.

As known, one of the major strong points of local regression models is that we can map the local coefficients (Matthews & Yang, 2012). From Figure 2, we can understand how space matters. In particular, we can observe how the strength of the net effect of each local coefficient varies across space - where it is statistically significant, in MGWR model a "specific" adjusted alpha-value and critical t-value are computed for each of the independent variables (Oshan *et al.*, 2020)- and the different magnitude of local R-squares. The historical north–south geographical contrast of Italy only partially explains the spatial patterns of local coefficients underlying the relevance of local scale dimension in measuring the demographic process (Salvati *et al.,* 2020). The geographical distributions of the local parameters of NATPGR and MIGPGR draw similar patterns: higher values are recorded in the north and in particular in the north-east part of the country. It seems to indicate that local context that act as attractors for internal migration flow are the ones where the natural growth is, comparatively, higher. If we bear in mind that, usually, the internal mobility of foreigners is higher than the one

Table 2. Three dimensions of multiscale spatial process for each independent variable based on the MGWR models

Variable (bandwidth)	Level of influence[(a)]	Scalability[(b)]	Specificity[(c)]
NATPGR (361)	Primary (7,527)	Local	2,511 (31.8%)
MIGPGR (161)	Primary (7,527)	Local	326 (4.1%)
INTPGR (170)	Primary (7,423)	Local	0 (0.0%)
ITAPGR (78)	Primary (7,783)	Local	5,067 (64.1%)
FORPGR (202)	Primary (7,800)	Local	0 (0.0%)

Note: The model was adapted from Yang *et al.,* (2022a, 2022b).
NATPGR (yearly average natural population growth rate), MIGPGR (yearly average internal migratory population growth rate), INTPGR (yearly average international migratory population growth rate), ITAPGR (yearly average of Italian population growth rate), FORPGR (yearly average of foreign population growth rate).
[(a)] If the variable affects more than 50% the total population it is a primary influencer; otherwise (≤50%) it is a secondary influencer. The percentage of municipalities affected by a factor is included in the parentheses.
[(b)] If the bandwidth of a variable is larger than 75% of the global bandwidth, it is a global determinant; if the bandwidth is smaller than 25% of the global bandwidth, it is a local determinant; if the bandwidth is between 75% and 25% of the global bandwidth, it is a regional determinant. Global bandwidth is the total number of municipalities (7,904).
[(c)] The number and percentage of municipalities that the focal variable has the strongest significant impact on the dependent variable (i.e., the largest absolute value of the standardized coefficients that are).

of Italians (Benassi *et al.,* 2019) and it follows a south to north axis, we can infer how relevant is the contribution of foreign population to the local population changes (Strozza *et al.,* 2016). The map of the local estimation of INTPGR is quite different in terms of intensity from that of NATPGR and of MIGPGR. The north still remain the part of Italy with higher values (the majority of the municipalities located in the north part of the country are classified in the last two classes of the legend, i.e., >0.300), but the intensity of the local coefficients is lower than the one of the first two maps. Interesting to note that among all of these first three maps the Sardinia Island does not present any statistically significant local estimation. The geographies of the local regression coefficients related to the ITAPGR and FORPGR variables appear partially mirrored each other and, to some extent, help to better understand what has emerged so far. The effects are generally more intense for the ITAPGR variable than for FORPGR. However, in both cases, the largest effects occur in central and southern Italy, where the effects (i.e., local coefficients) of the NATPGR, MIGPGR, and INTPGR were smaller. In contrast to the Italian component, in the case of foreigners, FORPGR, particularly small effects are also registered in the north-east and, albeit to a lesser extent, in the north-west as well as in some specific areas of the south including the islands.

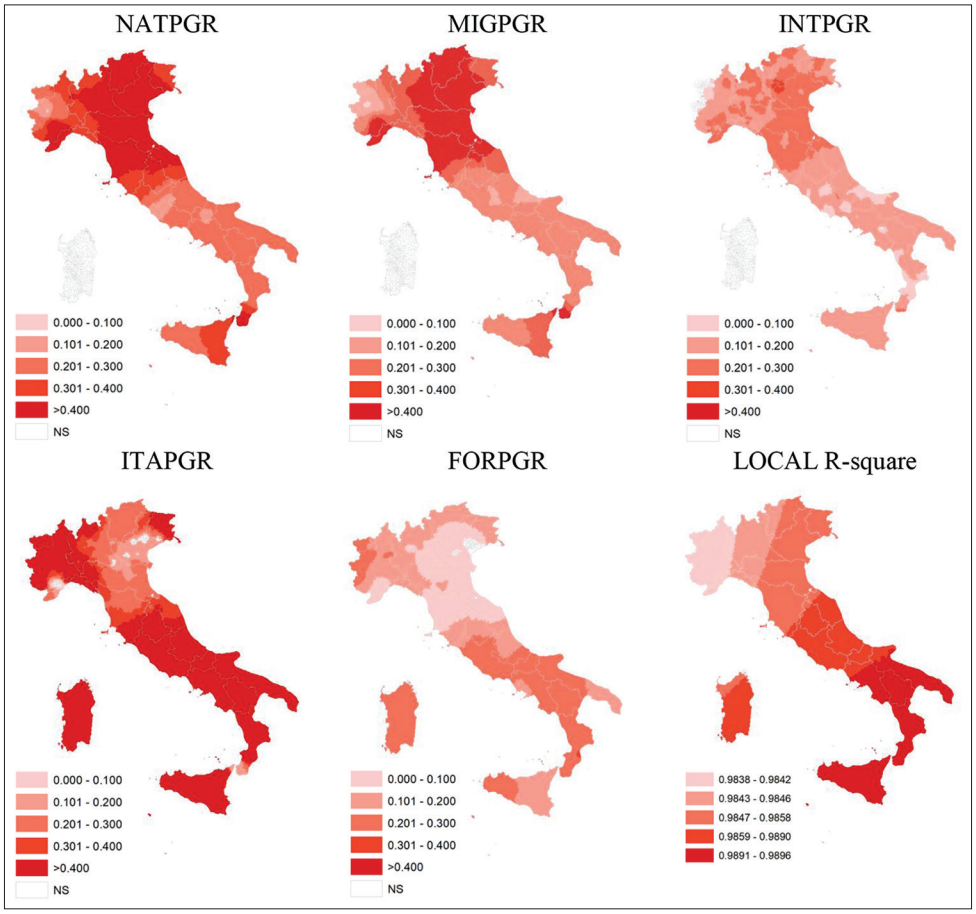


Figure 2. MGWR local coefficients and local R^2 for the growth rate of the total population 2011 – 2019 by municipality, Italy
Note: Dependent variable is TOTPGR 2011 – 2019. NATPGR: Yearly average natural population growth rate, MIGPGR: Yearly average internal migratory population growth rate, INTPGR: Yearly average international migratory population growth rate, ITAPGR: Yearly average of Italian population growth rate, and FORPGR: Yearly average of foreign population growth rate, NS: Not significant. All other parameters are statistically significant at $p<0.05$.
Source: Authors' elaboration on Istat data.

Finally, the geographical distribution of local R^2 is very peculiar. Indeed, local R^2 values are all very high although the highest values are found in southern Italy itself. The levels then tend to decrease moving northward. This means that in southern Italy the local variation in population is basically totally explained by the combination of the variables introduced in the model (local $R^2 > 0.98$).

A way to analyze these local and spatial scale varying effect has been recently proposed by Yang *et al.* (2022a; 2022b). In their approach, they proposed three dimensions of multiscale spatial process: level of influence, scalability, and specificity. Following Yang *et al.* (2022a; 2022b) based on the local estimates of an independent variable, we could identify the municipalities where the effect of this independent variable on TOTGR is statistically significant. We then divided the sum of the municipalities where the variable is statistically significant by the total number of municipalities in the entire study area. If a variable is found to influence 50% or more of the total number of municipalities, this variable will be categorized as into the primary influencer group; otherwise, (<50%) it is a secondary influencer. Scalability can be defined with the calibrated bandwidth of a variable. It has three groups: Global, regional, and local. According to Yang *et al.* (2022a; 2022b) when a calibrated bandwidth of a variable is >75% of the global bandwidth (i.e., the total number of municipalities in our case: 7,904), it can be defined as a global factor. If the bandwidth is between 75% and 25% of the global bandwidth, it is regarded as a regional factor. Finally, when the bandwidth of a variable is smaller than 25% of the global bandwidth, this variable is defined as local. Specificity is based on the standardized coefficients produced by MGWR. Each municipality has its own estimates of the independent variable and these estimates can be compared within each municipality. An independent variable may have strongest association with the dependent variable in some municipalities but not in others. Specificity is based on the number and percentage

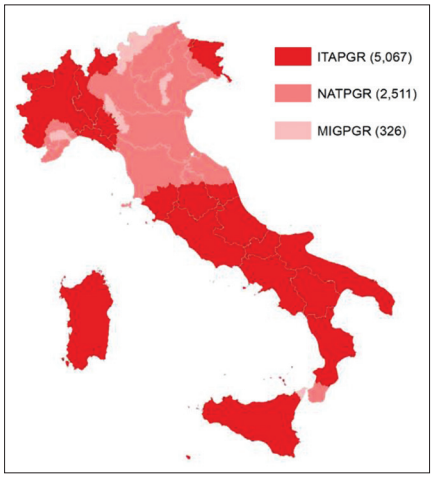


Figure 3. Specificity for ITAPGR, NATPGR, and MIGPGR[(a)]
Note: (a)In brackets the number of municipalities. ITAPGR: Yearly average of Italian population growth rate, NATPGR: Yearly average natural population growth rate, and MIGPGR: Yearly average internal migratory population growth rate.
Source: Authors' elaboration on Istat data.

of municipalities that the focal variable has the strongest significant impact on the dependent variable, TOTPGR (Yang *et al.*, 2022a; 2022b).

Multiscale results with the three dimensions are presented in Table 2. They are quite interesting because they prove the relevance to modeling population growth not only as a spatial process but, most of all, as local spatial varying process. In particular, we can see – column (a) – that each independent variable plays primary level of influence on the dependent variable (TOTPGR). Therefore, the local importance of each covariate is high. Moreover, all the independent variables prove to be local determinants in terms of scalability so that their effects have to be detected at local level. In terms of specificity, we can appreciate a quite high heterogeneity between the dependent variables. ITAPGR records the highest specificity while INTPGR and FORPGR presents no specificity.

The map of specificity in Figure 3 reveals different spatial patterns for the three variables that prove to have a specificity effect, namely, ITAPGR, NATPGR, and MIGPGR. In particular, we can observe how the effect of ITAPGR involves much more municipalities than the other two. Most of them are located in the southern Italy but also in the north-east area. The NATPGR specificity cover the central part of Italy and the north-west too. Finally, the MIGPGR local specificity distribution covers few areas that are almost located in the northern part of Italy.

4. Concluding Remarks

In recent years, many papers have underlined the intrinsic spatial nature of demography (De Castro, 2007; Gu *et al*, 2020; Raymer *et al.*, 2019; Voss, 2007; Weeks, 2016) and the need to use appropriate spatial methodologies in population-based studies, i.e., considering space in the analysis (Chi & Zu, 2008; Matthews, 2019; Matthews & Parker, 2014; Weeks, 2004). In this general framework, a crucial variable is the scale of analysis (Burillo *et al.* 2020; Oshan *et al.* 2022).

In this study, we showed that this is particularly true for Italy and its local demographic dynamics but with two major additions: the spatial varying relationships and multiscale nature of these relationships. In our view, this proves the spatial complexity of demographic changes in Italy and the need for measuring demographic processes without a constant scale approach.

Indeed, it can be misleading if modeling the spatial demographic process is without considering the spatial dimension (classic OLS model), without considering local dimensions – such as, spatial global regression models like spatial lag model, spatial error model, and spatial Durbin model – or without a multiscale framework (classic GWR model).

At least, the case for Italy for the period 2011 – 2019 as this paper clearly proves it. We argue that the results achieved provide new insights into the importance of treating the population process as spatial phenomena and in particular as local and multiscale (spatial) phenomena. The achieved results also have relevance in terms of policy implications. In Italy, as in other parts of Europe, there are vast areas of land in systematic depopulation (shrinking regions) (Klingholz, 2009), a real challenge for territorial planners and policy makers. Adopting this type of model (MGWR) allows the depopulation phenomenon to be modeled locally by identifying the radius of influence of the different explanatory variables and thus enabling the territorial calibration of policies to counter it.

Acknowledgments

The authors would like to thank the two anonymous reviewers and the editor for their suggestions, which helped to improve the paper significantly.

Funding

None.

Conflict of interest

The authors declare that they have no competing interests.

Author contributions

Conceptualization: Federico Benassi, Gerardo Gallo
Investigation: Federico Benassi

Methodology: Massimo Mucciardi
Formal analysis: Massimo Mucciardi
Writing – original draft: Federico Benassi, Massimo Mucciardi
Writing – review & editing: Federico Benassi, Massimo Mucciardi, Gerardo Gallo

Ethics approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

Availability of data

Data used in the paper can be downloaded from the Italian National Statistical Institute (Istat) web site: https://www.istat.it/en

References

Benassi, F., & Carella, M. (2022). Modelling geographical variations in fertility and population density of Italian and foreign populations at the local scale: A spatial Durbin approach for Italy (2002-2018). *Quality and Quantity*.

https://doi.org/10.1007/s11135-022-01446-1

Benassi, F., & Naccarato, A. (2017). Households in potential economic distress. A geographically weighted regression model for Italy, 2001-2011. *Spatial Statistics*, 21:362-376.

https://doi.org/10.1016/j.spasta.2017.03.002

Benassi, F., Bonifazi, C., Heins, F., Licari, F., & Tucci, E. (2019). Population change and international and internal migration in Italy, 2002-2017: Ravenstein revisited. *Comparative Population Studies*, 44: 497-531.

https://doi.org/10.12765/CPoS-2020-16

Benassi, F., Busetta, A., Gallo, G., & Stranges, M. (2021). The Inequalities between Territories. In: Billari, F.C., & Tomassini, C. (A Cura di). *AISP-Population Report. Italy and the challenges of demography*. Bologna: Il Mulino, p.135-161. [In Italian].

Benassi, F., Busetta, A., Gallo, G., & Stranges, M. (2023). Neighbourhood Effects and Determinants of Demographic Changes in Italy: A Spatial Perspective. *Vienna Yearbook of Population Research*. Vienna, Austria: Austrian Academy of Sciences Press.

https://doi.org/10.1553/p-5dfz-c44a

Billari, F.C., & Tommasini, C. (2021). *Population Report. Italy and the Challenges of Demography*. Bologna: Il Mulino. [In Italian].

Bonifazi, C., Heins, F., Licari, F., & Tucci, E. (2021). The regional dynamics of internal migration intensities in Italy. *Population, Space and Place,* 27(7):e2331.

https://doi.org/10.1002/psp.2331

Burillo, P., Salvati, L., Matthews, S.A., & Benassi, F. (2020). Local-scale fertility variations in a low-fertility country: Evidence from Spain (2002-2017). *Canadian Studies in Population*, 47(4):279-295.

https://doi.org/10.1007/s42650-020-00036-6

Burnham, K.P., & Anderson, D.R. (2004). Multimodel inference: Understanding AIC and BIC in model selection. *Sociological Methods and Research*, 33(2):261-304.

https://doi.org/10.1177/0049124104268644

Caltabiano, M., Dreassi, E., Rocco, E., & Vignoli, D. (2019). A subregional analysis of family change: The spatial diffusion of one-parent families across Italian municipalities, 1991-2011. *Population, Space and Place*, 25(4):e2237.

https://doi.org/10.1002/psp.2237

Chi, G., & Zhu, J. (2008). Spatial regression models for demographic analysis. *Population Research and Policy Review*, 27(1):17-42.

https://doi.org/10.1007/s11113-007-9051-8

Cupido, K., Fotheringham, A.S., & Jevtic, P. (2021). Local modelling of U.S. mortality rates: A multiscale geographically weighted regression approach. *Population Space and Place*, 27(151):e2379.

https://doi.org/10.1002/psp.2379

De Castro, M.C. (2007). Spatial demography: An opportunity to improve policy making at diverse decision levels. *Population Research and Policy Review*, 26(5):477-509.

https://doi.org/10.1007/s11113-007-9041-x

Fotheringham, A.S., Brunsdon, C., & Charlton, M. (2002). *Geographically Weighted Regression: The Analysis of Spatially Varying Relationships*. Chichester: Wiley.

Fotheringham, A.S., Yang, W., & Kang, W. (2017). Multiscale geographically weighted regression (MGWR). *Annals of the American Association of Geographers*, 107(6):1247-1265.

https://doi.org/10.1080/24694452.2017.1352480

Gu, H., Lao, X., & Shen, T. (2020). Research progress on spatial demography. In: Ye, X., & Lin, H. (eds.). *Spatial Synthesis: Computational Social Science and Humanities*. New York City: Springer International Publishing, p.125-145.

Howell, F.M., Porter, J.R. & Matthews, S.A. (2016). *Recapturing Space: New Middle-Range Theory in Spatial Demography*. Champ: Springer.

Klingholz, R. (2009). Europe's Real Demographic Challenge. *Policy Review*. Vol.157, p.61-70 Available from: https://www.proquest.com/openview/30d877f0a74a1cb1d568d0a9a57d1f0b/1.pdf?cbl=47546&pq-origsite=gscholar [Last accessed on 2022 Jul 20].

Lamonica, G.R., & Zagaglia, B. (2013). The determinants of

internal mobility in Italy, 1995-2006: A comparison of Italians and resident foreigners. *Demographic Research*, 29:407-440.

https://doi.org/10.4054/demres.2013.29.16

Li, Z., & Fotheringham, S. (2020). Computational improvements to multi-scale geographically weighted regression. *International Journal of Geographical Information Science*, 34(7):1378–1397.

https://doi.org/10.1080/13658816.2020.1720692

Lloyd, C.D. (2016). Are spatial inequalities growing? The scale of population concentrations in England and Wales. *Environment and Planning A,* 48(7):1318-1336,

https://doi.org/10.1177/0308518X15621306

Matthews, S.A. (2019). Methods and applications in spatial demography. *Mathematical Population Studies*, 26(4):183-184.

https://doi.org/10.1080/08898480.2019.1653058

Matthews, S.A., & Parker, D.M. (2013). Progress in spatial demography. *Demographic Research*, 28(10):271-312.

https://doi.org/10.4054/demres.2013.28.10

Matthews, S.A., & Yang, T.C. (2012). Mapping the results of local statistics: Using geographically weighted regression. *Demographic Research*, 26:151-166.

https://doi.org/10.4054/DemRes.2012.26.6

Mucciardi, M. (2021). Local and global analysis of fertility rate in Italy. In: Popkova, E.G., & Sergi, B.S. (eds.) *Smart Technologies for Society, State and Economy.* Cham: Springer, p. 465–474.

Nakaya, T. (2015). Semiparametric geographically weighted generalized linear modelling: The concept and implementation using GWR4. In: Brunsdon, C., & Singleton, A. (eds.). *Geocomputation: A Practical Primer*. London: Sage, p.201-220.

Nakaya, T., Fotheringham, A.S., Brunsdon, C., & Charlton, M. (2005). Geographically weighted Poisson regression for disease association mapping. *Statistics in Medicine*, 24:2695-2717.

https://doi.org/10.1002/sim.2129

Oshan, T.M., Li, Z., Kang, W., Wolf, L.J., & Fotheringham, A.S. (2019). MGWR: A Python implementation of multiscale geographically weighted regression for investigating process spatial heterogeneity and scale. *ISPRS International Journal of Geo-Information*, 8(6):269.

https://doi.org/10.3390/ijgi8060269

Oshan, T.M., Smith, J.P., & Fotheringham, A.S. (2020). Targeting the spatial context of obesity determinants via multiscale geographically weighted regression. *International Journal of Health Geography*, 19(1):11.

https://doi.org/10.1186/s12942-020-00204-6

Oshan, T.M., Wolf, L.J., Sachdeva, M., Bardin, S., & Fotheringham, A.S. (2022). A scoping review on the multiplicity of scale in spatial analysis. *Journal of Geographical Systems*, 24:293-324.

https://doi.org/10.1007/s10109-022-00384-8

Preston, S.H., Heuveline, P., & Guillot, M. (2001). *Demography: Measuring and Modeling Population Processes*. Oxford: Blackwell Publishers.

Raymer, J., Willekens, F., & Rogers, A. (2019). Spatial demography: A unifying core and agenda for further research. *Population, Space and Place*, 25(4):e2179.

https://doi.org/10.1002/psp.2179

Reynaud, C., & Miccoli, S. (2018). Depopulation and the aging population: The relationship in Italian municipalities. *Sustainability*, 10(4):1004.

https://doi.org/10.3390/su10041004

Reynaud, C., Miccoli, S., & Lagona, F. (2018). Population ageing in Italy: An empirical analysis of change in the ageing index across space and time. *Spatial Demography*, 6(3):235-251.

https://doi.org/10.1007/s40980-018-0043-6

Reynaud, C., Miccoli, S., Benassi, F., Naccarato, A., & Salvati, L. (2020). Unravelling a demographic 'Mosaic': Spatial patterns and contextual factors of depopulation in Italian municipalities, 1981-2011. *Ecological Indicators*, 115:106356.

https://doi.org/10.1016/j.ecolind.2020.106356

Salvati, L., Benassi, F., Miccoli, S., Rabiei-Dastjerdi, H., & Matthews, S.A. (2020). Spatial variability of total fertility rate and crude birth rate in a low-fertility country: Patterns and trends in regional and local scale heterogeneity across Italy, 2002-2018. *Applied Geography*, 124:102321.

https://dx.doi.org/10.1016/j.apgeog.2020.102321

Song, J., Yu, H., & Lu, Y. (2021). Spatial-scale dependent risk factors of heat-related mortality: A multiscale geographically weighted regression analysis. *Sustainable Cities and Society*, 74: 103159.

https://doi.org/10.1016/j.scs.2021.103159

Strozza, S., Benassi, F., Ferrara, R., & Gallo, G. (2016). Recent demographic trends in the major Italian Urban agglomerations: The role of foreigners. *Spatial Demography*, 4(1): 39–70,

https://doi.org/10.1007/s40980-015-0012-2

Vitali, A., & Billari, F.C. (2017). Changing determinants of low fertility and diffusion: A spatial analysis for Italy. *Population, Space and Place* 23(2):e1998.

https://doi.org/10.1002/psp.1998

Voss, P.R. (2007). Demography as a spatial social science. *Population Research and Policy Review*, 26(5):457-476.

https://doi.org/10.1007/s11113-007-9047-4

Weeks, J.R. (2004). The Role of Spatial Analysis in Demographic Research. In: Goodchild, M.F., & Janelle, D.G. (eds.). *Spatially Integrated Social Science*. New York: Oxford

University Press, p.381-399.

Weeks, J.R. (2016). Demography is an inherently spatial science. In: Howell, F.M., Porter, J.R., & Matthews, S.A. (eds.). *Recapturing Space: New Middle-range Theory in Spatial Demography.* Cham: Springer, p.99-122.

Wolf, L.J., Oshan, T.M., & Fotheringham, A.S. (2017). Single and multiscale models of process spatial heterogeneity. *Geographical Analysis*, 50(3):223-246.

https://doi.org/10.1111/gean.12147

Yang, T.C., Matthews, S.A., & Sun, F. (2022a). Multiscale dimensions of spatial process: COVID-19 fully vaccinated rates in U.S. counties. *American Journal of Preventive Medicine*, 63(6):954-961.

https://doi.org/10.1016/j.amepre.2022.06.006

Yang, T.C., Shoff, C., Choi, S.W.E., & Sun, F. (2022b). Multiscale dimensions of county-level disparities in opioid use disorder rates among older Medicare beneficiaries. *Frontiers in Public Health*, 10: 993507.

https://doi.org/10.3389/fpubh.2022.993507

Yu, H., Fotheringham, A.S., Li, Z., Oshan, T., Kang, W., & Wolf, L.J. (2020a). Inference in multiscale geographically weighted regression. Geographical Analysis, 52(1):87-106.

https://doi.org/10.1111/gean.12189

Zambon, I., Rontos, K., Reynaud, C., & Salvati, L. (2020). Toward an unwanted dividend? Fertility decline and the north-south divide in Italy, 1952-2018. *Quality and Quantity*, 54(1): 169-187.

https://doi.org/10.1007/s11135-019-00950-1

ACCSCIENCE PUBLISHING

International Journal of Population Studies

RESEARCH ARTICLE

Association between food insecurity severity and major depression: Findings from the United States National Health and Nutrition Examination Survey

Elizabeth Ann Luke, Josh Wallace, and Roger Wong*

Department of Public Health and Preventive Medicine, Norton College of Medicine, SUNY Upstate Medical University, Syracuse, New York, USA

Abstract

Food insecurity and mental health disorders have been increasing in all populations globally due to a variety of sociopolitical factors. Our study examines how the severity of food insecurity is associated with major depression in adults. We analyzed data from the 2017–2018 National Health and Nutrition Examination Survey, which includes a nationally representative sample from households across the United States. Our sample was restricted to adults aged 18 and older, resulting in a sample size of 5856 participants. We used a multiple logistic regression with sampling weights applied to evaluate whether adult food insecurity severity is associated with major depression. Overall, higher severity of food insecurity was associated with increased odds of depression. Specifically, adults with very low food security had a 315% significantly increased odds of depression compared to those with full food security (adjusted odds ratio [aOR] = 4.15, 95% CI = 3.09 – 5.64, $p < 0.05$). Females also had a 60% significantly higher odds of depression (aOR = 1.60, 95% CI = 1.12 – 2.30, $p < 0.05$) and higher income levels were significantly associated with lower odds of depression (aOR = 0.90, 95% CI = 0.83–0.97, $p < 0.05$). Our study supports prior research that food insecurity has adverse effects on mental health. These results can be used to inform public health research and interventions for food insecurity and mental health moving forward.

Keywords: Depression; Food insecurity; Hunger; Mental health; Prevention; Public health

***Corresponding author:**
Roger Wong
(WongRo@upstate.edu)

Citation: Luke, E.A., Wallace, J., & Wong, R. (2023). Association between food insecurity severity and major depression: Findings from the United States National Health and Nutrition Examination Survey. *International Journal of Population Studies,* 9(1):11-17. https://doi.org/10.36922/ijps.435

Received: January 1, 2023

Accepted: April 13, 2023

Published Online: April 27, 2023

1. Introduction

Food insecurity is a public health concern that has been investigated widely over the past few decades. Food insecurity is defined as a disruption in the intake or eating patterns due to cost or other access barriers (Jones *et al*., 2013). According to the United States Department of Agriculture Economic Research Service (USDA ERS), 10.2% of U.S. households were food insecure at some point in 2021, with 3.9% experiencing very low food security. Food insecurity is not uniform across America and has a higher prevalence in southern states. For example, Mississippi had a 15.3% rate of food insecurity compared to New Hampshire's 5.4% (USDA ERS, 2022).

In recent years, as there has been a cultural shift toward discussing and destigmatizing mental health and mental illness, more studies have sought to investigate a link between food insecurity and mental health disorders. Several studies have found that food insecurity is associated with lower quality of life and increased prevalence of mental health issues or increased likelihood of seeking mental health services (Chung *et al*., 2016; Hatsu *et al*., 2017; Nagata *et al*., 2019; Pound & Chen, 2021; Tarasuk *et al*., 2020; Tarasuk *et al*., 2018). In particular, depression is a debilitating disorder that affects five percent of adults worldwide (Institute for Health Metrics and Evaluation, 2022). Those suffering from depression will often experience lower function at work and poorer personal relationships. Depression can also lead to suicide in worst-case scenarios. Recent studies showed that 9.2% of Americans 12 years and older experienced a major depressive episode within the past year (Goodwin *et al*., 2022). The economic burden due to depression in U.S. adults was approximately $236 billion in 2018 (Greenberg *et al*., 2021). Despite the breadth and severity of depression, the amount spent on direct treatment was only 11.2% of the total economic burden.

In a study on food security and quality of life in individuals living with HIV, Hatsu *et al*. (2017) found that participants who reported experiencing very low food security had significantly lower mental component summary scores, indicating food insecurity had serious adverse mental health effects in their sample.

One potential mechanism between food insecurity and depression is the stress response pathway. An increase in allostatic load due to food insecurity can raise cortisol and norepinephrine levels which have been associated with depression (McClain *et al*., 2018). An increase in allostatic load is also accompanied by chronic issues such as inflammation, unhealthier cholesterol levels, and hypertension. Each of these issues can create or contribute to ongoing medical issues, creating a positive feedback loop for stress.

Another study focusing on food insecurity and maternal outcomes in Ontario found that the prevalence of postpartum mental health disorders was higher among women who experienced food insecurity (34.8%) compared to those who experienced marginal (15.2%) or no food insecurity (20.6%) (Tarasuk *et al*., 2020).

Food insecurity may also increase the risk of depression through social support. Food insecurity has been shown to lead to social isolation in older adults, which, in turn, is associated with depression (Burris *et al*., 2021). Likewise, Ashe & Lapane (2018) found that those who were food insecure were 80% less likely to have strong social support compared to those who were fully food secure (Ashe & Lapane, 2018).

Tarasuk *et al*. (2018) examined the relationship between food security and utilization of public mental health care services in Ontario, Canada. They found that over the past year of the study, 40.4% of adults in severely food-insecure households had received treatment for their mental health compared to 15.6% of adults in food-secure households (Tarasuk *et al*., 2018). Several additional studies determined that young adults experiencing food insecurity had increased odds of mental health issues and poorer sleep (Nagata *et al*., 2019). Individuals experiencing food insecurity also had a significantly higher prevalence of perceived poor or fair mental health status (Pound & Chen, 2021). Other research has shown an association of food insecurity with nutritional deficiencies, adverse mental health, and overall lower quality of life (Chung *et al*., 2016).

The purpose of our present study was to examine how the severity of food insecurity is associated with major depression in adults using a nationally representative U.S. sample. The previous studies have focused on examining the relationship between food insecurity and utilization of mental health treatment or poorer mental health status in general, but few have examined the specific association with major depressive disorder. Due to the often more severe outcomes that result from major depressive disorder, it would be prudent to explore any factors related to the condition. We hypothesized that those individuals experiencing more severe food insecurity would be more likely to experience depression. Results from this study may provide further insight into the relationship between food insecurity and depression and may be used to identify preventable social risk factors for depression.

2. Data and methods

2.1. Data source

We used the National Health and Nutrition Examination Survey (NHANES) 2017–2018 data for our analysis. Although the most recent 2019–2020 data is available, we opted not to analyze this wave as the NHANES stated data collection was halted in March 2020 due to the COVID-19 pandemic, which subsequently led to the 2019–2020 data being neither nationally representative nor generalizable to the U.S. population. As of January 2023, the NHANES 2021–2022 data have not been released as well. Thus, the NHANES 2017–2018 data set includes a nationally representative sample of 5856 individuals aged 18 years or older.

2.2. Major depression

Our outcome of interest was major depression. We constructed this variable using the Patient Health Questionnaire-9 (PHQ-9), a nine-question depression module with each question ranging from a frequency of zero (not at all) to three (nearly every day) in the past 12 months. The aggregate score had a range of 0–27 and we followed guidance on classifying individuals with major depression using a cutoff of 10 or greater, which has a high sensitivity and specificity of 88% (Kroenke *et al.*, 2001).

2.3. Food insecurity severity

Our main predictor variable was the severity of adult food insecurity derived from a 10-question NHANES algorithm that queried adult households with no children. The NHANES uses the standardized 10-item food security module developed by the USDA, which has been extensively tested for validity and reliability (Bickel *et al.*, 2000). The 10 questions in the module assess three situations: (1) Anxiety or perception that the food budget or food supply was inadequate, (2) perceptions that the food eaten was inadequate in quality, and (3) reported instances of reduced food intake or consequences of reduced intake. Based on USDA methodology, the NHANES algorithm classifies adults into four categories: (1) Full food security (had no problems, or anxiety about, consistently accessing adequate food), (2) marginal food security (had problems at times, or anxiety about, accessing adequate food, but the quality, variety, and quantity of their food intake were not substantially reduced), (3) low food security (reduced the quality, variety, and desirability of their diets, but the quantity of food intake and normal eating patterns were not substantially disrupted), and (4) very low food security (at times during the year, eating patterns were disrupted, and food intake reduced due to lack of money and other resources for food) (Bickel *et al.*, 2000).

2.4. Covariates

The regression model was adjusted for the following covariates: Age, income, race/Hispanic origin, sex, education level, and access to care. Age was a continuous variable ranging from 18 and top-coded at 80 years to protect respondent anonymity. For income, we specifically analyzed the ratio of family income to poverty, which was calculated by dividing family or individual income by the poverty guidelines specific to the survey year. This variable is continuous with a range of zero and top-coded to five to protect respondent anonymity. Race/Hispanic origin is nominal, and responses included Mexican American, other Hispanic, non-Hispanic White, non-Hispanic Black, and other races. Sex includes male and female. Education level is ordinal and includes the following responses: <9th grade, 9–11th grade, high school graduate/General Educational Development, some college, and college graduate or above. Access to care is a binary yes or no response based on the question, "Have you seen a mental health professional in the past year?".

2.5. Statistical analysis

A Pearson Chi-square test was conducted to test for an association between adult food security and depression. A weighted multiple logistic regression was run to evaluate the relationship between food insecurity and depression after adjusting for covariates. The NHANES sampling weights were calculated based on the probability of selection at each stage of the sampling process, which included stratification, clustering, and multistage sampling. To make sure that the sample was representative of the population of interest, the sampling weights were adjusted for nonresponse by demographic factors such as age, sex, race/ethnicity, and poverty status. This ensures that the data are representative of the U.S. civilian, non-institutionalized population. We used IBM SPSS statistical software version 28 and SAS Studio 3.81 for all statistical analyses with a 0.05 significance level and two-tailed tests.

3. Results

3.1. Sample characteristics

In our study sample of 5,856 U.S. adults, the average age of participants was 49.9 years (SD = 18.8) and the majority of participants identified as female (51.5%) (Table 1). The average ratio of family income to poverty was 2.52 (SD = 1.61), indicating mid-level socioeconomic status. Most of the participants identified as non-Hispanic White (34.7%), while those who identified as other Hispanic made up the lowest proportion of study participants. The highest proportion of study participants reported an education level of some college (32.0%). Participants who reported only having a 9–11th grade or <9th grade education level represented the lowest proportion of our sample. When examining measures of health, 89.7% of participants reported that they had not seen a mental health professional in the last year. In addition, 63.3% of participants were categorized as experiencing full food security, while only 9.6% of participants experienced very low food security. About 8% of the NHANES participants met the criteria for major depression based on the PHQ-9.

3.2. Bivariate results

There was a statistically significant relationship between food insecurity severity and major depression (χ^2 [3] = 197.9, p < 0.001) (Table 2). In general, more severe food insecurity trended with a higher prevalence

Table 1. Sample characteristics for respondents in the 2017–2018 National Health and Nutrition Examination Survey

Characteristic	Mean (SD) or % (n)
Age (range 18–80 years)	49.89 (18.78)
Ratio of income to poverty (range 0 – 5)	2.52 (1.61)
Race/Hispanic origin	
Mexican American	13.50% (792)
Other Hispanic	9.30% (543)
Non-Hispanic White	34.70% (2,032)
Non-Hispanic Black	22.90% (1,343)
Other races	19.60% (1,146)
Sex	
Male	48.50% (2,840)
Female	51.50% (3,016)
Education level	
<9th grade	8.60% (479)
9 – 11th grade	11.50% (638)
High school graduate/GED	23.80% (1,325)
Some college	32.00% (1,778)
College graduate or above	24.00% (1,336)
Seen mental health professional in past year	
Yes	10.30% (605)
No	89.70% (5,250)
Food insecurity severity	
Full food security	63.30% (3,488)
Marginal food security	14.20% (785)
Low food security	12.90% (711)
Very low food security	9.60% (527)
Major depression	
No	92.10% (5,395)
Yes	7.90% (461)

Note: GED: General educational development.

of depression. For example, most respondents with full food security did not have depression (65.3%) compared to those with depression (40.0%). In contrast, those who experienced very low food security had a higher proportion of depression (27.0%) compared to no depression (8.1%).

3.3. Multiple logistic regression results

Our regression model predicting major depression was statistically significant ($F[6, 97] = 22.36$, $p < 0.001$]. The regression model correctly predicted 77.2% of cases, indicating a good model fit. There are no independent variables with a variance inflation factor (VIF) >10 and the average VIF for the regression model is approximately 1.4, which indicates there is no multicollinearity (Kutner *et al.*, 2004).

Table 2. Bivariate association between food insecurity severity and major depression

Food insecurity severity	No depression (N=5,395)	Depression (N=461)	Chi-square test
Full food security	65.3% (3316)	40.0% (172)	Σ^2 (3)=197.9, P<0.001
Marginal food security	14.2% (721)	14.9% (64)	
Low food security	12.5% (633)	18.1% (78)	
Very low food security	8.1% (411)	27.0% (116)	

Overall, as food insecurity severity increases, the odds ratio of experiencing major depression increases and is statistically significant for all severity categories (Table 3). For example, respondents who experienced very low food security had a 318% significantly increased odds of major depression compared to participants who experienced full food security after adjusting for age, sex, race-ethnicity, education, income, and mental healthcare (adjusted odds ratio [aOR] = 4.18, 95% confidence interval [CI] = 3.09 – 5.64, $p < 0.05$).

Several of our covariates in the regression model were also significantly associated with depression. Those who were female had a 60% significantly increased odds of major depression compared to males (aOR = 1.60, 95% CI = 1.12 – 2.30, $p < 0.05$). Every one-point increase in the income-to-poverty ratio significantly decreased the odds of major depression by 10% (aOR = 0.90, 95% CI = 0.83 – 0.97, $p < 0.05$). Finally, those who reported not seeing a mental health professional in the past year had an 81% significantly decreased odds of major depression compared to those who did (aOR = 0.19, 95% CI = 0.12 – 0.28, $p < 0.05$).

4. Discussion

Our results showed a positive association between food insecurity and major depression. Higher severity of food insecurity corresponded with higher odds of individuals experiencing depression. This association was statistically significant for every severity category, and especially pronounced for those in the category "very low food security," which the USDA defines as those with disrupted eating patterns and reduced food intake due to a lack of money and other resources for food (Bickel *et al.*, 2000). These findings are consistent with the previous research on the relationship between food insecurity and poor mental health (Chung *et al.*, 2016; Hatsu *et al.*, 2017; Nagata *et al.*, 2019; Pound & Chen., 2021; Tarasuk *et al.*, 2020).

Table 3. Weighted multiple logistic regression examining the association between food insecurity severity and major depression

	aOR	*p*-value	95% CI
Food insecurity severity			
Full food security	Reference	Reference	Reference
Marginal food security	2.14	<0.05	1.21 – 3.79
Low food security	2.66	<0.05	1.42 – 4.95
Very low food security	4.18	<0.05	3.09 – 5.64
Age	1.00	0.36	0.98 – 1.01
Sex			
Male	Reference	Reference	Reference
Female	1.60	<0.05	1.12 – 2.30
Race/Hispanic origin			
Mexican American	0.52	0.09	0.24 – 1.11
Other Hispanic	0.73	0.36	0.37 – 1.43
Non-Hispanic White	Reference	Reference	Reference
Non-Hispanic Black	0.71	0.05	0.51 – 1.00
Other Race	1.25	0.30	0.82 – 1.87
Education level			
<9th grade	1.21	0.52	0.68 – 2.15
9–11th grade	1.47	0.16	0.86 – 2.50
High school graduate/GED	1.03	0.79	0.83 – 1.27
Some college	Reference	Reference	Reference
College graduate or above	0.67	0.21	0.36 – 1.25
Ratio of income to poverty	0.90	<0.05	0.83 – 0.97
Seen mental health professional in past year			
Yes	Reference	Reference	Reference
No	0.19	<0.05	0.12 – 0.28

Note: GED: General educational development; aOR: Adjusted odds ratio.

A variety of socioeconomic and physiological factors may contribute to this outcome. One potential explanation is that the impact nutritional deficiency has on antidepressant drugs. Individuals with low folate levels have demonstrated a lower treatment response to selective serotonin reuptake inhibitor antidepressants (Alpert *et al.*, 2002). In tandem with these findings, it has also been noted that increased serum levels of Vitamin B_{12} and folic acid supplementation can strengthen antidepressant therapy (Hintikka *et al.*, 2003; Roberts *et al.*, 2007). Low Vitamin B_{12} levels have been observed in the American population and varied by age, with adults 70 years and older being the most impacted at about 6% of prevalence (Allen, 2009).

The regression model also indicated that females, individuals with lower income, and those who had seen a mental health professional in the past year also had significantly increased odds of depression. Several reasons for higher rates of depression among females have been discussed in the literature, such as higher exposure to stressors and adverse conditions than males, leading to depression. Some of these stressors include lower income and higher strain from their caregiving roles (Hammen, 2018). Another source of added stress may stem from a lack of social support which can contribute to depression. Previous finings have shown that women with low food security are 80% less likely to have social support compared to their food-secure counterparts (Ashe & Lapane, 2018). Similarly, poor health and physiological stress are commonly purported to be the key mediators for the association between low income and depression (Patel *et al.*, 2018). Our regression model also adjusted for visit to a mental health professional, in which this association is logical due to individuals with depression who are more likely to seek support from a health professional. When the dependent variable is replaced with the variable "visit to a mental health professional," those with very low food security had significantly lower odds of visiting a professional, which held true in both unadjusted and adjusted weighted regression models. Previous research using a national U.S. sample found that depression is more prevalent among adults who self-identified as multi-racial or White, and less prevalent among Black and Hispanic respondents (Substance Abuse and Mental Health Services Administration, 2019), which aligns with the racial-ethnic disparities in depression that we observed in our study.

Our results have several implications for public health research and practice. Despite a plethora of literature demonstrating that food insecurity is associated with poorer mental health, future studies should investigate other specific mental health disorders, such as generalized anxiety disorder, and how they may be affected by food insecurity. Public health professionals should continue to work on implementing interventions to reduce food insecurity by increasing access to nutritious food options and decreasing costs. For example, one intervention could be the development of local community gardens in vacant neighborhood spaces, which have been reported to offer numerous benefits such as affordable food, community building, healthy and fresh food, and exercise for community residents (Wong *et al.*, 2018). In addition, as we saw in our results, individuals with a higher income relative to the poverty threshold were less likely to experience depression. Alleviating poverty and income disparities is an ongoing focus of public health work and other fields, and poverty plays an important role in an individual's experiences with food security and mental health. Policies aimed at reducing poverty through

universal basic income, increasing minimum wage, and increasing job opportunities at the local, state, and federal level should be considered to reduce depressive symptoms across all populations (Patel *et al.*, 2018).

Our study has several limitations. First, the NHANES is a cross-sectional data set, which limits our ability to establish causality that food insecurity leads to depression. Second, we restricted our sample to only household adults without children because the NHANES and the USDA provide a different food insecurity module measuring child food insecurity, which cannot be merged with our 10-item food security questionnaire for adults. Despite these limitations, our study has some noteworthy strengths. In particular, we utilized a nationally representative sample with sampling weights applied, which enables our results to be generalizable to the entire U.S. adult population. In addition, we used standardized measures for both food insecurity and depression, which have both been tested extensively to have high psychometric properties.

5. Conclusions

Our study supports prior literature that experiencing food insecurity has adverse effects on mental health, specifically in the context of depression. Interventions are therefore essential to address household food insecurity, especially during the era of the COVID-19 pandemic, given that recent research has also identified that food insecurity is significantly associated with increased COVID-19 risk (Searles & Wong, 2022). Future work should expand on these findings and examine whether the association between food insecurity and depression may be moderated by sex and income, which we identified were also significantly associated with depression. Our results can be used to inform public health research and interventions for food security and mental health moving forward.

Acknowledgments

None.

Funding

None.

Conflict of interest

The authors declare no competing of interests.

Author contributions

Conceptualization: Elizabeth Ann Luke, Roger Wong
Formal analysis: Elizabeth Ann Luke, Josh Wallace
Supervision: Roger Wong
Writing – original draft: Elizabeth Ann Luke, Josh Wallace, Roger Wong
Writing – review & editing: Elizabeth Ann Luke, Josh Wallace, Roger Wong

Ethics approval and consent to participate

This study was approved by the SUNY Upstate Institutional Review Board for the Protection of Human Subjects (#1999060-2).

Consent for publication

Not applicable.

Availability of data

This study uses public data, which may be obtained through the NHANES website: https://www.cdc.gov/nchs/nhanes/index.htm

References

Allen, L.H. (2009). How common is Vitamin B-12 deficiency? *American Journal of Clinical Nutrition*, 89(2): 693S-696S.

https://doi.org/10.3945/ajcn.2008.26947A

Alpert, J.E., Mischoulon, D., Rubenstein, G.E.F., Bottonari, K., Nierenberg, A.A., & Fava, M. (2002). Folinic acid (Leucovorin) as an adjunctive treatment for SSRI-refractory depression. *Annals of Clinical Psychiatry*, 14(1): 33-38.

https://doi.org/10.1023/a:1015271927517

Ashe, K.M., & Lapane, K.L. (2018). Food insecurity and obesity: Exploring the role of social support. *Journal of Womens Health* (*Larchmt*), 27(5): 651-658.

https://doi.org/10.1089/jwh.2017.6454

Bickel, G., Nord, M., Price, C., Hamilton, W., & Cook, J. (2000). Guide to Measuring Household Food Security, Revised 2000. US Department of Agriculture, Food and Nutrition Service, p.52. Available from: https://fns-prod.azureedge.us/sites/default/files/fsguide.pdf [Last accessed on 2023 Dec 31].

Burris, M., Kihlstrom, L., Arce, K.S., Prendergast, K., Dobbins, J., McGrath, E., Renda, A., Shannon, E., Cordier, T., Song, Y., & Himmelgreen, D. (2021). Food insecurity, loneliness, and social support among older adults. *Journal of Hunger and Environmental Nutrition*, 16(1): 29-44.

https://doi.org/10.1080/19320248.2019.1595253

Chung, H.K., Kim, O.Y., Kwak, S.Y., Cho, Y., Lee, K.W., & Shin, M.J. (2016). Household food insecurity is associated with adverse mental health indicators and lower quality of life among Koreans: Results from the Korea National Health and Nutrition Examination Survey 2012-2013. *Nutrients*, 8(12): 819.

https://doi.org/10.3390/nu8120819

Goodwin, R.D., Dierker, L.C., Wu, M., Galea, S., Hoven, C.W., & Weinberger, A.H. (2022). Trends in U.S. depression

prevalence from 2015 to 2020: The widening treatment gap. *American Journal of Preventive Medicine*, 63(5): 726-733.

https://doi.org/10.1016/j.amepre.2022.05.014

Greenberg, P.E., Fournier, A.A., Sisitsky, T., Simes, M., Berman, R., Koenigsberg, S.H., & Kessler, R.C. (2021). The economic burden of adults with major depressive disorder in the United States (2010 and 2018). *Pharmacoeconomics*, 39(6): 653-665.

https://doi.org/10.1007/s40273-021-01019-4

Hammen, C. (2018). Risk factors for depression: An autobiographical review. *Annual Review of Clinical Psychology*, 14: 1-28.

https://doi.org/10.1146/annurev-clinpsy-050817-084811

Hatsu, I., Hade, E., & Campa, A. (2017). Food security status is related to mental health quality of life among persons living with HIV. *AIDS and Behavior*, 21(3): 745-753.

https://doi.org/10.1007/s10461-016-1573-9

Hintikka, J., Tolmunen, T., Tanskanen, A., & Viinamäki, H. (2003). High Vitamin B12 level and good treatment outcome may be associated in major depressive disorder. *BMC Psychiatry*, 3(1): 17.

https://doi.org/10.1186/1471-244X-3-17

Institute for Health Metrics and Evaluation. (2022). The 2019 Global Burden of Disease (GBD) Study Database. Available from: https://vizhub.healthdata.org/gbd-results [Last accessed on 2022 Dec 27].

Jones, A.D., Ngure, F.M., Pelto, G., & Young, S.L. (2013). What are we assessing when we measure food security? A compendium and review of current metrics. *Advances in Nutrition*, 4(5): 481-505.

https://doi.org/10.3945/an.113.004119

Kroenke, K., Spitzer, R.L., & Williams, J.B. (2001). The PHQ-9: Validity of a brief depression severity measure. *Journal of General Internal Medicine*, 16(9): 606-613.

https://doi.org/10.1046/j.1525-1497.2001.016009606.x

Kutner, M.H., Nachtsheim, C.J., Neter, J., & Wasserman, W. (2004). Applied Linear regression Models. Vol. 4. New York: McGraw-Hill/Irwin, p.563-568.

McClain, A.C., Xiao, R.S., Gao, X., Tucker, K.L., Falcon, L.M., & Mattei, J. (2018). Food insecurity and odds of high allostatic load in Puerto Rican adults: The role of participation in the supplemental nutrition assistance program during 5 years of follow-up. *Psychosomatic Medicine*, 80(8): 733-741.

https://doi.org/10.1097/PSY.0000000000000628

Nagata, J.M., Palar, K., Gooding, H.C., Garber, A.K., Whittle, H.J., Bibbins-Domingo, K., & Weiser, S.D. (2019). Food insecurity is associated with poorer mental health and sleep outcomes in young adults. *Journal of Adolescent Health*, 65(6): 805-811.

https://doi.org/10.1016/j.jadohealth.2019.08.010

Patel, V., Burns, J.K., Dhingra, M., Tarver, L., Kohrt, B.A., & Lund, C. (2018). Income inequality and depression: A systematic review and meta-analysis of the association and a scoping review of mechanisms. *World Psychiatry*, 17(1): 76-89.

https://doi.org/10.1002/wps.20492

Pound, C.M., & Chen, Y. (2021). Female sex and food insecurity in relation to self-reported poor or fair mental health in Canadian adults: A cross-sectional study using national survey data. *Canadian Medical Association Journal*, 9(1): E71-E78.

https://doi.org/10.9778/cmajo.20200112

Roberts, S.H., Bedson, E., Hughes, D., Lloyd, K., Menkes, D.B., Moat, S., Pirmohamed, M., Slegg, G., Thome, J., Tranter, R., Whitaker, R., Wilkinson, C., & Russell, I. (2007). Folate augmentation of treatment-evaluation for depression (FolATED): Protocol of a randomised controlled trial. *BMC Psychiatry*, 7(1): 65.

https://doi.org/10.1186/1471-244X-7-65

Searles, M., & Wong, R. (2022). Food insecurity and COVID-19 diagnosis: Findings from a national United States sample. *Journal of Hunger and Environmental Nutrition*, 1-16.

https://doi.org/10.1080/19320248.2022.2128961

Substance Abuse and Mental Health Services Administration. (2019). Key Substance Use and Mental Health Indicators in the United States: Results from the 2018 National Survey on Drug Use and Health. United States: Substance Abuse and Mental Health Services Administration. Available from: https://www.samhsa.gov/data/sites/default/files/cbhsq-reports/nsduhnationalfindingsreport2018/nsduhnationalfindingsreport2018.pdf [Last accessed on 2023 Dec 31].

Tarasuk, V., Cheng, J., Gundersen, C., de Oliveira, C., & Kurdyak, P. (2018). The relation between food insecurity and mental health care service utilization in Ontario. *The Canadian Journal of Psychiatry*, 63(8): 557-569.

https://doi.org/10.1177/0706743717752879

Tarasuk, V., Gundersen, C., Wang, X., Roth, D.E., & Urquia, M.L. (2020). Maternal food insecurity is positively associated with postpartum mental disorders in Ontario, Canada. *Journal of Nutrition*, 150(11): 3033-3040.

https://doi.org/10.1093/jn/nxaa240

USDA ERS-Food Security and Nutrition Assistance. (2022). Available from: https://www.ers.usda.gov/data-products/ag-and-food-statistics-charting-the-essentials/food-security-and-nutrition-assistance [Last accessed on 2022 Dec 26].

Wong, R., Gable, L., & Rivera-Núñez, Z. (2018). Perceived benefits of participation and risks of soil contamination in St. Louis urban community gardens. *Journal of Community Health*, 43(3): 604-610.

https://doi.org/10.1007/s10900-017-0459-8

ACCSCIENCE PUBLISHING

International Journal of Population Studies

RESEARCH ARTICLE

Population aging and immigration: Evidence from Japan

Mikiko Oliver*

Department of Demography, University of Texas at San Antonio, 501 W. César E. Chávez Boulevard, San Antonio, TX 78207, USA

Abstract

In Japan, the population of immigrants has been increasing sharply, while the population is aging rapidly. Therefore, Japan is chosen for a case study to examine the relationship between demographic change and immigration. Immigration is important to the growth of the labor force due to population aging and the decline in working age population. Existing studies generally support the hypothesis that a positive association exists between population aging and immigration, which is as aging population increases, the number of immigrants increases in industrialized countries. However, there remain uncertainties as to what age range of the population is considered to increase in the proportion of older people related to the positive association, and how population composition by age group is related to the immigration in Japan. This study examines how the population composition by age group is related to immigration in Japan by applying econometric methods for the period 1975 – 2019. The results indicate that a decrease in the ratio of the population aged 60 – 64 to the total population and an increase in the population aged 65 and over are associated with increases in the ratio of foreign resident population to the total population of Japanese nationals.

Keywords: Population aging; Older people; Labor force; Immigration; Immigrants; International migration; Japan

***Corresponding author:**
Mikiko Oliver
(mikikomoliver@gmail.com)

Citation: Oliver, M. (2023). Population aging and immigration: Evidence from Japan. *International Journal of Population Studies,* 9(1):18-29.
https://doi.org/10.36922/ijps.407

Received: November 11, 2022

Accepted: April 20, 2023

Published Online: May 15, 2023

1. Introduction

Japan is often described as an ethnically homogeneous nation. However, Japan is changing with more older people and more foreigners (BBC Worklife, 2018). The ratio of Japan's foreign resident population to the total population of Japanese nationals (F2J) more than tripled from 0.67% to 2.37% between 1975 and 2019, according to the data from the Statistics Bureau of Japan (2023a). At the same time, Japan's population is aging rapidly. Japan's population is aging much faster than any other countries (Higo, 2022). While the issue on population aging and immigration is a concern to both public and private sectors, it remains uncertain as to how population aging affects immigration. Existing studies generally support the hypothesis that a positive association exists between population aging and immigration, which is as aging population increases, the number of immigrants increases in industrialized countries (Australian Government Productivity Commission, 2006; Bijak *et al*., 2008; Denton & Spencer, 2015; Keely, 2008; Lutz *et al*., 2019). However, there remain uncertainties as to what age range population

is considered to increase the positive association. This study examines how demographic change measured by population composition by age group is related to population change in immigration in Japan by applying econometric methods for the period 1975 – 2019.

In the past few decades, the age distribution of the population of Japanese nationals (thereafter Japan's population) has shifted considerably with more people reaching advanced ages than ever before. In the future, the share of the population aged 65 and over (65+) is expected to increase from 28.9% in 2021 to 38.1% in 2060 according to recent demographic projections by the Statistics Bureau of Japan (2022). This change leads to a reduction in the share of the working age population and a supply shortage of qualified workers. The government is struggling to balance its own deeply conservative views on immigration with the need for new and younger workers (CNN, 2018). In 2018, Japan's law makers approved a bill to introduce new visa categories for foreign workers to address the shrinking workforce.

Immigration is considered to be preventing declines in the working age population. However, determining an optimal immigration policy is complex because economic, cultural, and security pressures all compete for political consideration (Congressional Research Service, 2009). To the question of how Japan should open its domestic labor market to foreign workers, former prime minister Koizumi responded that the "If [the foreign labor] exceeds a certain level, it is bound to cause a clash. It is necessary to consider measures to prevent it and then admit foreign workers as necessary. Just because there is a labor shortage does not mean we should readily allow [foreign workers] to come in" (Kashiwazaki & Akaha, 2006, p. 1). To devise an immigration policy under the conditions of population aging, it is important to know how different dimensions of population composition affect immigration. This study addresses this issue. To my knowledge, this study is the first empirical analysis to examine the relationship between population composition by age group and immigration in Japan.

1.1. A brief description of Japan's immigration and governance

In response to population aging and the decline in labor force population, Japan's government has introduced numerous policies and practices to increase more foreign workers. In the early 1990s, the number of South American *Nikkeijin* (Japanese origin) in Japan rose sharply, encouraged by the Revised Immigration Control Law of 1990. The majority of *Nikkeijin* workers are employed in the manufacturing sector. They are employed by labor contractors and dispatched to production lines, according to the Ministry of Justice. When an increasing number of Brazilian *Nikkeijin* began to come to Japan in the early 1990's, most of them were temporary guest workers who stayed in Japan for a few years and returned to their country of origin (Goto, 2007).

Following the revised law of 1990, the Japan International Training Cooperation Organization (JITCO) program was founded in 1991. JITCO (2023) explains that JITCO's main purpose is to promote the acceptance of foreign nationals, such as technical intern trainees and foreigners with specified skills and to contribute to the development of the international economic community.

In April 2019, Japan amended the immigration control law, reflecting a major shift in Japan's immigration policy. Under the act, lower-skilled and semi-skilled foreign workers are opened to enter Japan for a maximum period of 5 years. It is expected to attract around 345,000 workers in the next 5 years (Immigration Services Agency, Japan, 2019; Nippon.com, 2019).

Most recently, on April 21, 2023, the Japan's government has introduced a new and simplified system for granting visas to highly skilled professional foreign workers. The aim of this new policy is to attract more overseas talents to Japan by offering preferential treatment for those who meet certain conditions, such as having a master's degree and annual income of at least 20 million yen (USD 150,000) (Corporate Immigration Partners, 2023; Ministry of Foreign Affairs of Japan, 2023).

1.2. Literature review

1.2.1. Population aging and demographic transition

The rapid aging population in Japan has resulted in an increase in the number of persons near the retirement age, a decline in labor force participation, and an increase in labor shortage. Therefore, immigration is considered to be preventing declines in the working age population. A report from the United Nations (2000) noted that immigration is needed to prevent declines in the working age population in Japan.

Wilbur Zelinsky (1971) proposed that the hypothesis of the mobility transition that states the type of migration depends on its development level and its society type. It is linked to the demographic transition theory. Demographic change has a profound effect on society, and increasing the immigrant population is one response to these changes. It is difficult to explain Japan's immigration without introducing demographic transition.

The demographic transition theory was presented by Warren Thompson, Adolphe Laudry, Frank Notestein, and

Kingsley Davis (Davis, 1945; Kirk, 1996; Landry, 1987). The demographic transition theory is based on historical population trends that suggest a country's total population growth rate cycles through five stages and describes why the population is aging in the country. Demographic transition theories have arisen in response to the emergence of very low fertility in a collection of European and East Asian countries (Cooke *et al*., 2019). The first stage of the demographic transition was the pre-industrial stage. During this stage, both mortality and fertility rates were high. In stage two, decline in mortality rates began while fertility rates were high. In stage three, fertility rates decreased. In stage four, both mortality and fertility rates were low. Finally, population aging occurs.

The second demographic theory (SDT) was presented by Lesthaeghe & van de Kaa (1986), which is a description of post-baby boom family and fertility patterns in Western Europe (Zaidi & Morgan, 2017). SDT began in Europe after World War II, and SDT empirically observed decline in fertility to below the replacement level of fertility in European countries. The replacement level of fertility is the number of children that a woman must have to replace themselves in a generation, which ranges 2.1 – 2.4 (Siegel & Swanson, 2004). SDT addresses the changes in the patterns of reproductive behavior when women benefited from new birth control techniques. These changes and the increased role of women in society and the workforce affected the demographic profile in an area in industrialized countries resulting in below the replacement level of fertility. The demographic transition has brought momentous changes, reshaping the demographic life cycles of individuals and restructuring populations (Lee, 2003). In Japan, as a destination country, immigration has become an important feature for the labor force due to the decreasing fertility rates and increasing life expectancy.

1.2.2. Population aging and immigration

This section reviews the few studies related to this research, as empirical analyses of the relationship between population composition by age group and immigration in Japan applying econometric methods are lacking. Historically, Western countries, such as Australia, Canada, New Zealand, and the United States, have hosted a large number of immigrants, and more empirical analyses of immigration exist for those countries than for Japan. Hatton & Williamson (1998) applied econometric methods to a series of empirical studies of immigration of Europeans to Australia and the United States. They observed that immigration had a profound effect on the demographic and economic conditions in the receiving countries. In Australia, immigration is significant in the context of an aging population as a source of future labor supply and a prospect for economic growth (Australian Government Productivity Commission, 2006).

Several European countries are also experiencing population aging. In many industrialized countries, the demographic change results in an increasing number of retirees, a declining number of workers, and an increasing number of immigrants (Bijak *et al*., 2007; Denton & Spencer, 2015; Keely, 2008; Lutz *et al*., 2019; United Nations, 2020; 2022). Bijak *et al*. (2008) demonstrated that reasonable levels of immigration and increases in the fertility rate and labor force participation helped to meet the socioeconomic challenges posed by population aging. They additionally noted that the long-term consequences of population aging should be addressed by policy-makers in European countries. Recently, Ghio *et al.* (2022) demonstrated that despite the shrinking of the working age population in most EU countries, the positive net migration was able to counterbalance the deficit due to cohort turnover and generate an increase in the working age population for the period 2015 – 2019. This effect was particularly pronounced in urban area.

Further, Jakovljevic *et al.* (2018) forecasted the net number of migrants in EU 28 and its east and south near neighborhood for the period 2020 – 2050. They demonstrated that in EU 28, the net number of migrants will increase from –91,000 in 1950 to 394,000 in 2050. In contrast, in the European Neighborhood Policy (ENP) East countries, it will decrease from 3000 in 1950 to –30,000 in 2050; and in the ENP South countries, the change will be from –72,000 in 1950 to –138,000 in 2050. At the same time, they observed that EU region currently experiences most advanced stage of demographic aging. In ENP East region, the fertility has declined since late 1980s while in ENP South, population is younger compared to their northern counterparts.

1.2.3. Immigration and non-demographic factors

In addition to demographic factors, other factors also affect immigration. Economic development is associated with immigration (Borjas, 1994; Massey & Zenteno, 1999; Sanderson & Kentor, 2009). Morley (2006) analyzed causality between immigration and economic growth using data for Australia, Canada, and the United States for the period 1930 – 2002. The author found a long-run causal relationship from economic growth to immigration but not the reverse. Immigration is conditioned by levels of unemployment and wages in the Organization for Economic Co-operation and Development (OECD) countries (Damette & Fromentin, 2013). Islam (2007) found in Canada that host country's unemployment has a negative impact on immigration but found no

evidence of immigration causing higher average rates of unemployment.

1.2.4. Population by age group and dependency ratio

This section reviews the literature that links population by age group and dependency ratios, as these demographic factors are examined in this study. In the late 20th century, population composition became an issue for economic growth. Horioka (1997) showed that the age structure of the population had a substantial impact on economic growth in Japan. Similarly, Bloom & Williamson (1998), Lindh & Malmberg (1999), and Feyrer (2005) demonstrated that population composition by age group was related to economic growth in industrialized countries.

Due to population aging, the youth and old-age dependency ratio has been changing considerably. The dependency ratio is defined as "the ratio of the number of persons in a given dependent age group of interest to the number in a different age group considered to contain those persons providing support to those dependent" (Siegel & Swanson, 2004, p. 758). Siegel & Swanson (2004) noted that dependency ratios are a measure of the age structure of a population. They relate the number of individuals that are likely to be economically "dependent" on the support of others. Kogel (2005), using data from 70 countries for the period 1965 – 1990, observed that the youth dependency was negatively related to total factor productivity growth, and he pointed out that age structure affected the most important determinant of international differences in output per worker. The changes in the dependency ratio are creating significant policy challenges in some Asian countries (Ogawa, 2009). Therefore, including the population composition by age group or dependency ratio as an explanatory variable is important when examining immigration while a population is aging.

To summarize, existing studies generally support the hypothesis that a positive association exists between population aging and immigration in industrialized countries. However, there remain uncertainties as to what age range population is considered to increase in the proportion of older people related to the positive association, and how population composition by age group is related to the immigration in Japan. This study offers new evidence using a set of data on various age groups and control variables in Japan for the period 1975 – 2019.

1.3. Research hypotheses

Based on the evidence from previous research and literature presented above, the functional relationship can be expressed as:

$$\begin{aligned} &\textit{Foreign resident} \\ &\textit{population} \quad = f(\textit{Demographic condition,} \\ &\qquad\qquad\quad \textit{non-Demographic conditions}) \end{aligned} \tag{I}$$

The functional Equation I states that foreign resident population is a function of demographic condition and non-demographic condition.

Equation I can be extended to include the demographic and non-demographic factors previously identified in the literature. The growth equation of immigrants in this study is based on the Hatton & Williamson (1998) model and the previous research reviewed herein. Thus, a few modifications are added to their model. The main difference from the Hatton & Williamson (1998) model is that the net migration is replaced by the ratio of foreign resident population to the total population of Japanese nationals (F2J). The selections of the control variables are followed from the literature review as seen in the section above.

The regression Equation II of the model is:

$$\begin{aligned} \triangle \textit{Foreign residents}_t = \beta_0 + \beta_1 \triangle X_{1t-1} + \beta_2 \triangle X_{2t-1} \\ + \beta_3 \triangle X_{3t-1} + \varepsilon_t \end{aligned} \tag{II}$$

Where $\triangle$ is the annual percentage change in a variable, which is the annual growth rate of a variable; X_1 contains the ratio of population by age group to the total population, the youth dependency ratio or the old-age dependency ratio; X_2 contains the demographic condition represented by the total fertility rate (TFR); and X_3 contains the overall economic condition represented by the unemployment rate and hourly earnings of manufacturing; t is the time index. The data set consists of annual series; thus, $t–1$ suggests 1 year before present.

The two main alternative hypotheses (H) are

H_1: An increase in the population by age group is associated with an increase or a decrease in the number of foreign residents.

H_2: An increase in the dependency ration is associated with an increase or a decrease in the number of foreign residents.

To test H_1 and H_2, this study examines the independent contribution of each age group and the dependency ratio to the change in the foreign resident population.

2. Data and methods

2.1. Data

The data consist of annual series for Japan for the period 1975 – 2019. All variables are quantitative with annual average values measured by indices. The dependent

variable is the ratio of foreign resident population to the total population of Japanese nationals (F2J). The independent variables include the ratio of population by age group to the total population (the term population refers to Japanese nationals unless otherwise stated), youth dependency ratio or old-age dependency ratio. The control variables include the TFR, unemployment rate, and hourly earnings of manufacturing.

The data on the registered foreign residents population were obtained from the Ministy of Justice, Japan. Foreign residents' registration is a system used to record information regarding foreign resident in Japan. Foreigners staying in Japan more than 90 days (tourists and persons who stay in Japan with a status of residence of "temporary visitor" are exempted) are required to register. Therefore, the number of registered foreign residents is a good proxy to measure Japan's immigrants.

The population data by age group were obtained from the Statistics Bureau of Japan. Japan's population age groups rely on historical birth registration, death registration, estimates of migration into Japan, and residence record system such as a *Juminhyo* system, which is a registry of current registered addresses maintained by the municipal governments. Japanese and foreign residents are required to report their addresses and related matters to their municipal governments, who then compile the information for tax, insurance, and census purposes.

The age groups for this study are as follows: Ages 15 – 24, 25 – 34, 35 – 44, 45 – 54, 55 – 59, 60 – 64, and 65+ years old. For the ages between 55 and 64, 5-year age groups of 55 – 59 and 60 – 64 are included, because the 55 – 59 and 60 – 64 are the later working years, but the 60 – 64 is also early retirement ages.

The youth dependency ratio and old-age dependency ratio were calculated using the population by age group. The youth dependency ratio at a given time is expressed in percentage form as (population aged 0 – 14/population aged 15 – 64) × 100. The old-age dependency ratio at a given time is expressed in percentage form as (population aged 65+/population aged 15 – 64) × 100.

The data on the TFR come from the Ministry of Health, Labor and Welfare, Japan. The definition of the TFR is the average number of children born to a woman in her lifetime (Siegel, 2002). TFR helps us project if a population size will increase, decrease, or stabilize over time. When the TFR is greater than 2.1, the population in a given area will increase if there is no out-migration. On the other hand, when the TFR is less than 2.1, the population in a given area will eventually decrease provided that there is no in-migration. As the demographic transition theory and the SDT theory show, fertility is the principal determinant of the age structure of a population, as noted in Section 1.2.1.

The data on the unemployment rate come from the Statistics Bureau of Japan. The unemployment rate represents the number of unemployed people as a percentage of the labor force. Therefore, the rate is the most commonly used indicator for understanding conditions in the labor market and the economy's growth rate.

The data on the hourly earnings of manufacturing were obtained from the OECD. Goto (2007) observed that the majority of *Nikkeijin* foreign workers were employed in the manufacturing sector, as noted in Section 1.1. It is possible that the hourly earnings of manufacturing are related to immigration in Japan.

2.2. Methods

The empirical analyses in this study consist of the following steps: (i) Graphical analysis, (ii) Augmented Dickey-Fuller (ADF) unit test, (iii) Pearson's correlation, and (iv) an ordinary least-squares (OLS) regression.

A regression analysis that contains non-stationary variables may produce misleading results. Therefore, ADF unit root test was employed to determine whether the time series were stationary. The precise definition of stationary is that "the distribution of the time series variable does not change over time" (Stock & Watson, 2003, p. 446). If there are unit roots which are stochastic trends, the series is not stationary. If there are no unit roots, then the series is stationary.

Pearson's correlation analysis was performed to describe the strength and direction of the linear relationship between the foreign residents and explanatory variables. In the next step, OLS regression was applied to analyze the relationship between a single dependent variable and several independent variables, while the other variables were held constant.

3. Results

3.1. Initial results

Figures 1A–C provide the time-series plots of trends in demographic variables. In the figures, the x-axis represents the year from 1975 to 2019. In the figures, the number of foreign residents decreased sharply in 2011 due to the tsunami on March 11, 2011. Figure 1A shows the fertility rate decreased from 1.8 in 1984 to 1.3 in 2005, then started to rebound in 2006, and then began to decrease in 2016. The ratio of foreign resident population to the total population of Japanese nationals (F2J) seems to move negatively with the fertility rate between 1975 and 2005. While the fertility rate trended downward, the F2J trended upward. The mean TFR of 1.517 was below the replacement level of fertility.

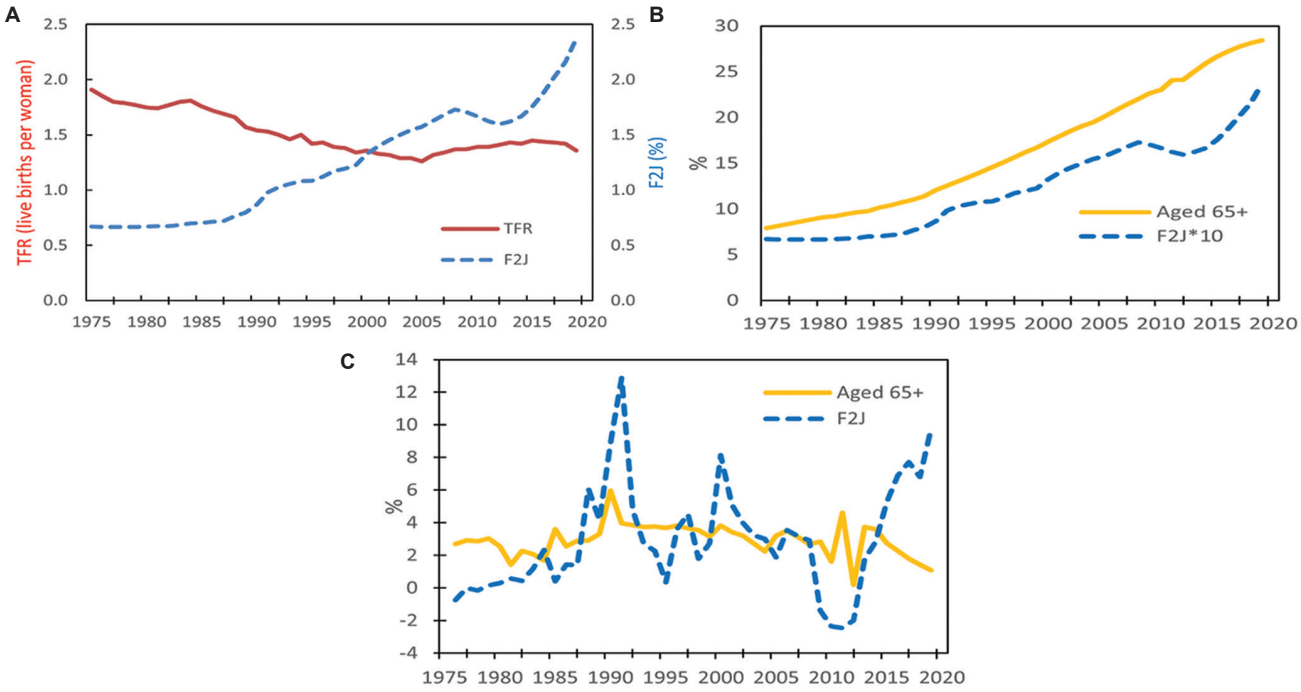


Figure 1. Trends in demographic variables, Japan, 1975 – 2019

Note: In Figures 1A-C, the x-axis represents the year; "F2J" stands for the ratio of the foreign resident population to the total population of Japanese nationals; the number of foreign residents decreased sharply in 2011 due to the tsunami on March 11, 2011. In Figure 1B, F2J was multiplied by 10 to make the scales comparable.

Sources: A: Ministry of Health, Labor and Welfare, Japan (2020); A, B, C: Ministry of Justice, Japan (2020); A, B, C: Statistics Bureau of Japan (2000–2020).

(A) Total fertility rate (TFR) and the ratio of foreign resident population to the total population of Japanese nationals (F2J), 1975–2019

(B) Proportion of population aged 65 and over and the ratio of F2J, 1975–2019

(C) The annual growth rates of the proportion of population aged 65 and over and F2J, 1975–2019

In Figure 1B, the F2J was multiplied by 10 to make the scales comparable. It appears that the population aged 65+ and the F2J co-move rather closely for the period 1975 – 2008. Figure 1C shows that for the period 1987 – 2011, the annual growth rates of population aged 65+ and F2J appear to move simultaneously and closely.

3.2. Unit root test

The unit root tests are shown in Table 1. The calculations are done using the ADF test with a constant, and the Schwarz's Bayesian Criterion (SBC) was used to select the optimal lag for the model from a set of lags that contained up to 9 lags. The results in Table 1 show that the series are stationary at rather significant levels.

3.3. Analyses of correlation coefficients

Correlation coefficients reported in Table 2 indicate that at a 0.1 significance level, there exists a positive relationship between the number of foreign residents and the population aged $65+_{t-1}$, while there exist negative relationships between the number of foreign residents and the population aged $35-44_{t-1}$ and $60-64_{t-1}$. The positive coefficient sign for the 65+ age group $_{t-1}$ was as expected. In addition, there exists a negative relationship between the foreign residents and the TFR_{t-1} and the unemployment $rate_{t-1}$.

3.4. Main results

The main results from the regression methods are reported in Table 3. Each model reports the coefficients from different regression specifications, thus: (i) In Model 1, the ratio of population by age group represents as the independent variable; and (ii) in Models 2 and 3, the youth dependency ratio or old-age dependency ratio represents as an independent variable. During the regression procedure, the variables for which the coefficients were not significant at a 0.05 level and/or exhibited from multicollinearity were excluded from the study.

Table 1. Augmented Dickey–Fuller (ADF) unit root test for core independent and dependent variables annual percentage change, Japan, 1975 – 2019

Series	ADF
Ratio of foreign resident population to the total population[a]	−2.675 (0.078)*
Ratio of the population aged 15 – 24 to the total population, 15 – 24_{t-1}	−4.028 (0.015)**
Ratio of the population aged 25 – 34 to the total population, 25 – 34_{t-1}	−5.854 (0.000)****
Ratio of the population aged 35 – 44 to the total population, 35 – 44_{t-1}	−6.193 (0.000)****
Ratio of the population aged 45 – 54 to the total population, 45 – 54_{t-1}	−3.545 (0.018)**
Ratio of the population aged 55 – 59 to the total population, 55 – 59_{t-1}	−3.575 (0.010)**
Ratio of the population aged 60 – 64 to the total population, 60 – 64_{t-1}	−3.242 (0.031)**
Ratio of the population aged 65+to the total population, $65+_{t-1}$	−5.196 (0.000)****
Youth dependency $ratio_{t-1}$	−1.972 (0.047)**
Old-age dependency $ratio_{t-1}$	−7.026 (0.000)****
Total fertility $rate_{t-1}$	−2.795 (0.068)*
Unemployment $rate_{t-1}$	−3.556 (0.011)**
Hourly earnings of $manufacturing_{t-1}$	−4.234 (0.001)***

Note: [a]Total population refers to Japanese nationals, and the same for age groups; The Schwarz's Bayesian Criterion (SBC) was used to select the optimal lag for the model from a set of lags that contained up to 9 lags; t statistics with the associated p values in parentheses; *p<0.1, **p<0.05, ***p<0.01, ****p<0.001.
Sources: Ministry of Health, Labor and Welfare, Japan (2020); Ministry of Justice, Japan (2020); OECD (2020); Statistics Bureau of Japan (2000 – 2020).

In Model 1, the results indicate that at a 0.05 significance level, the population aged 60 – 64_{t-1} is negatively related to the foreign resident population, while the population aged $65+_{t-1}$ is positively related to the number of foreign residents when other variables are held constant. The estimated signs are consistent with the results from the correlation analyses. The coefficient for the population aged $65+_{t-1}$ is 1.018. This means that a 1% increase in the population aged 65+ of 1 year prior is associated with a 1.018% increase in the foreign residents when other variables are held constant. However, there was not sufficient evidence that the populations from 15 – 24_{t-1}, 25 – 34_{t-1}, 35 – 45_{t-1}, 45 – 54_{t-1}, and 55 – 59_{t-1} age groups are correlated to the number of foreign residents, as the significant level of these age groups did not reach 0.05 and thus they were excluded from the final model.

In Models 2 and 3, the estimated coefficients for the youth dependency $ratio_{t-1}$ and the old-age dependency $ratio_{t-1}$ are not statistically significant at a 0.05 significance level when other variables were held constant. In Model 2, the results indicate that there is no robust evidence to reject the null hypothesis namely, that a change in the youth dependency $ratio_{t-1}$ is not associated with a change in the number of foreign residents and accept alternative hypothesis that a change in the youth dependency $ratio_{t-1}$ is associated with a change in the number of foreign residents. Similarly, in Model 3, the null hypothesis of the old-age dependency $ratio_{t-1,}$ namely, that a change in the old-age dependency $ratio_{t-1}$ is not associated with a change in the number of foreign residents, was not rejected. Therefore, there is not strong evidence that the youth dependency ratio and the old-age dependency ratio of 1 year prior are associated with the ratio of foreign resident population to the total population of Japanese nationals (F2J).

Table 2. Pearson's correlation coefficient between the ratio of foreign resident population to the total population of Japanese nationals $(F2J)_t$ and explanatory $variable_{t-1}$, annual percentage change, Japan, 1975 – 2019

Variable	Coefficients
$15 – 24_{t-1}$ [a]	0.241
$25 – 34_{t-1}$	0.010
$35 – 44_{t-1}$	−0.320**
$45 – 54_{t-1}$	−0.021
$55 – 59_{t-1}$	0.196
$60 – 64_{t-1}$	−0.367**
$65+_{t-1}$	0.274*
Youth dependency $ratio_{t-1}$	−0.213
Old-age dependency $ratio_{t-1}$	0.075
Total fertility $rate_{t-1}$	−0.261*
Unemployment $rate_{t-1}$	−0.352**
Hourly earnings of $manufacturing_{t-1}$	−0.094

Note: [a]15 – 24t–1 refers to the ratio of the population aged 15 – 24 to the total Japanese nationals at time–1, and the same for other age groups; *p<0.1, **p<0.05, ***p<0.01 (two-tailed).
Sources: Ministry of Health, Labor and Welfare, Japan (2020); Ministry of Justice, Japan (2020); OECD (2020); Statistics Bureau of Japan (2000 – 2020).

In addition, in Models 1–3, the signs for the fertility $rate_{t-1}$ and unemployment $rate_{t-1}$ are negative. The finding for the unemployment rate is consistent with the results of Islam (2007) who found in Canada that host country's unemployment has a negative impact on immigration.

4. Discussion

The population of immigrants in Japan has been increasing sharply recent decades, while the population is aging rapidly.

Table 3. Coefficients of the variables from ordinary least squares regression models, Japan, 1975-2019

Explanatory variables (% change)	Model 1	Model 2	Model 3
Intercept	0.369 (0.239)	2.604 (4.039)***	3.116 (2.395)*
Aged 60 – 64_{t-1}	–0.304 (–2.163)*	-	-
Aged $65+_{t-1}$	1.018 (2.203)*	-	-
Fertility $_{t-1}$	–0.437 (–2.044)*	–0.478 (–2.230)*	–0.505 (–2.224)*
Unemployment $_{t-1}$	–0.122 (–2.516)*	–0.141 (–2.902)**	–0.122 (–2.304)*
Hourly earnings $_{t-1}$	–0.198 (–1.392)	–0.312 (–2.129)*	–0.253 (–1.569)
Youth dependency ratio$_{t-1}$	-	–0.515 (–1.898)	-
Old-age dependency ratio$_{t-1}$	-	-	0.056 (0.172)
p-value on joint	0.001	0.006	0.047
R^2	0.422	0.321	0.220
Adjusted R^2	0.343	0.245	0.134

Note: Dependent variable: ratio of foreign resident population to the total population of Japanese nationals (F2J) t, annual percentage change; t statistics are in parentheses; *p<0.05, **p<0.01, ***p<0.001 (two-tailed).
Sources: Ministry of Health, Labor and Welfare, Japan (2020); Ministry of Justice, Japan (2020); OECD (2020); Statistics Bureau of Japan (2000 – 2020).

Existing studies generally support the hypothesis that as aging population increases, the number of immigrants increases. However, it is not clear how different dimensions of population composition affect immigration. Therefore, this study examined how demographic change measured by population by age group is related to immigration in Japan for the period 1975 – 2019.

Several results from this study merit discussion. First, the results from the OLS analysis indicate that an increase in the ratio of the population aged 60 – 64 to the total population of 1 year prior is associated with a decrease in the ratio of foreign resident population to the total population of Japanese nationals (F2J). This age group is in the transition period from the workforce into retirement. The first possible for the negative relationship result is that a growing number of people aged 60 – 64 is still working. The labor force participation rate of people aged 60 – 64 increased from 60.6% in 2012 to 75.3 in 2022 (Statistics Bureau of Japan, 2023b). The second possible reason is that this particular age group has a higher level of productivity. A report from the WHO Commission on Macroeconomics and Health (2002) found that older workers have cumulated more work experience, which increases their productivity. Viviani *et al.* (2021) compared productivity in older versus younger workers and found that older workers performed better than younger workers, but had more absenteeism. These reasons could partly account for why this study found that an increase in the population aged 60 – 64 of 1 year prior is associated with a decrease in the number of foreign residents. Further studies are needed to better understand this negative relationship.

Second, the results show that an increase in the ratio of population aged 65+ to the total population of 1 year prior is associated with an increase in the ratio of foreign resident population to the total population of Japanese nationals (F2J). This finding indicates that the demographic change results in an increasing number of retirees, a declining number of workers, and an increasing number of immigrants. Over the next 30 years, the share of the population aged 65+ is expected to increase. Consequently, the number of foreign residents is also expected to increase.

Third, immigration can be considered to be preventing declines in the working age population. However, many Asian countries from where Japan's foreign workers originate are also likely to face the shortage of the future supply labor due to reductions in fertility. For example, in 2020, according to the Ministry of Health, Labor and Welfare, Japan (Asahi Shimbun, 2021), over 60% of foreign workers in Japan were from China, Vietnam, and the Philippines. Yet, the total fertility rate decreased from 3.57 in 1975 to 1.28 in 2020 for China, from 5.64 in 1975 to 1.95 in 2020 for Vietnam, and from 5.60 in 1975 to 2.77 in 2020 for the Philippines (United Nations, 2022b). Concerns have already been raised about the labor force shortages in China (Wu, 2016), and there may also have some concerns about the labor force shortage in Vietnam in the coming decades (Bartels, 2023). As the population is expected to grow older in Japan in the future (United Nations, 2022b), it will create new challenges for policymakers. Therefore, Japan has to identify other ways to increase labor force participation. The results from this study indicate that in Japan, an increase in the total fertility rate is associated with a decrease in the foreign resident population. Thus, increasing Japan's total fertility rate is still important to improve the labor market.

Finally, this study has limitations. The number of registered foreign residents was used to measure immigrants, because

the historical immigration data including unauthorized immigrants were not available. Accurate immigration data are difficult to obtain (Disney *et al*., 2015; Raymer *et al*., 2013; Sardoschau, 2020). Furthermore, the relationships found in this study do not imply the relationships between demographic change and the overall international migration, as the overall international migration includes international out-migration or emigration. Furthermore, the relationships found in this study do not imply a causal relation from demographic change to immigration change, as the main purpose of this study was to examine the relationship between demographic change and immigration change. More research is clearly warranted to shed light on the theme.

5. Conclusions

This study examined how population composition is related to population change, specifically immigration to Japan for the period 1975 – 2019. The results indicate that an increase in the ratio of the population aged 60 – 64 to the total population of 1 year prior is associated with a decrease in the ratio of foreign resident population to the total population of Japanese nationals, while an increase in the ratio of the population aged 65+ to the total population of 1 year prior is associated with an increase in the ratio of foreign resident population to the total population of Japanese nationals. A 1% increase in the population aged 65+ of 1 year prior is associated with a 1.018% increase in the foreign resident population.

In addition, the results indicate that decreases in the total fertility rate and unemployment rate of 1 year prior are associated with increases in the number of foreign national residents.

Increases in the share of the population aged 65+, until approximately 2050, seem to be unavoidable. This increase is likely to lead to labor shortages. In the short-term, an increase in the labor force can be accomplished by obtaining further labor forces from abroad. However, a number of the Asian countries from where these foreign workers originate are also likely to face domestic labor shortages in future. Alternatively, decreases in the total fertility rate are avoidable. The labor force can be increased long-term by increasing the total fertility rate. Policies to increase the total fertility rate are still important to improve the labor market.

To conclude, population composition plays a central role in determining Japan's immigration. Some methods to determine an immigration policy for balancing labor supply include focusing on the population aged 60 – 64 and 65+ because they are related to immigration in Japan.

Acknowledgments

I would like to express my appreciation to Dr. Gabriela Sánchez-Soto, anonymous reviewers, and the editor. This study could not have been accomplished without their suggestions and comment.

Funding

None.

Conflict of interest

The author has no conflicts of interest to declare.

Author contributions

This is single-authored article

Ethics approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

Availability of data

In this empirical analysis, publicly available secondary data were used.

References

Asahi Shimbun. (2021). Foreign workers in Japan hit record in 2020 despite COVID-19. Available from: https://www.asahi.com/ajw/articles/14149062 [Last accessed on 2023 Apr 07].

Australian Government Productivity Commission. (2006). Economic Impacts of Migration and Population Growth. Melbourne, Australia: Productivity Commission Position Report. Available from: https://apo.org.au/sites/default/files/resource-files/2006-01/apo-nid2795.pdf [Last accessed on 2023 Apr 07].

Bartels J. (2023). Summary of Vietnam's Labor Market in 2022. Business Information Industry Association. Available from: https://www.biia.com/summary-of-vietnams-labor-market-in-2022/ [Last accessed on 2023 Apr 28].

BBC Worklife. (2018). More Seniors, More Foreigners: How Japan is Changing. Available from: https://www.bbc.com/worklife/article/20181210-more-seniors-more-foreigners-how-japan-is-rapidly-changing [Last accessed on 2023 Apr 07].

Bijak, J., Kupiszewska, D., & Kupiszewski, M. (2008). Replacement migration revised: Simulations of the effects of selected population and labor market strategies for the aging Europe 2002-2052. *Population Research and Policy Review*, 27(3): 321-342.

Bijak, J., Kupiszewska, D., Kupiszewski, M., Saczuk, K., & Kicinger, A. (2007). Population and labour force

projections for 27 European countries, 2002-2052: Impact of International Migration on Population Ageing. *European Journal of Population*, 23(1): 1-31.

https://doi.org/10.1007/s10680-006-9110-6

Bloom, D.E., & Williamson, J.G. (1998). Demographic transitions and economic miracles in emerging Asia. *World Bank Economic Review*, 12(3): 419-455.

https://doi.org/10.1093/wber/12.3.419

Borjas, G. (1994). The economics of immigration. *Journal of Economic Literature*, 32(4): 1667-1717.

CNN. (2018). Japan Needs Immigrants, but Do Immigrants Need Japan? Available from: https://www.cnn.com/2018/12/06/asia/japan-immigration-bill-foreign-workers/index.html [Last accessed on 2023 Apr 07].

Congressional Research Service. (2009). Policy Challenges in International Migration. USA: CRS Report for Congress. Available from: https://www.everycrsreport.com/files/20090811_r40753_d72d874d59203d936e53ae2a2ddda83891e6b969.pdf [Last accessed on 2023 Apr 07].

Cooke, T.J., Wright, R., & Ellis, M. (2018). A prospective on Zellinsky's hypothesis of the mobility transition. *Geographical Review*, 108: 503-522.

https://doi.org/10.1111/gere.12310

Corporate Immigration Partners. (2023). Japan: New Highly Skilled Professional Visa Routes in April 2023. Available from: https://corporateimmigrationpartners.com/japan-new-highly-skilled-professional-visa-routes-in-april-2023/ [Last accessed on 2023 Apr 28].

Damette, O., & Fromentin, V. (2013). Migration and labour markets in OECD countries: A panel co-integration approach. *Applied Economics*, 45(16): 2295-2304.

https://doi.org/10.1080/00036846.2012.661400

Davis, K. (1945). The world demographic transition. *The Annals of the American Academy of Political and Social Science*, 237(1): 1-11. http://dx.doi.org/10.1177/000271624523700102

Denton, F.T., & Spencer, B.G. (2015). A simulation analysis of the long-term effects of immigration on per capita income in an aging population. *International Journal of Population Studies*, 1(1): 75-93.

https://doi.org/10.18063/ijps.2015.01.006

Disney, G., Wiśniowski, A., Forster, J.J., Smith, P.W.F., & Bijak, J. (2015). Evaluation of Existing Migration Forecasting Methods and Models. Report for the Migration Advisory Committee: Commissioned Research. United Kingdom: ESRC, Centre for Population Change, University of Southampton. Available from: https//www.research.manchester.ac.uk/portal/files/32468230/full_text.pdf [Last accessed on 2023 Apr 07].

Feyrer, J. (2005). Demographics and productivity. *The Review of Economics and Statistics*, 89(1): 100-109.

https://doi.org/10.1162/rest.89.1.100

Ghio, D., Goujon, A., & Natale, F. (2022). Assessing the demographic impact of migration on the working age population across European territories. *Demographic Research*, 46(9): 261-272.

https://doi.org/10.4054/DemRes.2022.46.9

Goto, J. (2007). Latin America of Japanese Origin (Nikkeijin). World Bank Policy Research Working Paper, No. 4203. Japan: Research Institute for Economics and Business Administration, Kobe University.

Hatton, T.J., & Williamson, J.G. (1998). The Age of Mass Migration: Causes and Economic Impact. New York: Oxford University Press.

Higo, M. (2022). Japan's death-laden society: Five areas of prospective policy challenges. *International Journal of Population Studies*, 8(2): 15-24.

https://doi.org/10.36922/ijps.v8i2.301

Horioka, C.Y. (1997). A cointegration analysis of the impact of the age structure of the population on the household saving rate in Japan. *The Review of Economics and Statistics*, 79(3): 511-516.

https://doi.org/10.1162/rest.1997.79.3.511

Immigration Services Agency. (2019). Immigration Control and Residency Management. Japan: Immigration Services Agency. Available from: https://www.moj.go.jp/isa/content/930004564.pdf [Last accessed on 2023 Apr 07].

Islam, A. (2007). Immigration unemployment relationship: The evidence from Canada. *Australian Economic Papers*, 46(1): 52-66.

https://doi.org/10.1111/j.1467-8454.2007.00305.x

Jakovljevic, M.M., Netz, Y., Buttigieg, S.C., Adany, R., Laaser, U., & Varjacic, M. (2018). Population aging and migration-history and UN forecasts in the EU-28 and its east and south near neighborhood-one century perspective 1950-2050. *Globalization and Health*, 14: 30.

https://doi.org/10.1186/s12992-018-0348-7

Japan International Training Cooperation Organization (JITCO). (2023). About the Japan International Trainee and Skilled Worker Cooperation Organization. Available from: https://www.jitco.or.jp/en/jitco/index.html [Last accessed on 2023 Apr 07].

Kashiwazaki, C., & Akaha, T. (2006). Japanese Immigration Policy: Responding to Conflicting Pressures. United States: Migration Policy Institute. Available from: http://www.migrationpolicy.org/article/japanese-immigration-policy-responding-conflicting-pressures [Last accessed on 2023 Apr 07].

Keely, C. (2008). Replacement of migration: The wave of the future? *International Migration*, 39(6): 103-110.

https://doi.org/10.1111/1468-2435.00181

Kirk, D. (1996). Demographic transition theory. *Population Studies*, 50(3): 361-387.

https://doi.org/10.1080/0032472031000149536

Kogel, T. (2005). Youth dependency and total factor productivity. *Journal of Development Economics*, 76(2005): 147-173.

https://doi.org/10.1016/j.jdeveco.2003.11.003

Landry, A. (1987). Adolphe landry on the demographic revolution. *Population and Development Review*, 13(4): 731-740.

https://doi.org/10.2307/1973031

Lee, R. (2003). The demographic transition: Three centuries of fundamental change. *Journal of Economic Perspective*, 17(4): 167-190.

https://doi.org/10.1257/089533003772034943

Lesthaeghe, R., & Kaa, D. (1986). Second Demographic Transition. Population: Growth and Shrinkage. Deventer: Van Loghum Slaterus, p. 9-24.

Lindh, T., & Malmberg, B. (1999). Age distributions and the current account: A changing relation? In: Prskawetz, A., & Lindh, T., (eds). The Relationship between Demographic Change and Economic Growth in the EU. Wien, Austria: Austrian Academy of Sciences Press, p. 42-49.

Lutz, W., Amran, G., Belanger, A., Conte, A., Gailey, N., & Ghio, D., Erofili, G., Kathrine, J., Elke, L., Guillaume, M., Raya, M., Michaela, P., Patrick, S., Marcin, S. (2019). Demographic Scenarios for the EU, EUR 29739 EN. Luxembourg: Publications Office of the European Union. Available from: https://publications.jrc.ec.europa.eu/repository/handle/JRC116398 [Last accessed on 2023 Apr 07].

Massey, D.S., & Zenteno, R.M. (1999). The dynamics of mass migration. *Proceedings of the National Academy of Sciences of the United States of America*, 96(9): 5328-5335.

https://doi.org/10.1073/pnas.96.9.5328

Ministry of Foreign Affairs of Japan. (2023). Visa. Available from: https://www.mofa.go.jp/j_info/visit/visa/long/index.html [Last accessed on 2023 Apr 28].

Morley, B. (2006). Causality between economic growth and immigration: An ARDL bounds testing approach. *Economics Letters*, 90(1): 72-76.

https://doi.org/10.1016/j.econlet.2005.07.008

Nippon.com. (2019). Japan's Historic Immigration Reform: A Work in Progress. Available from: https://www.nippon.com/en/in-depth/a06004/japan%E2%80%99s-historic-immigration-reform-a-work-in-progress.html [Last accessed on 2023 Apr 07].

Ogawa, N. (2009). Comment on "long-term forecast of the demographic transition in Japan and Asia. *Asian Economic Policy Review*, 4: 39-42.

https://doi.org/10.1111/j.1748-3131.2009.01104.x

Raymer, J., Wiśniowski, A., Forster, J., Smith, P.W.F., & Bijak, J. (2013). Integrated modeling of European migration. *Journal of the American Statistical Association*, 108(503): 801-819.

https://doi.org/10.1080/01621459.2013.789435

Sanderson, M.R., & Kentor, J.D. (2009). Globalization, development and international migration: A cross-national analysis of less-developed countries, 1970-2000. *Social Forces*, 88(1): 301-336.

https://doi.org/10.1353/sof.0.0225

Sardoschau, S. (2020). The Future of Migration to Germany: Assessing Methods in Migration Forecasting. Research Report. Berlin, Germany: DeZIM Institute.

Siegel, J. (2002). Applied Demography. San Diego, CA: Academic Press.

Siegel, J.S., & Swanson, D.A. (2004), The Methods and Materials of Demography. 2nd ed. San Diego: Elsevier Academic Press.

Statistics Bureau of Japan. (2022). Statistical Hand Book of Japan. Tokyo, Japan: Statistics Bureau of Japan. Available from: https://www.stat.go.jp/english/data/handbook/pdf/2022all.pdf#page=1 [Last accessed on 2023 Apr 07].

Statistics Bureau of Japan. (2023a). Search Statistics Surveys and Data. Available from: https://www.stat.go.jp/english [Last accessed on 2023 Apr 07].

Statistics Bureau of Japan. (2023b). Summary Tables. Available from: https://www.stat.go.jp/english/data/roudou/results/month/index.html [Last accessed on 2023 Apr 07].

Stock, J.H., & Watson, M.W. (2003). Introduction to Econometrics. Boston: Addison Wesley.

United Nations. (2000). New Report on Replacement Migration Issued by UN Population Division. New York, USA: Press Release, DEV/2234, POP/735.

United Nations. (2020). International Migration 2020 Highlights. Department of Economic and Social Affairs, Population Division. New York, NY, USA: United Nations Publications. Available from: https://www.un.org/development/desa/pd/sites/www.un.org.development.desa.pd/files/undesa_pd_2020_international_migration_highlights.pdf [Last accessed on 2023 Apr 07].

United Nations. (2022a). World Population Prospects 2022: Summary of Results. Department of Economic and Social Affairs, Population Division. New York, NY, USA: United Nations Publications. Available from: https://www.un.org/development/desa/pd/sites/www.un.org.development.desa.pd/files/w/pp2022summary_of_results.pdf [Last accessed on 2023 Apr 07].

United Nations (2022b). World Population Prospects 2022. Available from: https://population.un.org/wpp/Download/Standard/MostUsed [Last accessed on 2023 Apr 07].

Viviani, C.A., Bravo, G., Lavallière, M., Arezes, P.M., Martinez, M.,

Dianat, I., Bragança, S., Castellucci, H.I. (2021). Productivity in older versus younger workers: A systematic literature review. *Work*, 68(3): 577-618.

https://doi.org/10.3233/wor-203396

WHO Commission on Macroeconomics and Health. Working Group 1 & World Health Organization. (2002). Health, Economic Growth and Poverty Reduction: the Report of Working Group I of the Commission on Macroeconomics and Health. Geneva, Switzerland: World Health Organization.

World Bank. (2023). Fertility Rate, Total (Births per Woman). Washington, D.C.: World Bank. Available from: https://genderdata.worldbank.org/indicators/sp-dyn-tfrt-in [Last accessed on 2023 Apr 07].

Wu, Y. (2016). China's labor market: Shrinking workforce, rising wages. China Daily. Available from: https://www.chinadaily.com.cn/china/2016-11/21/content_27444998.htm [Last accessed on 2023 Apr 28].

Zaidi, B., & Morgan, S.P. (2017). The second demographic transition theory: A review and appraisal. *Annual Review of Sociology*, 43: 473-492.

https://doi.org/10.1146/annurev-soc-060116-053442

Zelinsky, W. (1971). The hypothesis of the mobility transition. *Geographic Review*, 61(2): 219-249.

https://doi.org/10.2307/213996

ACCSCIENCE PUBLISHING

International Journal of Population Studies

RESEARCH ARTICLE

Shouting *"chin min yau lok"* (stop at the front) in a minibus: Transportation assimilation among immigrants in Hong Kong

Skylar Biyang Sun[1], Xiaohang Zhao[2]*, and Guixiang Zhang[3]

[1]School of International Development and Cooperation, University of International Business and Economics, Beijing, China

[2]National Institute of Social Development, Chinese Academy of Social Sciences, Beijing, China

[3]School of Law, Guizhou University, Guizhou, China

Abstract

Transportation socialization as a rising field of study has gained much attention in traditional immigration countries, such as the United States and European countries. Treating transportation behaviors as a routine activity, previous studies mainly looked at the discrepancy in transportation choices between immigrants and natives, for example, automobile usage in the U.S. By examining immigrants' minibus ridership in Hong Kong (a unique local public transportation service) and extending the previous theoretical thread on spatial assimilation, this study expands the social and geographical scope of transportation assimilation to a non-traditional immigration region and further tests the applicability of general immigration theory on transportation socialization. Capitalizing on a large sample of pooled census data, we are the first to explore the changing pattern of immigrants' transportation socialization in Hong Kong and Asia. By looking at the transportation assimilation through individual and locational level factors, we found the pattern in Hong Kong to be generally in line with the previous studies in traditional immigration countries on the individual level but not on the locational level.

Keywords: Transportation socialization; Hong Kong; Minibus; Immigration; Assimilation

***Corresponding author:**
Xiaohang Zhao
(xiaohangzhao510@gmail.com)

Citation: Sun, S.B., Zhao, X., & Zhang G. (2023). Shouting "*chin min yau lok*" (stop at the front) in a minibus: Transportation assimilation among immigrants in Hong Kong. *International Journal of Population Studies,* 9(1):30-50.
https://doi.org/10.36922/ijps.0386

Received: April 2, 2023

Accepted: April 27, 2023

Published Online: May 18, 2023

1. Introduction

Traditional studies on immigrant integration often focus on economic, social, and spatial integration. Social integration often looks at intergroup communications, which would require direct interaction between immigrants and locals. While direct interaction provides strong evidence for boundary-crossing for immigrants, some less mentioned frequent participation in locals' daily routine also provides information on immigrants' adaption. Concerning this, transportation assimilation offers a leading example in this field. Exploring transportation assimilation in Hong Kong, in other words, immigrants' likelihood of choosing minibus for work journeys, this research is the first to look at transportation assimilation in a non-western society.

The long-established mobility culture within each geographical region works smoothly with local residents who learned and grew with the culture throughout their

lives. While they may consider the culture completely as a norm, it can create dizzy feelings for outsiders who first arrived from a dramatically different geographical context with different commuting behaviors. At this moment, transportation studies intersect with immigration studies in which immigrants' adaption to natives' commuting behaviors represents the formers' transportation assimilation, a rising field in immigration studies.

Transportation assimilation is closely linked to several classical immigration theories, especially spatial assimilation theories. An established thread of scholarly works has focused on the relationship between spatial assimilation and social integration, in which most argued that an important outcome of socioeconomic advancement for minorities is residential integration within mainstream society (Bell, 1954; Benassi *et al*., 2023; Massey & Denton, 1985). However, since the previous literature usually focused on traditional immigrant countries, it would be interesting to see whether similar findings persist in a compact and non-traditionally immigrant region, such as Hong Kong. Similarly, the previous literature on transportation assimilation was mainly situated in countries with large immigrant populations in the Global North, such as North American and European countries, in which scholars conducted cross-sectional analysis on different ethnic groups' adaptation to the locals' modes of transportation (Beige & Axhausen, 2012; Blumenberg & Shiki, 2007; Haustein *et al*., 2019; Klinger & Lanzendorf, 2016; Smart, 2015; Tal & Handy, 2010; Valenzuela Jr *et al*., 2005; Welsch *et al*., 2018; Xu, 2018). Due to the nature of the data, except for some interview-based studies, few large-scale quantitative studies have looked into the long-term adaptation process of immigrants' transportation behaviors, which misses transportation adaptation as a dynamic process. In addition, similar to immigration literature, transportation assimilation research has mostly focused on countries in the Global North, which left other societies in other continents experiencing large quantities of migration inflows under-researched, such as Hong Kong.

Hong Kong is a popular destination for migrants from all over the world. In particular, Chinese who were born in mainland China constitute the majority of immigrants in Hong Kong. According to the 2016 census conducted by the Government of Hong Kong Special Administrative Region (S.A.R.), Chinese immigrants consisted of approximately 2 million or 23% of the total population, while the corresponding numbers for non-Chinese immigrants were 0.58 million or 8% of the total population (Census and Statistics Department, 2017). Given a large number of Chinese immigrants in Hong Kong and the unique historical trajectory of Hong Kong from a Crown Colony to a Special Administrative Region, it is important to acknowledge the internal heterogeneity of the Chinese immigrants arriving in Hong Kong during different time periods. At the same time, while much literature has focused on the Chinese immigration experience in Hong Kong, non-Chinese immigrants have continuously been under-researched in all aspects, including their transportation assimilation, even if they also consisted of a sizable amount. Capitalizing on the Hong Kong census data that include representative transportation data for a long period, for example, pooled Hong Kong Censuses from 2001 to 2016, our research is unique by being the first study on transportation assimilation in an Asian context. By analyzing Hong Kong immigrants' habits of minibus taking, such as the immigrant workforce's work journeys, this study contributes to the current literature by broadening the geographical and social contexts and incorporating a dynamic mode of transportation assimilation into the analysis. In the next section, we provide a brief history of minibus development in Hong Kong, which explains why we consider taking the minibus, a unique transportation mode in Hong Kong, as an important step of transportation assimilation for immigrants of all ethnic backgrounds.

1.1. The history and development of minibuses in Hong Kong

Hong Kong is weaved into a dense web of public transportation that runs twenty-four-seven. Today, there are seven major types of public transportation in Hong Kong, which are railways, franchised buses, non-franchises buses, minibuses, taxis, ferries, and trams. According to the transportation statistics provided by the Transport Department in 2019, minibuses consist of the third largest transportation choice (Transport Department, 2020). Minibuses cover both urban and suburban areas. Although small in size, as shown in Figure 1, minibuses are the more expensive options compared to franchised buses. According to the latest bus fare set by the Transportation Department, the caps for minibus fees were $5.7 for 3KM, $8.3 for 5KM, $10.9 for 9KM, and $14.3 for 15KM, while the corresponding franchised fares for the same distance were $4.1, 5.2, $8.1, and $9.4, respectively (Transport Department, 2020). The minibus fare is approximately 1.5 times the fare of the franchised bus.

To better explain the complexity and nuances of minibus taking, we briefly describe the process of getting on and off a minibus. Two types of minibuses are prevalent today, which are green minibuses and red minibuses. While green minibuses have clear bus stops, some red minibuses do not have bus stop podiums for each stop, and they stop anywhere when requested. A passenger needs to check

Figure 1. Green minibus (top) and red minibus (down) in Hong Kong

the minibus route beforehand and patiently wait along the route to wave to the minibus driver when the minibus approaches. After getting on, the passenger must be very familiar with the minibus route to shout to the driver in Cantonese loudly when the bus is close to the destination. The "shouting" of "*chin min yau lok*" (stop at the front) not only needs much courage for a non-native passenger who is often not fluent in Cantonese, but it also is not rare that the driver somehow has not heard or fully understood the "shouting" and the minibus passes the stop.

As a medium between franchised buses and taxis, minibuses have provided both flexibility and convenience for local passengers at an affordable price. However, this whole set of localized and culturally loaded procedures to take minibuses creates many difficulties for non-native passengers, who rarely master Cantonese or have enough knowledge of the local geography. Therefore, taking a minibus is an important step in marking a non-native's transportation assimilation in Hong Kong.

1.2. Theories and previous research: The homophily principle – preferences and opportunities

Literature on travel socialization has mainly focused on two sets of factors that may influence immigrants' travel behaviors, which are individual variables, such as one's demographic and economic background, and ethnic group characteristics, represented by the density of certain ethnic population within a region (Haustein *et al.*, 2019; Smart, 2015).

While the minibus is a major type of transportation in Hong Kong, compared to other major transportation types, immigrants are less likely to take a minibus. As shown in Table 1, Hong Kong locals were consistently more likely to take the minibus than immigrants throughout the census years. Except for Chinese who migrated before 1997, migrants from all other cultural backgrounds were significantly less likely to take minibus than the locals. This observation is in line with the previous research on immigrants in Hong Kong, in which immigrants arriving before 1997 were the most well-integrated due to the rather tolerant sociopolitical environment toward the mainlanders in the pre-Handover period (Fong & Guo, 2018; Sun & Fong, 2021; Sun & Fong, 2022). We postulate that one major reason for most immigrants' relatively low participation in minibus taking is the non-standardized logistics of getting on and getting off the minibus. As staying longer in Hong Kong would increase one's knowledge of this place, we hypothesized that *a longer duration in Hong Kong is positively related to one's likelihood to take minibuses (H1)*.

To better analyze both the individual and contextual variables that influence immigrants' travel socialization, we applied a social integration theory about preferences and opportunities in this study (Martinovic *et al.*, 2009). This standard theory was previously used in research on ethnic intermarriage or casual contact in leisure time (Kalmijn, 1998; Martinovic *et al.*, 2009). Here, we further extend the theory to interethnic contacts that require even less verbal communication but need much interaction, such as immigrants' minibus ridership in Hong Kong.

1.2.1. Preferences: Individual-level characteristics

McPherson *et al.* (2001) propose the homophily principle, which argues that social networks of every type are partially guided by people's preference for interaction with similar others. People prefer to interact with culturally similar individuals because the similarity promotes mutual understanding (Kalmijn, 1998). Translating the homophily principle into immigrants' transportation socialization, we would expect immigrants to avoid certain modes of transportation that are not common in their original cultures at the time of arrival.

To understand how individuals form their preferences in transportation behaviors, we look into the demographic and economic variables pointed out in the previous literature, including their age, ethnicity, cultural origin, gender, education, language ability, socioeconomic

Table 1. Proportion of minibus users by year, migration status, and ethnic group

	% of minibus users	Observations	Chi² test [χ^2 (1)]
Year=2001			
Local	14.83	89,586	
Migrant			
Chinese who migrated before 1997	13.70	38,738	27.98***
Chinese who migrated in/after 1997	8.44	3,034	96.04***
East Asian	7.00	357	17.28***
South Asian	6.15	715	42.43***
South-east Asian	10.81	1,730	21.81***
White	9.08	1,013	26.29***
Others	10.27	584	9.55**
Year=2006			
Local	14.18	97,441	
Migrant			
Chinese who migrated before 1997	13.71	33,039	4.64**
Chinese who migrated in/after 1997	12.73	6,550	10.64***
East Asian	10.95	283	2.42
South Asian	10.10	703	9.57***
South-east Asian	10.96	602	5.10**
White	9.65	974	16.31***
Others	11.40	351	2.23
Year=2011			
Local	16.56	101,560	
Migrant			
Chinese who migrated before 1997	14.69	28,187	56.87***
Chinese who migrated in/after 1997	14.75	12,901	27.38***
East Asian	7.75	400	21.42***
South Asian	7.40	1,068	64.51***
South-east Asian	11.57	674	12.07***
White	9.86	1,288	41.48***
Others	13.09	191	1.66
Year=2016			
Local	16.58	95,846	
Migrant			
Chinese who migrated before 1997	16.40	21,540	0.412
Chinese who migrated in/after 1997	15.50	18,392	13.13***
East Asian	8.36	347	16.93***
South Asian	8.83	1,348	59.24***
South-east Asian	12.30	854	11.27***
White	11.78	1,435	23.68***
Others	13.33	435	3.31*

Note: *p<0.05, **p<0.01, ***p<0.001 (two-tailed tests).

background, and life cycle stage. In European countries with a high cycling level, scholars have identified obviously different commuting behaviors between natives and immigrants, with the former tending to cycle more while the latter preferring public transportation (Haustein *et al.*, 2019; Welsch *et al.*, 2018).

One classical factor in immigration studies is one's age because the age at migration also sets a starting point for later social integration in the destination. On arrival, generally, both younger and older immigrants could be equally unfamiliar with the context (Martinovic *et al.*, 2009). However, those who arrive at a younger age are better at grasping the host city's language, which provides them with more opportunities to interact with the local society (Chiswick & Miller, 2001). In addition, we expect immigrants arriving at a younger age to be less socialized into their own cultures by cultural identity shapers and can absorb the ways of living in the destination with less of a cultural burden. Thus, we hypothesized that *arriving in Hong Kong at a younger age is positively related to one's likelihood of taking the minibus (H2)*.

Another set of transportation assimilation research focused on the heterogeneity of immigrants' transportation assimilation in the United States. For example, compared to Hmong immigrants in Minnesota, who rated privacy with higher importance, Latino immigrants were more open to "social" types of travel, including public transit and carpooling (Douma, 2004). In our research, as Hong Kong is a predominantly Chinese ethnic society, we have enough Chinese immigrants in the dataset. To retain enough observations within each non-Chinese ethnic group simultaneously, we regrouped the non-Chinese immigrants based on geographical and cultural proximity. Compared to immigrants of all other ethnicities, Chinese immigrants in Hong Kong might be the best-assimilated group due to the latter's cultural and linguistic proximity to the locals. Moreover, it is important to acknowledge the internal heterogeneity of the Chinese immigrants arriving in Hong Kong during different time periods, given the unique historical trajectory of Hong Kong from a Crown

Colony to a Special Administrative Region. It is possible that the Chinese arriving before the Handover might be more likely to take the minibus as they entered a relatively more tolerating socio-political environment nurturing better integration when first entering Hong Kong. In this way, we hypothesized that *Chinese immigrants are more likely to take the minibus than immigrants of any other ethnicity in Hong Kong, and those Chinese immigrants arriving before 1997 were even more likely to take the minibus compared to the latecomers (H3).*

Among the non-Chinese immigrants in Hong Kong, South-east Asians, who are mainly Filipino and Indonesian domestic helpers, constitute the largest population. The increasing discrimination from the locals toward the domestic helpers comes hand in hand with their large population. Numerous studies have empirically confirmed that South-east Asian domestic helpers in Hong Kong often experience physical and verbal abuse that increases their level of depression (Cheung *et al*., 2019; Ng *et al*., 2019). Against this backdrop, we postulate that South-east Asian immigrants might become less likely to integrate into the local society. Thus, we hypothesized that *compared to immigrants from other ethnic backgrounds, the longer length of stay in Hong Kong, the less likely for South-east Asian immigrants to take the minibus (H4).*

The language barrier also plays a role in immigrants' transportation preferences. For example, to circumvent the language barrier and to compensate for other deficiencies in regular public transit service, Camionetas (the Spanish word for privately operated minivans) have been popular among Latino communities throughout the U.S. (Valenzuela Jr *et al*., 2005). In Hong Kong, Cantonese is the most used language. In addition, immigrants often assume that Cantonese is a must for taking a minibus. Therefore, we hypothesized that *the ability to speak Cantonese is positively related to one's likelihood of taking the minibus (H5).*

1.2.2. Opportunities: district-level characteristics

In addition to individual-level features, district-level characteristics could also be influential in the social integration process as the latter affects the opportunities for interethnic interaction. In a more specific sense, this opportunity to meet coethnic peers depends, among others, on the size of the ethnic group, the size of the major population, and the degree of segregation (Blau & Schwartz, 1984). Immigrants would have more opportunities to meet the coethnics when the coethnic group is large and intergroup segregation is evident (Leurent, 2022). Such a structural condition would slow down immigrants' interethnic social integration. In contrast, when the immigrants cannot consist of a sizeable group, they are structurally conditioned to more interethnic communications and assimilate to the host society at a faster speed. In transportation integration, the size of the coethnic group in the residential location is a crucial structural condition influencing the opportunities.

Residential location becomes influential for immigrants' transportation socialization through two channels: The social and physical characteristics of the locality itself and the distance between the locality and the important places (e.g., churches, work location). The previous literature on U.S. immigrants discovered that newly arrived immigrants tend to live closer to public transit, especially the rail. For Latin Americans, living closer to the rail is positively correlated with their likelihood of taking public transportation and lowers the probability of car ownership. This correlation might vary across different ethnic groups, as Indians also exhibit a higher propensity for rail use but do not necessarily live closer to rail stations (Chatman, 2014).

In the U.S., the clustering of immigrants in urban dwellings is a well-known phenomenon. A recent study investigating Latino immigrant groups in six metropolises in the U.S. confirmed that living in areas with higher ethnic concentrations increases the likelihood of relying on carpooling and public transit (Liu & Painter, 2012). Hong Kong displays a much different urban setting, where districts are all quite close and have a much denser population. At the same time, Hong Kong is also unique in the sense that certain non-Chinese immigrants are likely to cluster in specific regions. We would expect that immigrants living in areas with a higher percentage of ethnic concentration, in other words, more immigrants with similar ethnic origins, are more likely to build intra-ethnic relations, which negatively influences their possibility of taking the minibus. Hence, we hypothesized that *living districts with a higher percentage of non-Chinese immigrants are negatively correlated to an immigrant's transportation assimilation* (*H6)*.

1.3. The dynamic mode of integration

With a few exceptions, one common feature of transportation assimilation or social integration literature, in general, is the static nature of the findings (Martinović, 2013). While the previous research has generally pointed out that a longer duration in the destination is positively correlated to a higher level of transportation assimilation, few have specified a possible dynamic assimilation phenomenon. The previous research has also confirmed that people with different characteristics or opportunities may integrate at a different pace (Martinović, 2013; Martinovic *et al*., 2009). With different types of initial

endowments at the point of arriving at the destination, some groups (e.g., Haitians in the U.S.) may display better interethnic integration while others eventually shy away from the host society (e.g., Cubans in the U.S.) (Portes & Zhou, 1993). Following a previous discussion on age at arrival and length of stay in Hong Kong, we argue that younger immigrants, who are more accepting towards the local culture compared to those arriving at an older age, may extend their initial advantages to the long-term. Hence, we hypothesized that *among those who have spent the same period of time in Hong Kong, immigrants arriving at a younger age are more likely to take the minibus than those arriving at an older age* (*H7*).

Extending the dynamic mode of integration to Chinese immigrants arriving in different periods, the initial sociopolitical environment they initially encountered at the destination might exert long-lasting impacts on their assimilation in the long-term. For example, taking advantage of a natural experiment, scholars confirmed that immigrants who fortunately went through naturalization at the beginning were much better integrated in the long-term than other very similar immigrants who narrowly missed naturalization (Hainmueller *et al*., 2017). We postulate that similar situations may also happen among Chinese immigrants in Hong Kong. Given the more tolerant sociopolitical environment toward Chinese immigrants before 1997, we hypothesized that *compared to Chinese immigrants arriving in or after 1997, those arriving before the Handover are increasingly more likely to take minibus in the long-term (H8).* In addition to Chinese integration, South-east Asians' lower likelihood of minibus taking in the long run, as previously explained under *H4*, is another example of the dynamic mode of integration.

Taken together, we would incorporate a dynamic mode of integration in our research. We can argue that immigrants exhibit different transportation behaviors based on their individual preferences, which is further intertwined with contextual constraints like residential locations that influence opportunities for interethnic contacts. Hong Kong, with its unique post-colonial culture, is the destination for many immigrants from developing and developed countries worldwide, providing an interesting and important context for analyzing immigrants' transportation behaviors in a non-western setting.

2. Data and variables

2.1. Data

We pooled 4 years (2001, 2006, 2011, and 2016) of 5% of Hong Kong census microdata obtained from the Census and Statistics Department of Hong Kong. With the relatively large coverage of the sample size in each census year, the Hong Kong census provides a fair representation of the overall demography of Hong Kong throughout the years.

Table 2 provides the descriptive statistics of our analytical sample, which consists of 169,766 individuals in total. Among the 169,766 immigrants in Hong Kong, 23,996, or approximately 14.13% of, respondents take the minibus as one of the major modes of daily transportation. Within our analytical sample, 91.19% are respondents of Chinese ethnicity, and 8.81% are immigrants with non-Chinese ethnic origins. Approximately 14.53% of Chinese immigrants have chosen a minibus as one of their transportation modes to work, while the corresponding number for immigrants of non-Chinese origin was 10.02%. We now move on to describe our variables of interest.

2.2. Variables of interest

We have limited our sample to those at least 15 years old and actively working/looking for jobs. We define immigrants as regular residents who were not born in Hong Kong.

2.2.1. Minibus

As shown in Table 2, the minibus is our binary dependent variable capturing whether a person takes the minibus to go to work. The census provides information on 1, the primary mode of transport to work, and 2, other modes of transport to work. Minibus users are coded as 1 for those who have included red or green minibus as one of their possible modes of transport to work; non-minibus users are coded as 0 for those who have not included minibus as a potential mode of transport to work.

2.2.2. Arriving in Hong Kong

Age at migration is a continuous variable derived from one's age and duration in Hong Kong. Based on the census year and duration in Hong Kong, we derived the arriving cohorts as follows: Pre-1997 cohort (i.e., those who arrived in Hong Kong before 1997), 1997 – 1999 cohort, 2000 – 2004 cohort, 2005 – 2009 cohort, and 2010 – 2016 cohort. For those who have stayed in Hong Kong for more than 20 years, since the census no longer provides their exact years of duration in Hong Kong, we lumped these people into the pre-1997 cohort. As shown in Table 2, the average age at migration for immigrants in Hong Kong is 27.36, with a standard deviation of 11.04. The mean age at migration for the immigrant minibus users is 26.55, which is 0.81 years younger than that of the full sample and 0.94 years younger than the non-minibus users. We also acknowledge that all the averaged ages are biased towards the left.

2.2.3. Ethnicity

We included seven ethnicity categories in our sample: Chinese immigrants arriving before 1997, Chinese

Table 2. Summary statistics of selected variables

	Full sample (*n*=169,766)	Non-minibus users (*n*=145,770)	Minibus users (*n*=23,996)	Difference
	Mean/% (SD)	Mean/% (SD)	Mean/% (SD)	
Minibus user	14.13			
Duration of residence in Hong Kong (years)	15.37 (6.32)	15.37 (6.39)	15.92 (5.91)	t=−13.31***
Age at migration	27.36 (11.04)	27.49 (11.00)	26.55 (11.21)	t=12.02***
Ethnic group				χ^2 (6)=255.23***
Chinese (migrated before 1997)	67.43	67.06	69.65	
Chinese (migrated in/after 1997)	23.76	23.70	24.10	
East Asian	0.80	0.85	0.48	
South Asian	2.18	2.34	1.25	
South-east Asian	2.25	2.32	1.79	
White	2.70	2.82	1.97	
Others	0.89	0.91	0.76	
Cantonese ability	92.18	91.76	94.72	χ^2 (1)=250.01***
District-level ethnic density	0.22 (0.11)	0.22 (0.11)	0.23 (0.10)	t=-14.07***
Arrival cohort				χ^2 (1)=45.93***
Before 1997	70.86	70.63	72.28	
1997–1999	8.53	8.52	8.56	
2000–2004	9.72	9.79	9.30	
2005–2009	6.19	6.25	5.84	
2010–2016	4.70	4.81	4.02	
Female	48.27	47.92	50.36	χ^2 (1)=49.01***
Married	72.52	72.83	70.64	χ^2 (1)=49.44***
Living with child (ren)	34.03	34.12	33.51	χ^2 (1)=3.47
Postsecondary education	17.46	17.76	15.65	χ^2 (1)=63.95***
Logged monthly personal income	9.18 (0.80)	9.18 (0.81)	9.15 (0.72)	t=7.48***
Industry				χ^2 (8)=271.59***
Agriculture, fishing, mining and quarrying	0.20	0.18	0.33	
Manufacturing	7.80	7.82	7.68	
Electricity, gas, and water	0.34	0.35	0.26	
Construction	9.00	9.12	8.27	
Wholesale, retail, and import/export trades, restaurants, and hotels	26.83	26.63	28.04	
Transport, storage, and communication	19.62	19.95	17.64	
Financing, insurance, real estate, and business services	14.01	14.24	12.60	
Community, social, and personal services	22.17	21.68	25.15	
Others	0.04	0.04	0.03	
Occupation				χ^2 (9)=313.44***
Managers and administrators	9.74	10.12	7.42	
Professionals	4.79	4.86	4.36	
Associate professionals	12.57	12.39	13.64	
Clerical support workers	11.86	11.72	12.77	
Service and sales workers	22.07	21.74	24.10	

(Cont'd...)

Table 2. ***(Continued)***

	Full sample (*n*=169,766)	Non-minibus users (*n*=145,770)	Minibus users (*n*=23,996)	Difference
	Mean/% (SD)	Mean/% (SD)	Mean/% (SD)	
Skilled agricultural and fishery workers	0.11	0.10	0.22	
Craft and related workers	9.66	9.75	9.13	
Plant and machine operators and assemblers	5.56	5.65	5.00	
Elementary occupations	23.60	23.64	23.35	
Others	0.02	0.03	0.01	

Note: ***$p<0.001$ (two-tailed tests).

immigrants arriving in or after 1997, East Asian, South Asian, South-east Asian, white, and others. As provided in the existing literature on immigration issues in Hong Kong, 1997, the year of the Handover, marks a special watershed that differentiates a Crown Colony of the United Kingdom from a Special Administrative Region under the People's Republic of China. The different sociopolitical contexts before and after the Handover may result in different social sentiments toward Chinese immigrants, especially those from mainland China. Other ethnic groups are broader categories compared to the Chinese. East Asian includes Japanese and Korean. South Asians refer to Bangladeshi, Indian, Nepalese, Pakistani, and Sri Lankan. South-east Asian includes Filipino, Indonesian, Thai, and Vietnamese. Mixed races, blacks, other Asians, and others are all categorized under others. As shown in Table 2, in the full sample, 67.43% are Chinese immigrants who migrated before 1997, 23.76% are Chinese immigrants who migrated in or after 1997, 0.80% are East Asians, 2.18% are South Asians, 2.25% are South-east Asians, 2.70% are whites, and 0.89% are others. In the minibus users (N = 23,996), 69.65% are Chinese who migrated before 1997, 24.10% are Chinese who migrated in or after 1997, 0.48% are East Asians, 1.25% are South Asians, 1.79% are South-east Asians, 1.97% are whites, and 0.76% are others.

2.2.4. Cantonese ability

The ability to speak Cantonese is a binary variable, with 1 referring to yes, and 0 referring to no. In our full sample, as shown in Table 2, those who indicated the ability to speak Cantonese consisted of 92.18% of all the individuals. This percentage is 94.72% for the minibus subsample, which is slightly higher than the full sample.

2.2.5. Index of interaction

The index of interaction aims to measure the possibility of meeting other co-ethnic immigrants in one's residential area. The index of interaction depicts the dimension of exposure, a rather standard indicator to measure the level of spatial segregation by sociologists (Massey & Denton, 1988). We followed Shevky and Bell's method to obtain the index of interaction, in which P^* represents the probability of a randomly selected member of a particular ethnic group meeting (in his census tract) another member of the same ethnic group (Bell, 1954; Shevky & Bell, 1955). The equation for P^* is $P^* = \frac{1}{A}\sum_{i=1}^{k}\frac{a_i^2}{b_i}$. We obtained P^* by dividing the number of coethnic immigrants living in the same residential district by the total number of residents in that district in each census year.

In addition to the independent variables mentioned above, we also control a list of covariates, including educational attainment, gender, life stages, monthly income, industry, occupation, residential district, working district, year dummies, and several district-year dummies. To control for residential district-fixed effects, for instance, to compare the residents living in the same district, we included 24 residential district dummies in our analysis. Similarly, to control for working district-fixed effects, such as comparing the passengers working in the same district, we included 24 working district dummies throughout the models. We also included the interactions between place of residence and place of work as well as the interactions between census year and residential/working district.

2.3. Methodology

We applied linear probability models (LPM) with the binary variable, such as the likelihood of taking the minibus as the dependent variable. We started with a base model (Model 1), in which we only included our key independent variables by themselves. In this way, the base model captures the static effects of individual-level and district-level variables on the probability of taking a minibus. From Model 2 to Model 5, we added interaction terms between certain key independent variables and the years of duration in Hong Kong one by one. In Model 4 and Model 5, we included three-way interaction terms to explore inter-ethnic differences in taking minibuses along with different lengths of stay in Hong Kong. Model

5 is our final model, which dissects the total effects into initial effects and long-term effects of our key independent variables.

Equations I – V below correspond to Models 1 – 5 in the Results section. We started with Equation I, in which we only included immigrant, *i*'s arrival, years of duration in Hong Kong, ethnic background, Cantonese ability, *i*'s index of interaction (represented by P^*), and a series of control variables. $Minibus_i$ is the dependent variable capturing immigrant *i*'s probability of choosing minibus over other modes of transportation in journeys to work, and ε_i is the individual-level robust standard error.

$$Minibus_i = MigAge_i + Duration_i + Ethicity_i + Cantonese_i + P^* + Controls_i + \varepsilon_i \quad (I)$$

In Equation II, we further included two interactions, which are individual *i*'s years of staying in Hong Kong and age at arrival and individual *i*'s years of staying in Hong Kong and ethnic group. In Equation III, we included more interactions (including one three-way interaction) to depict the potential interethnic differences in minibus ridership, which are individual *i*'s age at arrival and ethnicity as well as individual *i*'s years of staying in Hong Kong, age at arrival, and ethnicity. In Equation IV, we again expanded our interactions terms by including some important control variables into the interactions, including the interaction between individual *i*'s years of staying in Hong Kong and logged personal income, individual *i*'s years of staying in Hong Kong and Cantonese ability, and individual *i*'s years of staying in Hong Kong and gender.

$$Minibus_i = MigAge_i + Duration_i + Ethnicity_i + Cantonese_i + P^* + Duration_i \times MigAge_i + Duration_i \times Ethnicity_i + Controls_i + \varepsilon_i \quad (II)$$

$$Minibus_i = MigAge_i + Duration_i + Ethnicity_i + Cantonese_i + P^* + Duration_i \times MigAge_i + Duration_i \times Ethnicity_i + MigAge_i \times Ethnicity_i + Duration_i \times MigAge_i \times Ethnicity_i + Controls_i + \varepsilon_i \quad (III)$$

$$Minibus_i = MigAge_i + Duration_i + Ethnicity_i + Cantonese_i + P^* + Income_i + Gender_i + Duration_i \times MigAge_i + Duration_i \times Ethnicity_i + MigAge_i \times Ethnicity_i + Duration_i \times MigAge_i \times Ethnicity_i + Duration_i \times Cantonese_i + Duration_i \times EthDen_i + Duration_i \times Income_i + Duration_i \times Gender_i + Controls_i + \varepsilon_i \quad (IV)$$

Equation V is our final model, in which we streamlined previous models by keeping only those more important items for *i*'s likelihood to take a minibus. Throughout the analysis, we applied linear regressions and robust standard errors clustered in residential districts. Below we further explain our reasons for including arrival cohorts and a series of locational- and temporal-fixed effects and applying linear approximation in our analysis.

$$Minibus_i = MigAge_i + Duration_i + Ethnicity_i + Cantonese_i + P^* + Income_i + Duration_i \times MigAge_i + Duration_i \times Ethnicity_i + MigAge_i \times Ethnicity_i + Duraiton_i \times MigAge_i \times Ethnicity_i + Duration_i \times Income_i + Controls_i + \varepsilon_i \quad (V)$$

Following classical immigration research on immigrants' integration, we controlled for one's arrival cohort in our analysis (Martinović, 2013). The major advantage of controlling for arrival cohorts is that we can trace the groups of immigrants in cross-sectional data, in our case, the immigrants arriving in Hong Kong in the same cohort, similarly to tracing individuals in longitudinal data. In this way, we can control for potential cohort effects.

We have also included a series of locational- and temporal-fixed effects, including residential district-fixed effects, working district-fixed effects, residential-working-district fixed effects, census year-fixed effects, year-residential-district fixed effects, and year-working-district fixed effects. By incorporating a series of residential district dummies, we are only comparing the transportation behaviors of immigrants living in the same district, which therefore wipes out the possibility of not taking minibuses as a result of having few minibus routes in certain residential districts. Similarly, by including working district dummies, we are only comparing the passengers working in the same district, which accounts for the possibility of not taking minibuses to work as a result of not having minibus routes in certain working districts. To also control the distance between one's residential location and working location, we included the interactions between residential location dummies and working location dummies. To account for the effects of potential district development throughout the years (e.g., any development of the subway system throughout the years that may affect minibus ridership), we have controlled for census year dummies. In the end, by incorporating the year-fixed effects and the district-year-fixed effects (i.e., the interaction between year dummies and district dummies), we can control potential time-specific regional factors (e.g., any suspension of the

minibus routes) that may affect minibus ridership (Xu, 2018).

We employed LPM with robust standard errors correcting heteroskedasticity to test our hypotheses. We acknowledge that our dependent variable is of binary nature, which generally should rate logistic regression with higher preference. However, since we will incorporate several interaction terms in our full model, the statistical interaction in models with categorical outcomes may result in inaccurate *P*-values (Mustillo *et al*., 2018). In addition, logistic regressions would eliminate the observations in which no minibus takers were present, which might unnecessarily reduce our sample size. Therefore, to avoid any inaccurate interpretation and maintain the high statistical power of our analysis, we simply relied on linear probability models. Nevertheless, for robustness check, please refer to Table S1 in the Online Supplementary Materials for the results from logic regressions, in which all major conclusions stand.

To ensure that our results are robust, we also carried out a series of analyses, including only immigrants whose main mode of transportation is a minibus. We reran Model 1, Model 2, Model 4, and Model 5, and all the major conclusions also stand. Please find the results in Table S2 in the Online Supplementary Materials as well.

3. Results

Tables 3 and 4 present the results of our five regression models, each of which has controlled for a collection of sociodemographic characteristics, year-specific fixed effects, and location-specific fixed effects. Model 1 is the base model that does not include any interaction terms. Model 1 suggests that the duration of residence in Hong Kong is positively associated with the likelihood of taking the minibus. By contrast, a negative relationship exists between age at migration and the probability of taking the minibus. In regard to the role of ethnic groups, we found ethnic differences in the likelihood of taking the minibus to be statistically significant. Specifically, South Asians are significantly less likely to take the minibus than Chinese immigrating in or after the year of the Handover (i.e., 1997). The latter has a slightly but insignificantly lower chance of taking minibus than other ethnic groups except for South Asians. In addition, Cantonese ability is another powerful determinant of immigrants' minibus taking. Inconsistent with the findings of prior research that reveal a negative link between ethnic density and transportation assimilation (Liu & Painter, 2012), our analysis indicates no substantial effect of district-level ethnic density. There are two possible explanations for such a result. First, since residential district dummies are included in all the models, we only performed within-district comparisons. Our analysis suggests that within each residential district, the population proportion of one's ethnic group has no association with the likelihood of taking the minibus. Second, this study depends on a context different from prior research. Unlike relatively sparsely populated areas, such as cities in Europe and North America, in the previous research, Hong Kong is a highly compact city with a high population density.

Model 2 incorporates the interactions between certain individual characteristics and the duration of residence in Hong Kong to capture the "dynamic mode" of transportation assimilation. Throughout the models, continuous variables are centered around their means, such as duration of residence in Hong Kong, age at migration, logged personal income, and others. Since the interaction between years of staying in Hong Kong and age at migration is statistically insignificant, we cannot suggest that age at migration moderates the effect of residence duration among all immigrants. The main effect of the ethnic group indicates the probability of taking the minibus by the ethnic group when the duration of residence in Hong Kong is equal to its mean (i.e., 15 years) and holding other factors constant. The interactions between the duration of residence in Hong Kong and ethnic group show that compared to Chinese immigrating in or after 1997, South-east Asians are significantly less likely to take minibus with longer years of staying in Hong Kong.

Model 3 adds three-way interactions among duration of residence in Hong Kong, age at migration, and ethnic group, as well as interactions between age at migration and ethnic group. The main effect of duration of residence in Hong Kong reveals that those staying in Hong Kong for more years are more likely to take the minibus. The main effect of age at migration shows that those arriving in Hong Kong at a younger age are more likely to take the minibus. Since we used Chinese immigrating in or after 1997 as the reference group for ethnicity, the statistically significant interaction between years of living in Hong Kong and age at arrival suggests that, for recent Chinese immigrants, the effect of duration of residence in Hong Kong on minibus taking is more pronounced for those immigrating at a younger age. Figure 2 summarizes the association between years of living in Hong Kong and the predicted probability of taking the minibus by age group at migration among Chinese immigrating in or after 1997. Recent Chinese immigrants arriving at a younger age have a higher initial probability of taking the minibus than those arriving at an older age, and such a difference grows with more years of staying in Hong Kong. Similar to Model 2, Model 3 also confirms South-east Asians' steeper decline

Table 3. Linear probability models predicting minibus usage (Models 1, 2, and 3)

	Model 1	Model 2	Model 3
Independent variables			
Duration of residence in Hong Kong (D)	0.0008380**	0.0014111*	0.0014904*
	(0.0002915)	(0.0005781)	(0.0005837)
Age at migration	−0.000783***	−0.000763***	−0.001011***
	(0.0000949)	(0.0000956)	(0.0002215)
Ethnic group (Chinese [in/after 1997]=ref.)			
Chinese [before 1997]	0.0070596	−0.0062835	−0.0046948
	(0.0071382)	(0.0095889)	(0.0095941)
East Asian	0.0065193	−0.0067763	−0.0027870
	(0.0087641)	(0.0150991)	(0.0168933)
South Asian	−0.0161889**	−0.0273267**	−0.0257558**
	(0.0061179)	(0.0090054)	(0.0090158)
South-east Asian	0.0089186	−0.0106081	−0.0095421
	(0.0063719)	(0.0091648)	(0.0092006)
White	0.0069552	−0.0090005	−0.0050199
	(0.0062437)	(0.0099641)	(0.0107389)
Others	0.0146943	−0.0007639	0.0035438
	(0.0092873)	(0.0127758)	(0.0130051)
Cantonese ability	0.0146034***	0.0151558***	0.0154833***
	(0.0039161)	(0.0039335)	(0.0039317)
District-level ethnic density	0.0373921	0.0263577	0.0267702
	(0.0262907)	(0.0344524)	(0.0344692)
Interactions			
D×Age at migration		−0.0000049	−0.0000587*
		(0.0000128)	(0.0000263)
D×Ethnic group (Chinese [in/after 1997]=ref.)			
D×Chinese (before 1997)		−0.0004988	−0.0006306
		(0.0006439)	(0.0006527)
D×East Asian		−0.0011811	−0.0014381
		(0.0012627)	(0.0015434)
D×South Asian		−0.0010096	−0.0007562
		(0.0007988)	(0.0008095)
D×South-east Asian		−0.0024034**	−0.0023418**
		(0.0008703)	(0.0008921)
D×White		−0.0016206+	−0.0021740*
		(0.0008318)	(0.0009613)
D×Others		−0.0016336	−0.0019054
		(0.0012010)	(0.0013231)
Age at migration×Ethnic group (Chinese [in/after 1997]=ref.)			
Age at migration×Chinese (before 1997)			−0.0000454
			(0.0002521)
Age at migration×East Asian			−0.0003968
			(0.0015593)

(Cont'd...)

Table 3. ***(Continued)***

	Model 1	Model 2	Model 3
Age at migration×South Asian			0.0005523
			(0.0006528)
Age at migration×South-east Asian			0.0005283
			(0.0007670)
Age at migration×White			−0.0002177
			(0.0008974)
Age at migration×Others			0.0016403+
D×Age at migration×Ethnic group (Chinese [in/after 1997]=ref.)			
D×Age at migration×Chinese (before 1997)			0.0001296***
			(0.0000392)
D×Age at migration×East Asian			0.0000430
			(0.0001343)
D×Age at migration×South Asian			−0.0000565
			(0.0000756)
D×Age at migration×South-east Asian			0.0000134
			(0.0000893)
D×Age at migration×White			0.0001056
			(0.0000841)
D×Age at migration×Others			0.0002493*
			(0.0001065)
Controls			
Arrival cohort (before 1997=ref.)			
1997–1999	0.0066226	−0.0059316	−0.0059412
	(0.0060425)	(0.0075843)	(0.0075801)
2000–2004	0.0041830	−0.0073039	−0.0063267
	(0.0063138)	(0.0081296)	(0.0081216)
2005–2009	0.0062574	−0.0035357	−0.0026838
	(0.0072692)	(0.0095166)	(0.0095110)
2010–2016	0.0086150	−0.0005012	−0.0006189
	(0.0083830)	(0.0115073)	(0.0115054)
Female	0.0053457**	0.0054121**	0.0059645**
	(0.0019259)	(0.0019328)	(0.0019490)
Married	−0.0028037	−0.0027136	−0.0024588
	(0.0022543)	(0.0022586)	(0.0022667)
Living with child (ren)	−0.0001933	−0.0001354	−0.0000190
	(0.0018880)	(0.0018919)	(0.0018929)
Postsecondary education	−0.0034206	−0.0034021	−0.0031982
	(0.0029009)	(0.0029030)	(0.0029058)
Logged personal income	0.0056519***	0.0056139***	0.0057795***
	(0.0014931)	(0.0014979)	(0.0014999)
Constant	0.1292658***	0.1418663***	0.1391784***
	(0.0299786)	(0.0303448)	(0.0303549)

(Cont'd...)

Table 3. ***(Continued)***

	Model 1	Model 2	Model 3
Year FE	Yes	Yes	Yes
Place of residence FE	Yes	Yes	Yes
Place of work FE	Yes	Yes	Yes
Place of residence FE×Place of work FE	Yes	Yes	Yes
Place of residence FE×Year FE	Yes	Yes	Yes
Place of work FE×Year FE	Yes	Yes	Yes
R-squared	0.077	0.077	0.077
Observations	169,766	169,766	169,766

Note: FE: Fixed effect; $+p<0.1$, $*p<0.05$, $**p<0.01$, $***p<0.001$ (two-tailed tests); The results for occupation and industry are not displayed.

in the likelihood of minibus usage. Figure 3 presents the link between the duration of residence in Hong Kong and the predicted probability of taking the minibus by ethnic group. As shown in Figure 3, South Asians have the lowest initial probability of minibus taking, while South-east Asians have the highest. As the duration of living in Hong Kong increased, South-east Asians became even less likely to take the minibus, which shows an opposite trend in minibus usage compared to any other ethnic group. In addition, we found no substantial inter-ethnic difference in arrival age on minibus taking. The three-way interactions show that while age at migration reduces the effect of duration of residence in Hong Kong among Chinese who immigrated in or after 1997, the moderating effect of age at migration is significantly less pronounced among Chinese who immigrated before 1997. We also employed a logit model to replicate Model 3 (Table S1), which reveals similar results to those of the LPM.

Model 4 tests how Cantonese ability, district-level ethnic density, logged personal income, and gender moderate the effect of duration of residence in Hong Kong on minibus usage. We found that only logged personal income is an effective moderator. The association between the duration of residence in Hong Kong and the likelihood of taking the minibus is significantly less pronounced in people with higher incomes, which may result from the fact that rich immigrants tended to swap public transportation for private cars. According to the 2016 census, among the immigrants who have stayed in Hong Kong for 20 years or more, 19.3% of the 10% richest people (i.e., the people with the top 10% income) chose private cars as their major transportation mode, while this proportion was only 2.9% for the rest of people. Figure 4 presents the association between the duration of residence in Hong Kong and the predicted probability of taking the minibus by income percentile. Model 5 is a simplified model excluding statistically insignificant interactions.

In sum, our findings support Hypotheses 1, 2, 4, and 5 and partly support Hypothesis 7. Hypotheses 3, 6, and 8 are not confirmed. Table 5 summarizes the results of our eight hypotheses.

4. Discussion

In general, we confirmed our expectation that immigrants in Hong Kong had been increasingly picking up the locals' transportation behaviors during the years spent at the destination; in other words, they were more likely to ride minibuses as one of the top three modes of transportation to work. However, the exact pace of this assimilation may vary strongly on individual-level factors, which in general can be grouped into two major categories: (1) The characteristics that result in entry differences which then continue with the length of stay in Hong Kong, and (2) those that we can only determine the average effects along with the length of stay.

Age at migration and ethnicity belong to the first category, whose effects were influential for immigrants' minibus taking both at the beginning and in the long run. Younger immigrants already had initial advantages in minibus taking over older immigrants. In addition, for certain ethnic groups, for example, recent Chinese immigrants in our case, the advantage of arriving in Hong Kong at a younger age further strengthened as time passed since younger immigrants demonstrated a faster speed of transportation adaptation. This also explains why we often observe immigrants arriving at a younger age are often more absorbable of local knowledge, even if they had the same length of stay in the destination as those who arrived at an older age.

Similarly, the seven ethnic groups began at different levels when they first arrived in Hong Kong, with Chinese arriving before 1997 at a more advantaged starting point than the Chinese arriving later and South Asians being the most disadvantaged group. However, throughout the years,

Table 4. Linear probability models predicting minibus usage (Models 4 and 5)

	Model 4	Model 5
Independent variables		
Duration of residence in Hong Kong (D)	0.0006615	0.0014437*
	(0.0008938)	(0.0005840)
Ethnic group (Chinese [in/after 1997]=ref.)		
Chinese (before 1997)	−0.0045155	−0.0039954
	(0.0096029)	(0.0096001)
East Asian	−0.0018566	−0.0025499
	(0.0169862)	(0.0168902)
South Asian	−0.0247590**	−0.0253147**
	(0.0091346)	(0.0090198)
South-east Asian	−0.0086768	−0.0091106
	(0.0092362)	(0.0092040)
White	−0.0027827	−0.0039780
	(0.0109656)	(0.0107540)
Others	0.0034494	0.0033468
	(0.0130295)	(0.0130023)
Age at migration	−0.0010161***	−0.0010099***
	(0.0002219)	(0.0002215)
Cantonese ability	0.0182503***	0.0167433***
	(0.0050770)	(0.0039773)
District-level ethnic density	0.0223478	0.0234693
	(0.0346453)	(0.0345013)
Logged personal income	0.0057689***	0.0058124***
	(0.0014993)	(0.0014994)
Female	0.0059081**	0.0059894**
	(0.0019468)	(0.0019490)
Interactions		
D×Ethnic group (Chinese [in/after 1997]=ref.)		
D×Chinese [before 1997]	0.0002024	−0.0006082
	(0.0010370)	(0.0006528)
D×East Asian	−0.0012567	−0.0011182
	(0.0016082)	(0.0015490)
D×South Asian	−0.0007201	−0.0006285
	(0.0009013)	(0.0008106)
D×South-east Asian	−0.0025297**	−0.0024571**
	(0.0009189)	(0.0008929)
D×White	−0.0017552+	−0.0017425+
	(0.0010605)	(0.0009789)
D×Others	−0.0018360	−0.0016327
	(0.0013795)	(0.0013300)
D×Age at migration	−0.0000607*	−0.0000591*
	(0.0000264)	(0.0000263)

(Cont'd...)

Table 4. ***(Continued)***

	Model 4	Model 5
Age at migration×Ethnic group (Chinese [in/after 1997]=ref.)		
Age at migration×Chinese [before 1997]	−0.0000420	−0.0000446
	(0.0002522)	(0.0002521)
Age at migration×East Asian	−0.0004080	−0.0004135
	(0.0015599)	(0.0015589)
Age at migration×South Asian	0.0005724	0.0005558
	(0.0006529)	(0.0006529)
Age at migration×South-east Asian	0.0005205	0.0005151
	(0.0007669)	(0.0007670)
Age at migration×White	−0.0001992	−0.0002217
	(0.0008985)	(0.0008979)
Age at migration×Others	0.0016247+	0.0016124+
	(0.0009185)	(0.0009187)
D×Age at migration×Ethnic group (Chinese [in/after 1997]=ref.)		
D×Age at migration×Chinese [before 1997]	0.0001298**	0.0001267**
	(0.0000395)	(0.0000393)
D×Age at migration×East Asian	0.0000532	0.0000494
	(0.0001345)	(0.0001344)
D×Age at migration×South Asian	−0.0000441	−0.0000472
	(0.0000758)	(0.0000758)
D×Age at migration×South-east Asian	0.0000238	0.0000187
	(0.0000896)	(0.0000895)
D×Age at migration×White	0.0001196	0.0001163
	(0.0000843)	(0.0000842)
D×Age at migration×Others	0.0002663*	0.0002607*
	(0.0001066)	(0.0001066)
D×Cantonese ability	0.0003051	
	(0.0005417)	
D×District-level ethnic density	−0.0039186	
	(0.0040039)	
D×Logged personal income	−0.0003245*	−0.0003419*
	(0.0001613)	(0.0001534)
D×Female	0.0001317	
	(0.0002784)	
Constant	0.1362044***	0.1320566***
	(0.0305408)	(0.0307300)
Controls	Yes	Yes
Year FE	Yes	Yes
Place of residence FE	Yes	Yes
Place of work FE	Yes	Yes
Place of residence FE×Place of work FE	Yes	Yes
Place of residence FE×Year FE	Yes	Yes

(Cont'd...)

Table 4. ***(Continued)***

	Model 4	Model 5
Place of work FE×Year FE	Yes	Yes
R-squared	0.0774	0.0774
Observations	169,766	169,766

Note: Fe: Fixed effect; +p<0.1, *p<0.05, **p<0.01, ***p<0.001 (two-tailed tests).

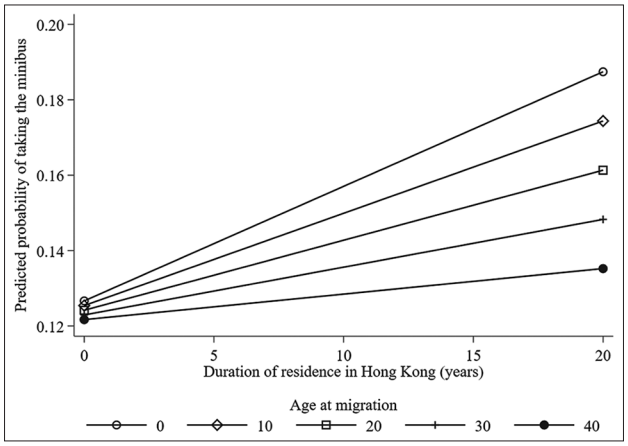


Figure 2. The association between duration of residence in Hong Kong and minibus usage by age at migration among Chinese who immigrated to Hong Kong in or after 1997

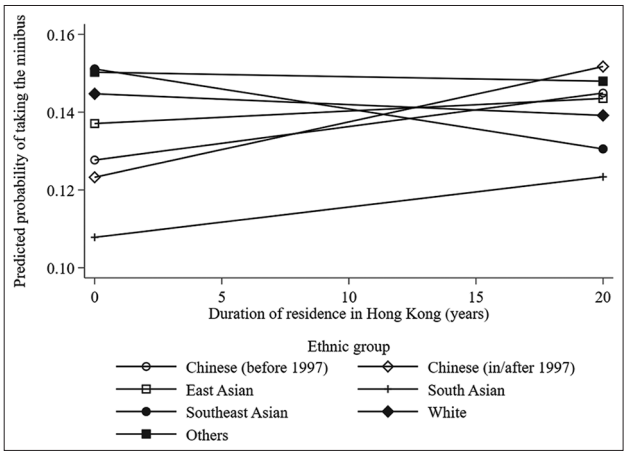


Figure 3. The association between duration of residence in Hong Kong and minibus usage by age at migration by ethnic group

South-east Asian and white immigrants quickly lost their initial advantages and were significantly slower than other groups to pick up minibus. We postulate that South-east Asian immigrants might have experienced discrimination in Hong Kong in the long run, which lowered their pace for integration (Loper, 2001; Sim, 2003; Tang *et al.*, 2004). Similar discrimination toward South Asians may also explain their significantly lower likelihood of taking the minibus. South Asians had long been viewed by the

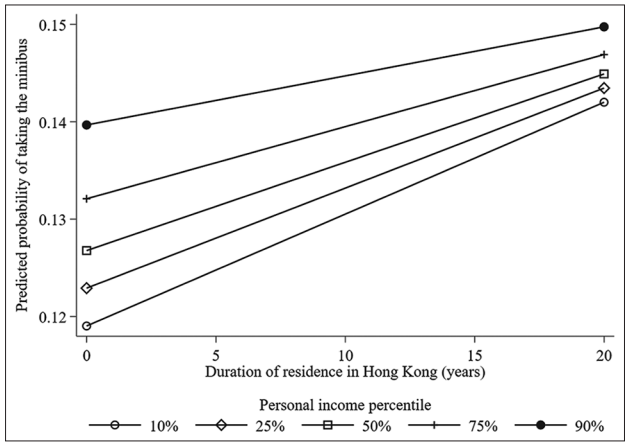


Figure 4. The association between duration of residence in Hong Kong and minibus usage by personal income percentile

locals as competitors for low-skilled jobs since the colonial period. In addition, South Asians, on average, maybe more economically disadvantaged than other ethnic groups, which may decrease the probability of choosing the more expensive transportation option, that is, the minibus (Law & Lee, 2013; Tonsing, 2013). Moreover, research has also revealed South Asian immigrants' lower language acquirement in Hong Kong, which might deter them from choosing the more culturally-loaded transportation mode (Shum *et al.*, 2011). Differently, Chinese arriving before 1997 were significantly faster in picking up minibus than the newly arrived Chinese, which might be explained by the different sociopolitical contexts in Hong Kong before and after the Handover. The social sentiments toward mainland immigrants were more empathized and tolerated before the Handover, during which massive numbers of mainlanders arrived as refugees and received help from their relatives in Hong Kong. However, as daily resources became more scarce with the presence of mainlanders after the Handover, increasing negative sentiments toward the recently arrived mainlander might have negatively affected their social integration (Fong & Guo, 2018).

The second category would include one's Cantonese ability. We are in line with previous findings that being able to speak the local language is all positively associated with one's higher likelihood of adopting the locals' transportation mode.

Table 5. Summary of hypotheses and results

	Hypotheses	Results (✓=Supported, ✗=Not supported)	Notes
1	Longer duration in Hong Kong is positively related to one's likelihood to take minibuses.	✓	$Duration_i$ is positive and significant throughout the models
2	Arriving in Hong Kong at a younger age is positively related to one's likelihood of taking the minibus.	✓	$MigAge_i$ is negative and significant throughout the models
3	Chinese immigrants are more likely to take the minibus than immigrants of any other ethnicity in Hong Kong, and those Chinese immigrants arriving before 1997 were even more likely to take the minibus compared to the latecomers.	✗	$Ethicity_i$ is not statistically significant in Model 1, meaning we did not observe significant inter-ethnic differences in terms of the total effects
4	Compared to immigrants from other ethnic backgrounds, the longer length of stay in Hong Kong, the less likely for Southeast Asian immigrants to take the minibus.	✓	$Duration_i \times Ethicity_i$ (D×South-east Asian) in Model 2 to Model 5 is negative and significant
5	The ability to speak Cantonese is positively related to one's likelihood of taking the minibus.	✓	$Cantonese_i$ is positive and significant throughout the models
6	Living in districts with a higher percentage of non-Chinese immigrants is negatively correlated to an immigrant's transportation assimilation.	✗	$EthDen_i$ is insignificant throughout the models
7	Among those who have spent the same period of time in Hong Kong, immigrants arriving at a younger age are more likely to take the minibus than those arriving at an older age.	Partially supported	$Duration_i \times MigAge_i \times Ethicity_i$ is only significant between Chinese arriving before 1997 versus Chinese arriving in or after 1997
8	Compared to Chinese immigrants arriving in or after 1997, those arriving before the Handover are increasingly more likely to take minibus in the long-term.	✗	Results in Figure 3 support the opposite

While the district-level characteristics are insignificant throughout the models, this result offers interesting implications for assimilation theories, especially the literature on residential segregation and inequality (Tessema *et al.*, 2021). The previous literature on assimilation theories has often argued for a bidirectional causal relationship between social and spatial integration (Patel & Pradhan, 2020). For example, in the Netherlands, the government attributes ethnic segregation to a lack of socioeconomic assimilation, which leads to the view that segregation, either ethnic or socioeconomic, can be combated by altering the uneven spatial distribution of affordable housing (Bolt *et al.*, 2008). Another example would be the scholars' examination of Turkish neighborhoods in Germany, in which ethnic concentration was viewed as immigrants' refusal to assimilate into the mainstream German sphere (Gruner, 2010). However, as Bolt *et al.* (2010) argued, the relationship between integration and residential segregation might not be as straightforward as previous scholars have claimed. Immigrants' "self-segregation" argument may be overstated, and we need to pay more attention to the roles played by both individuals and institutions of the host society in creating a segregated society (Bolt *et al.*, 2010). In our case, the rather compacted topography of Hong Kong has created a much less spatially segregated society. Nevertheless, we witnessed immigrants' different patterns of social assimilation across ethnic groups. It is possible that the ethnic concentration is not directly related to immigrants' assimilation *per se*. Instead, it may well be that "the street, community center, work, park, and other public spaces" consist of more meaningful sites of ethnic segregation in people's daily lives (Phillips, 2007). Then, the minibus itself becomes a type of public space that either encourages or impedes social integration. Unsurprisingly, immigrants of Chinese ethnicity, who are more culturally similar to the local people, are more likely to pick up minibus in the long-term.

Our research is also with several limitations. First, similar to most migration studies in general, our data also suffer from selection bias, in which the individuals we can observe are those choosing to stay in Hong Kong. Since those who find it challenging to adapt to Hong Kong society may have already left and are no longer in our dataset, we may thus overestimate the importance of the positive effects on transportation assimilation brought by the length of stay in the destination. In addition, for the same reason, our dependent variable also tends to include the more integrated immigrants as it does not comprehensively capture the difficulty of taking a minibus. Since the question asks for respondents' major mode of transportation to work, immigrants who need to work already represent a selected group. In addition, compared to hopping onto a minibus casually, taking a minibus bus to

work is a more routine process in which the random shifting routes or waving to the minibus between stations are less involved. The relatively lower difficulty in this process might explain the models' significant but small effect size. Second, to explore the dynamic mode of integration, we could not include the locals in our model. We acknowledge that comparing immigrants to the locals is a more common practice in integration studies. Some research on immigrants' integration into the destination also used a similar approach to ours (Martinović, 2013; Martinovic *et al*., 2009). Third, we could not obtain information on the initial ethnic concentration when immigrants first arrived in Hong Kong, which becomes impossible to infer whether the initial district-level ethnic diversity was important for one's social integration. Fourth, as a large-scale quantitative study, we lack depth in interpreting inter-ethnic differences in transportation adaptation. The future research might want to conduct interviews with immigrants from different ethnic groups regarding their minibus ridership.

5. Conclusion

Our paper provides another avenue for studying immigrant adaptation by exploring the transportation mode of immigrants. By looking at immigrants' minibus ridership throughout the years, our research zooms in on a routine activity to delineate immigrants' integration process in Hong Kong. This research creatively examines immigration and mobility in a non-traditional immigrant region, which extends the scope of the application of immigration theories. In addition, our research further expands transportation socialization studies by adding the dynamic mode of integration of immigrants. Capitalizing on a pooled set of census data and relying on linear probability models, we confirmed several expectations on immigrants' minibus taking in Hong Kong. By dissecting the main effects from the total effects of transportation assimilation, we applied general theories on interethnic contacts to a specific type of interethnic contact, for example, transportation assimilation as a typical type of non-leisure contact.

One innovation in this study is differentiating the effects between entry and long-term differences in the process. Compared to other immigration research on Hong Kong, one major contribution of our study is using a regionally representative dataset to explore immigrants' social integration into the local society. Due to data limitations, the previous Hong Kong studies had either only focused on economic integration (Tong *et al*., 2018; Zhang & Wu, 2011) or social integration with a much smaller sample size (Chen *et al*., 2019).

From a more local level, our research efficiently captures a fleeting scene in Hong Kong. According to the Transport Department of Hong Kong, which started in August 2017, all newly registered minibuses must be equipped with a stop button. This requirement would free passengers from shouting "*chin min yau lok*" (stop at the front), thus easing immigrants' procedures to take the minibus. Nevertheless, the minibus deserves more scholarly attention as a unique and culturally loaded transportation mode in Hong Kong.

Acknowledgments

The first author thanks her father for taking pictures of the minibusses. The first author wants to provide a brief background of writing the paper. She has lived in Hong Kong as an immigrant for several years but was always intimidated by taking the minibus. The primary reason is that she does not speak perfect Cantonese and is not very familiar with the topography in Hong Kong. However, during the Umbrella Movement, the metro service, and the mode of transportation, which she relied on the most, halted due to the protest. The only possible transportation route to her workplace was the minibus. Therefore, she picked up some Cantonese and forced herself to step on the very secretive and culturally-loaded public transportation option in Hong Kong, and she liked it.

Funding

The authors did not receive any funding for this research.

Conflict of interest

The authors declare no conflicts of interest.

Author contributions

Conceptualization: Skylar Biyang Sun, Xiaohang Zhao

Data curation: Skylar Biyang Sun, Xiaohang Zhao

Formal analysis: Skylar Biyang Sun

Methodology: Skylar Biyang Sun, Xiaohang Zhao

Writing – original draft: Skylar Biyang Sun

Writing – review & editing: Skylar Biyang Sun, Xiaohang Zhao, Guixiang Zhang

Ethics approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

Availability of data

Interested scholars may apply to the Census and Statistics Department of Hong Kong to obtain the microdata used in this research.

References

Beige, S., & Axhausen, K.W. (2012). Interdependencies between turning points in life and long-term mobility decisions. *Transportation*, 39(4): 857-872.

https://doi.org/10.1007/s11116-012-9404-y

Bell, W. (1954). A probability model for the measurement of ecological segregation. *Social Forces*, 32(4): 357-364.

https://doi.org/10.2307/2574118

Benassi, F., Mucciardi, M., & Gallo, G. (2023). Local population changes as a spatial varying multiscale process: The Italian case. *International Journal of Population Studies*, 9(1): 393.

https://doi.org/10.36922/ijps.393

Blau, P.M., Schwartz, J.E. (1984). Crosscutting Social Circles. New Brunswick, NJ: Transaction Publishers.

Blumenberg, E., & Shiki, K. (2007). Transportation Assimilation: Immigrants, Race and Ethnicity, and Mode Choice. Available from: https://trid.trb.org/view/802238 [Last accessed on 23 Apr 26].

Bolt, G., Özüekren, A.S., & Phillips, D. (2010). Linking integration and residential segregation. *Journal of Ethnic and Migration Studies*, 36(2): 169-186.

https://doi.org/10.1080/13691830903387238

Bolt, G., Van Kempen, R., & Van Ham, M. (2008). Minority ethnic groups in the Dutch housing market: Spatial segregation, relocation dynamics and housing policy. *Urban Studies*, 45(7): 1359-1384.

https://doi.org/10.1177/0042098008090678

Census and Statistics Department. (2017). Thematic Report: Ethnic Minorities. Available from: https://www.statistics.gov.hk/pub/B11201002016XXXXB0100.pdf [Last accessed on 2023 Apr 26].

Chatman, D.G. (2014). Explaining the "immigrant effect" on auto use: The influences of neighbourhood and preferences. *Transportation*, 41(3): 441-461.

https://doi.org/10.1007/s11116-013-9475-4

Chen, J., Li, Z., Xu, D., & Wu, X. (2019). Effects of neighborhood discrimination towards Mainland immigrants on mental health in Hong Kong. *International Journal of Environmental Research and Public Health*, 16(6): 1025.

https://doi.org/10.3390/ijerph16061025

Cheung, J.T.K., Tsoi, V.W.V., Wong, K.H.K., & Chung, R.Y. (2019). Abuse and depression among Filipino foreign domestic helpers. A cross-sectional survey in Hong Kong. Public Health, 166: 121-127.

https://doi.org/10.1016/j.puhe.2018.09.020

Chiswick, B.R., & Miller, P.W. (2001). A model of destination-language acquisition: Application to male immigrants in Canada. Demography, 38(3): 391-409.

https://doi.org/10.1353/dem.2001.0025

Douma, F. (2004). Using ITS to Better Serve Diverse Populations. Retrieved from the University of Minnesota Digital Conservancy. Available from: https://hdl.handle.net/11299/1138 [Last accessed on 2023 Apr 26].

Fong, E., & Guo, H. (2018). Immigrant integration and their negative sentiments toward recent immigrants: The case of Hong Kong. *Asian Pacific Migration Journal*, 27(2): 166-189.

https://doi.org/10.1177/0117196818772326

Gruner, S. (2010). 'The others don't want…'. Small-scale segregation: Hegemonic public discourses and racial boundaries in German neighbourhoods. *Journal of Ethnic and Migration Studies*, 36(2): 275-292.

https://doi.org/10.1080/13691830903387402

Hainmueller, J., Hangartner, D., & Pietrantuono, G. (2017). Catalyst or crown: Does naturalization promote the long-term social integration of immigrants? *American Political Science Review*, 111(2): 256-276.

https://doi.org/10.1017/S0003055416000745

Haustein, S., Kroesen, M., & Mulalic, I. (2020). Cycling culture and socialisation: Modelling the effect of immigrant origin on cycling in Denmark and the Netherlands. *Transportation*, 47: 1689-1709.

https://doi.org/10.1007/s11116-019-09978-6

Kalmijn, M. (1998). Intermarriage and homogamy: Causes, patterns, trends. *Annual Review of Sociology*, 24(24): 395-421.

https://doi.org/10.1146/annurev.soc.24.1.395

Klinger, T., & Lanzendorf, M. (2016). Moving between mobility cultures: What affects the travel behavior of new residents? *Transportation*, 43(2): 243-271.

https://doi.org/10.1007/s11116-014-9574-x

Law, K.Y., & Lee, K.M. (2013). Socio-political embeddings of South Asian ethnic minorities' economic situations in Hong Kong. *Journal of Contemporary China*, 22(84): 984-1005.

https://doi.org/10.1080/10670564.2013.795312

Leurent, F. (2022). Used (lived) versus offered (plain) densities of human settlement in space: An instance of the probabilistic consumption model. *International Journal of Population Studies*, 8(2): 34-50.

https://doi.org/10.36922/ijps.v8i2.297

Liu, C.Y., & Painter, G. (2012). Travel behavior among Latino immigrants: The role of ethnic concentration and ethnic employment. *Journal of Planning Education and Research*, 32(1): 62-80.

https://doi.org/10.1177/0739456X11422070

Loper, K. (2001). Cultivating a Multicultural Society and Combating Racial Discrimination in Hong Kong. Hong

Kong: Civic Exchange.

Martinović, B. (2013). The inter-ethnic contacts of immigrants and natives in the Netherlands: A two-sided perspective AU. *Journal of Ethnic and Migration Studies*, 39(1): 69-85.

https://doi.org/10.1080/1369183X.2013.723249

Martinovic, B., Van Tubergen, F., & Maas, I. (2009). Changes in immigrants' social integration during the stay in the host country: The case of non-western immigrants in the Netherlands. *Social Science Research*, 38(4): 870-882.

https://doi.org/10.1016/j.ssresearch.2009.06.001

Massey, D.S., & Denton, N.A. (1985). Spatial assimilation as a socioeconomic outcome. *American Sociological Review*, 50(1): 94-106.

https://doi.org/10.2307/2095343

Massey, D.S., & Denton, N.A. (1988). The dimensions of residential segregation. *Social Forces*, 67(2), 281-315.

https://doi.org/10.1093/sf/67.2.281

McPherson, M., Smith-Lovin, L., & Cook, J.M. (2001). Birds of a feather: Homophily in social networks. *Annual Review of Sociology*, 27(1): 415-444.

https://doi.org/10.1146/annurev.soc.27.1.415

Mustillo, S.A., Lizardo, O.A., & McVeigh, R.M. (2018). Editors' Comment: A few Guidelines for Quantitative Submissions. Los Angeles, CA: SAGE Publications.

Negussie, S.T., Chalachew, G.D., Nigatu, R.G., & Terefe, D.B. (2021). Residential inequalities in child mortality in Ethiopia: Multilevel and decomposition analyses. *International Journal of Population Studies*, 7(2): 47-59.

https://doi.org/10.36922/ijps.v7i2.392

Ng, H.Y., Kennedy, K.J., & Hue, M.T. (2019). What contributes to ethnic minorities' identification with Hong Kong? The cases of South Asian and Filipino youth. *Asian Ethnicity*, 20(2): 228-249.

https://doi.org/10.1080/14631369.2018.1507725

Patel, S.K., & Pradhan, M.R. (2020). Inequalities in urban exposure to infrastructure, services, and environment in million-plus cities of India. *International Journal of Population Studies*, 6(1): 16-29.

https://doi.org/10.18063/ijps.v6i1.1051

Phillips, D. (2007). Ethnic and racial segregation: A critical perspective. *Geography Compass*, 1(5): 1138-1159.

https://doi.org/10.1111/j.1749-8198.2007.00051.x

Portes, A., & Zhou, M. (1993). The new second generation: Segmented assimilation and its variants. *The Annals of the American Academy of Political and Social Science*, 530(1): 74-96.

https://doi.org/10.1177/0002716293530001006

Shevky, E., & Bell, W. (1955). Social Area analysis; Theory, Illustrative Application and Computational Procedures. California: Stanford University Press.

Shum, M.S.K., Gao, F., Tsung, L., & Ki, W.W. (2011). South Asian students' Chinese language learning in Hong Kong: Motivations and strategies. *Journal of Multilingual and Multicultural Development*, 32(3): 285-297.

https://doi.org/10.1080/01434632.2010.539693

Sim, A. (2003). Organising discontent: NGOs for Southeast Asian migrant workers in Hong Kong. *Asian Journal of Social Science*, 31(3): 478-510.

https://doi.org/10.1163/156853103322895351

Smart, M.J. (2015). A nationwide look at the immigrant neighborhood effect on travel mode choice. *Transportation*, 42(1): 189-209.

https://doi.org/10.1007/s11116-014-9543-4

Sun, B., & Fong, E. (2021). Immigrant entrepreneurship in Hong Kong. In: Immigrant Entrepreneurship in Cities. Germany: Springer, p.67-96.

Sun, S.B., & Fong, E. (2022). The role of human capital, race, gender, and culture on immigrant entrepreneurship in Hong Kong. *Journal of Small Business and Entrepreneurship*, 34(4): 363-396.

https://doi.org/10.1080/08276331.2021.1959177

Tal, G., & Handy, S. (2010). Travel behavior of immigrants: An analysis of the 2001 National household transportation survey. *Transport Policy*, 17(2): 85-93.

https://doi.org/10.1016/j.tranpol.2009.11.003

Tang, K.L., Lam, M.C., & Ngai, S. (2004). Tackling discrimination against ethnic minorities: The case of post-colonial Hong Kong. *Indian Journal of Social Work*, 65(3): 352-372.

Tong, Y., Su, W., & Fong, E. (2018). Labor market integration of non-Chinese immigrants in Hong Kong from 1991 to 2011: Structure of global market or White privilege? *Chinese Journal of Sociology*, 4(1): 79-108.

https://doi.org/10.1177/2057150X17748533

Tonsing, K.N. (2013). Predictors of psychological adaptation of South Asian immigrants in Hong Kong. *International Journal of Intercultural Relations*, 37(2): 238-248.

https://doi.org/10.1016/j.ijintrel.2013.01.002

Transport Department. (2021). Public Bus Services Ordinance. Available from: https://www.elegislation.gov.hk/hk/cap230!en-sc [Last accessed on 2023 Apr 26].

Transport Department. (2020). Section 5 Public Transport-Average Daily Public Transport Passenger Journeys by Mode during 2010-2019 (in thousands), Hong Kong. Available from: https://www.td.gov.hk/mini_site/atd/2020/en/section5_2.html [Last accessed on 2023 Apr 26].

Valenzuela, A. Jr., Schweitzer, L., & Robles, A. (2005). Camionetas: Informal travel among immigrants. *Transportation Research Part A: Policy and Practice*, 39(10): 895-911.

https://doi.org/10.1016/j.tra.2005.02.026

Welsch, J., Conrad, K., & Wittowsky, D. (2018). Exploring immigrants travel behaviour: Empirical findings from Offenbach Am Main, Germany. *Transportation*, 45(3): 733-750.

https://doi.org/10.1007/s11116-016-9748-9

Xu, D. (2018). Transportation assimilation revisited: New evidence from repeated cross-sectional survey data. *PLoS One*, 13(4): e0194296.

https://doi.org/10.1371/journal.pone.0194296

Zhang, Z., & Wu, X. (2011). Social change, cohort quality and economic adaptation of Chinese immigrants in Hong Kong, 1991-2006. *Asian and Pacific Migration Journal*, 20(1): 1-29.

https://doi.org/10.1177/011719681102000101

ACCSCIENCE PUBLISHING

International Journal of Population Studies

RESEARCH ARTICLE

The promoting effects of neighborhood social cohesion on self-reported depression: A cross-sectional analysis of adult Irish migrants in the United Kingdom

Jeff Moore[1,2]* and Mary Tilki[3,4]

[1]Jigsaw: the National Centre for Youth and Mental Health, Dublin

[2]Dublin City University, Drumcondra Road, Dublin 9, Ireland

[3]The Federation of Irish Societies, London, United Kingdom

[4]Middlesex University, London, United Kingdom

Abstract

While studies have demonstrated a link between neighborhood social cohesion (NSC) and mental health, this relationship has been inadequately explained for migrant communities. This study explores the effect of NSC on the self-reported depression (SRD) of Irish migrants in the United Kingdom. Considering differing migration experiences and health outcomes across age groups of Irish migrants to the United Kingdom, we explore how this relationship was moderated by age. Logistic regression models showed that NSC promoted mental health in universal contexts. As risks increased, only perceived neighborhood safety promoted mental health. Age had a significant effect on the relationship between NSC and depression. NSC may be associated with reduced SRD for younger but not older Irish migrants. Our findings support interventions, which promote NSC in low-risk contexts and safety in higher-risk settings for Irish migrants. This study reiterates the mental health vulnerability of older Irish migrants.

Keywords: Migrant; Mental health; Self-report depression; Health promotion; Social cohesion; Ireland

***Corresponding author:**
Jeff Moore
(Jeffc.moore@gmail.com)

Citation: Moore, J., & Tilki, M. (2023). The promoting effects of neighborhood social cohesion on self-reported depression: A cross-sectional analysis of adult Irish migrants in the United Kingdom. *International Journal of Population Studies,* 9(1):51-57. https://doi.org/10.36922/ijps.431

Received: December 23, 2022

Accepted: March 25, 2023

Published Online: April 11, 2023

1. Introduction

Migrant communities experience elevated risk of mental health difficulties, such as depression (Smith *et al.*, 2020). Although studies have explored the prevalence and predictors of migrant depression, migrant resilience and social protective factors have received less attention (Kemmak *et al.*, 2021). Social cohesion is commonly reported as an essential component of strategies to improve outcomes for migrants and has been linked to better mental health outcomes (Echeverría *et al.*, 2008). While some studies have reported a link between social cohesion and migrant health (Zhang *et al.*, 2021), this relationship has not been adequately examined from a social psychological perspective (Sandal-Önal *et al.*, 2022) and we know little about individual moderating factors.

Irish migrants to the United Kingdom (UK) experience poor mental health outcomes (for a detailed overview, see Delaney *et al.*, 2013). There has been a lack of research

into the resilience and post-migration protective factors of this community (Moore *et al.*, 2018). In this article, we draw on a community-based participatory action research (CBPAR) project which aimed to explore the health needs and resources of Irish migrants to London (Moore *et al.*, 2018). Neighborhood cohesion was identified as an important health facilitator by a migrant advisory group in the design stage of this project. In this paper, we examine the main effects of neighborhood social cohesion (NSC) on the self-reported depression (SRD) of Irish migrants and how these effects are modified by age.

1.1. Neighborhood social cohesion

While a variety of definitions exist, NSC can be defined as the extent of connectedness and solidarity among groups in neighborhood and consists of (i) the absence of latent social conflict and (ii) the presence of strong social bonds and connections in neighborhood settings (Holmes and Marcelli, 2020; Kim *et al.*, 2016). Social bonds and support may protect from loneliness, provide emotional, information, and tangible support and it may also transmit positive health behaviors and disseminate mental health promoting information (Oberndorfer *et al.*, 2022). Researchers assert that this mechanism is not frequently or adequately reported in the research literature (Zhang *et al.*, 2021) and few studies have scientifically examined this relationship within specific migrant populations (Holmes and Marcelli, 2020). While neighborhood safety is widely linked to improved health, studies with migrant communities have been mixed and some have found that this relationship may be modified by individual characteristics (Chen & Chen, 2015).

1.2. Irish communities in the United Kingdom

Studies show high rates of depression and other mental health difficulties among Irish migrants in England over several decades (Delaney *et al.*, 2013). Second-generation Irish migrants also experience high levels of psychological morbidity (Delaney *et al.*, 2013). Ireland's geographical proximity to Britain and the shared language reduce barriers to movement and this may result in a negative selection bias. Studies have explored a range of social resettlement factors, such as discrimination (Hickman & Walter, 1997), identity loss and belonging. Fewer studies have explored how social cohesion might promote mental health and well-being for this established community. Ryan *et al.* (2006) found that low levels of social support were associated with increased depression, and recent studies have indicated that social support may buffer against the negative effects of unfair treatment (Moore *et al.*, 2018). Despite these advances, there remain significant gaps in our knowledge, and no study has explored the link between NSC and mental health outcomes for Irish migrants. A range of studies have highlighted differences in terms of migratory experiences and health outcomes across age cohorts of Irish migrants. For example, Delaney *et al.* (2013) found that Irish migrants to the UK born between 1920 and 1960 experienced a substantial health penalty, which may be partly a result of pre-migration experiences. Similarly, studies in the United States (US) found that the age of migration may influence social integration and mental health outcomes (Jang *et al.*, 2022). As a result, alongside the direct influences of NSC on self-report depression of Irish migrants, we examine how these effects differ by age.

2. Data and methods

2.1. Data sources

Data come from a CBPAR study conducted with the Irish community in London (for more detail, see Moore *et al.*, 2018). The study employed a non-proportionate purposeful sampling strategy targeting Irish people in London. Participants were recruited through Irish-specific newspapers, social media networks, and a wide range of Irish and non-Irish community-based organizations (CBOs). The previous analysis showed that the majority of the sample resided in central London boroughs, similar to previous census data and other migrant communities (Moore *et al.*, 2018). Data were collected through an online survey and in CBOs across London by trained volunteer researchers. All participants provided informed consent, and ethical clearance for the original study was obtained from the Middlesex University Research Ethics Committee.

2.2. Measures

SRD was measured using a single-item question (Yes/No). Studies have found that single-item self-report methods can be used to identify depression with a good degree of confidence (Turon *et al.*, 2019). "Yes" responses have ranged from 8.1% to 11.2% in population studies (Block *et al.*, 2014).

We define social cohesion as the presence of strong social bonds and connections and safety and security (Holmes and Marcelli, 2020; Kim *et al.*, 2016). Drawing on this definition, our CBPAR project measured both perceived neighborhood safety (PNS) and perceived neighbor social support (PSS). PSS was measured using the Oslo 3-item social support scale (OSSS-3). The OSSS-3 has been widely used and found to be a reliable and valid measure of functional social support and focuses on neighborhood settings (Bøen *et al.*, 2012). The OSSS-3 covers three domains: (i) Number of people that respondents feel able to rely on if they have a serious problem, (ii) practical help from neighbors, and (iii) the interest and concern

shown by others. Cronbach's alpha in the current study was acceptable (α = 0.58; Mallery, 2003). Participants were to ask response Yes/No to a question about feeling safe in their neighborhood, mirroring other studies, which have conceptualized neighborhood safety as a single construct.

To assess the influence of social cohesion in riskier contexts, we included four post-migration risk factors: Perceived discrimination, self-reported general health (SRGH), unemployment, and housing status. Participants were asked if they had experienced unfair treatment in the past 12 months based on ethnicity, age, gender, sexual orientation and disability, and categories were summed to create a variable to represent any form of perceived discrimination in the previous year. Housing, employment, and SRGH was measured via a single-item measure (excellent, very good, good, fair, or poor).

2.3. Analysis

A hierarchical logistic regression was conducted using SPSS 23 to test the unique association between SRD and both (i) PNS and (ii) PSS. The data were assessed for independence of errors, linearity, and outliers, and the sample size was sufficient for logistic regression (Bujang *et al.*, 2018). The dependent variable was SRD (Yes/No). In Step 1, the unique association of PSS and PNS with SRD was tested while controlling for demography. In this step, we assessed the unique effects of PSS and PNS in universal or low-risk settings. In Step 2, we included employment- and housing-related risks. In Steps 3 and 4, we included SRGH and perceived discrimination, respectively. Essentially, we wanted to know if PSS and PNS predicted SRD in higher-risk contexts. Model variables were included based on the previous research on Irish migrants (Delaney *et al.*, 2013; Moore, 2019).

To test the interaction between age and both PNS and PSS, we used the Andrew Hayes' Process Macro for SPSS (Hayes, 2012). The same covariates as the direct effects models were included and continuous predictor variables were mean-centered to aid interpretation of interaction effects. When a significant interaction was found, we performed a simple slope test using the pick-a-point method. Using the standard conditional values of ±1 *SD* from the mean, we probed interactions at 27, 45, and 65 years of age. These age groups were theoretically relevant representing young adulthood, middle aged, and elderly. Missing data were within acceptable ranges (max 10.61%; Bennett, 2001) and managed through the pairwise function in SPSS.

3. Results

3.1. Descriptive statistics

Table 1 provides demography of the sample, which has been reported in full previously (Moore, 2019). Just over

Table 1. Descriptive statistics and associations with self-reported depression (n=790)

Variables	Self-reported depression				Univariate statistics	
	No		Yes		χ^2	*p*
	n	%	*n*	%		
Gender						
Male	268	39.81%	38	40.9%	0.03	0.46
Female	405	60.21%	55	59.1%		
Age						
≤29	190	27.90%	15	16.1%	7.55	0.05
30 – 41	165	24.22%	21	22.6%		
42 – 64	164	24.11%	27	29.0%		
≥65	162	23.84%	30	32.3%		
Country of Birth						
Ireland	510	75.10%	62	65.3%	4.19	0.02
UK	169	24.93%	33	34.7%		
Housing						
Non-homeowner	412	61.51%	68	70.8%		
Homeowner	258	38.54%	28	29.2%		
Employment						
Unemployed	33	4.84%	7	7.3%	16.38	0.001
Not unemployed	661	95.23%	89	92.7%		
SRGH						
Very poor	4	0.61%	3	3.2%	93.83	0.001
Poor	34	5.46%	25	26.6%		
Fair	90	14.34%	30	31.9%		
Good	241	38.32%	30	31.9%		
Very good	260	41.33%	6	6.4%		
Neighborhood safety						
No	34	5.50%	21	25.6%	40.43	0.001
Yes	584	94.51%	61	74.4%		
Support from neighbors						
Very difficult	64	10.62%	23	25.0%	16.89	0.02
Difficult	104	17.38%	18	19.6%		
Possible	202	33.62%	25	27.2%		
Easy	131	21.84%	13	14.1%		
Very easy	100	16.61%	13	14.1%		
People close for support						
None	25	4.10%	11	11.7%	16.43	0.001
1 – 2 people	219	36.23%	40	42.6%		
3 – 5 people	181	29.94%	29	30.9%		
≥5 people	180	29.81%	14	14.9%		
People showing concern						
None	22	3.70%	10	10.9%	19.82	0.001
Little	49	8.28%	16	17.4%		
Uncertain	84	14.15%	12	13.0%		
Some	251	42.02%	34	37.0%		
A lot	191	32.08%	20	21.7%		
Any unfair treatment						
No	455	80.28%	47	53.4%	30.64	0.001
Yes	112	19.89%	41	46.6%		

one-tenth reported SRD. Bivariate analyses showed a significant difference across age groups with those over 65 years of age scoring the highest levels of SRD. There was a significant difference in SRD by country of birth, with those born in the United Kingdom scoring higher (16.31%) than those born in Ireland (10.83%). There was also a significant difference in SRD across domains of PSS with lower social support related to depression. Likewise, those who did not feel safe in their neighborhood were more likely to report SRD.

3.2. Results of regression predicting SRD

Bivariate correlation between predictors showed the strongest relationships between SRD and unemployment (r = −0.54, p = 0.001) and PSN and SRD (r = −0.18, p = 0.001), which indicated multicollinearity was within acceptable levels (table available on request). The variance inflation factor values of the independent variables were lower than the common cut-off threshold of 3.0 (Miles & Shevling, 2001). Table 2 provides hierarchical multiple regression results predicting SRD. In the first model, both PNS and PSS were significantly associated with SRD. For each unit increase in PSS, participants were 1.20 times less likely to report SRD. Feeling unsafe was related to SRD (OR = 0.22, p = 0.001 0.00) and those who reported feeling safe were 4.54 times less likely to report SRD. With the inclusion of risk exposure variables, the model remained a significant predictor of SRD and accounted for nearly a quarter of the variance in SRD. The inclusion of unemployment and social housing in the second step and SRGH in the third step made minimal difference to the model. With the inclusion of perceived discrimination in the fourth step, PSS no longer significantly predicted SRD. On the other hand, PNS remained a significant predictor of SRD (OR = 0.35, p = 0.01). Inverting this statistic showed that with those reporting feeling safe in their neighborhood were 2.85 times less likely to report SRD. In the final two models, those who had perceived any form of discrimination in the past year were significantly more likely to report SRD. We conducted a backward selection, removing the variables with the lowest predictive power (employment, gender, and housing). We observed no differences in model fit statistics and significances of predictor variables.

The model with interaction effects was a significant predictor of SRD, R^2 = 0.36, F (1, 10) = 118.39, p = 0.001. Results showed a significant interaction between PNS and age, although the effect was small (B = 0.07, p = 0.001, OR = 1.07). Table 3 provides data from the pick-a-point method. As illustrated by Figure 1, at 65 years, PNS was not significantly associated with SRD (B = 0.11, SE = 0.58, p = 0.84). For participants at 45 years old, feeling safe in their neighborhood was associated with reduced

Table 2. Logistic regression predicting self-reported depression

	Model 1					Model 2					Model 3					Model 4				
	B	SE	p	OR	95% CI	B	SE	p	OR	95% CI	B	SE	p	OR	95% CI	B	SE	p	OR	95% CI
					LL UL					LL UL					LL UL					LL UL
Gender (Female)	0.17	0.27	0.54	1.18	0.69 2.01	0.16	0.27	0.56	1.17	0.69 2.01	0.03	0.30	0.91	1.04	0.58 1.86	0.05	0.30	0.87	1.05	0.58 1.90
Country of birth (UK/Ireland)	−0.74	0.29	0.01	0.48	0.27 0.83	−0.86	0.30	0.00	0.42	0.24 0.76	−0.65	0.33	0.05	0.52	0.28 0.99	−0.62	0.33	0.06	0.54	0.28 1.03
Age	0.01	0.01	0.16	1.01	1.00 1.02	0.01	0.01	0.07	1.01	1.00 1.03	−0.03	0.01	0.01	0.97	0.95 0.99	−0.02	0.01	0.03	0.98	0.96 1.00
PSS (Scale)	−0.18	0.06	0.00	0.83	0.74 0.94	−0.17	0.06	0.00	0.84	0.75 0.95	−0.11	0.06	0.09	0.90	0.79 1.02	−0.10	0.06	0.12	0.91	0.80 1.03
PNS (No)	−1.53	0.35	0.00	0.22	0.11 0.43	−1.48	0.36	0.00	0.23	0.11 0.46	−1.17	0.40	0.00	0.31	0.14 0.68	−1.04	0.41	0.01	0.35	0.16 0.80
Employment (Yes/No)						0.06	0.54	0.92	1.06	0.37 3.04	−0.35	0.65	0.59	0.71	0.20 2.50	−0.45	0.67	0.51	0.64	0.17 2.40
Housing (Social/Private)						0.46	0.32	0.15	1.58	0.85 2.93	0.12	0.35	0.73	1.12	0.57 2.21	0.13	0.35	0.71	1.14	0.57 2.26
SRGH											1.27	0.19	0.00	3.54	2.44 5.16	1.18	0.20	0.00	3.26	2.22 4.78
PD (Yes)																0.85	0.31	0.00	2.34	1.28 4.31
Model fit																				
χ^2	42.68 (5), p=0.001					44.83 (7), p=0.001					97.76 (8), p=0.001					103.29 (9), p=0.001				
-2LL	388.64					386.54					333.96					328.05				
R^2	0.13					0.14					0.29					0.31				

B: Standardized coefficients; CI: Confidence interval; LL: Lower limit; OR: Odds ratio; PD: Perceived discrimination; PNS: Perceived neighborhood safety; PSS: Perceived social support; *SE*: Standard error; UL: Upper limit

Table 3. Moderation effects of age of the relationship between perceived social support and perceived neighborhood safety on self-reported depression

Age	Effect	*SE*	Wald	*p*	95% CI	
					LL	UL
PSS						
27	−0.40	0.10	−3.69	0.001	−0.61	−0.188
45	−0.13	0.071	−1.94	0.051	−0.27	0.001
65	0.122	0.82	1.42	0.155	−0.04	0.292
PNS						
27	−2.72	0.67	−4.41	0.0001	−4.04	−1.40
45	−1.31	0.43	−3.01	0.002	−2.15	−0.45
65	0.11	0.586	0.19	0.84	−1.03	1.26

B: Standardized coefficients; CI: Confidence interval; LL, lower limit; OR, odds ratio; PNS, perceived neighborhood safety; PSS, perceived social support; SE, standard error; UL, upper limit.

SRD ($B = -1.30$, $SE = 0.43$, $p < 0.001$). Likewise, at 27 years old, PNS was related to reduced likelihood of SRD ($B = -2.72$, $SE = 0.63$, $p < 0.001$) showing a stronger effect than at 45 years old. Like PNS, moderation analysis showed an interaction between PSS and SRD ($B = 0.01$, $p = 0.001$, OR = 1.01). Figure 2 shows that at 27 years old, lower levels of PSS was associated with an increase likelihood of SRD ($B = -0.40$, $SE = 0.10$, $p < 0.001$). Likewise, at 46 years, lower PSS was related to increased SRD ($B = -0.139$, $SE = 0.01$, $p = 0.05$), although the effect was stronger for the younger age group. Increased PSS was not significantly related to SRD for those 65 years old and over ($B = 0.12$, $SE = 0.82$, $p = 0.15$) and for this age group, those with high PSS were more likely to report SRD.

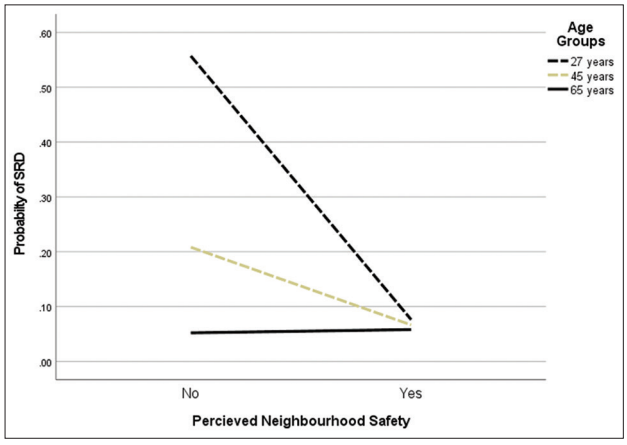


Figure 1. Simple slopes illustrating the moderating effects of age on the relationship between perceived neighborhood safety and self-reported depression.

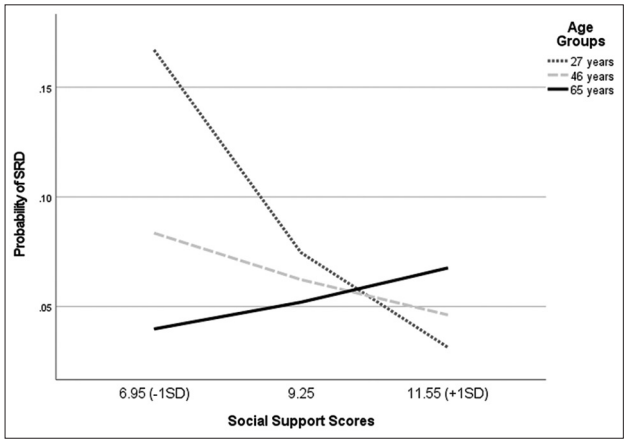


Figure 2. Simple slopes illustrating the moderating effects of age on the relationship between perceived social support and self-reported depression.

4. Discussion

To the best of our knowledge, this study is one of the first to explore the effects of NSC on the SRD for an established migrant population. By examining the moderating effect of age, we provide new information on the mechanisms influencing the well-established direct association of social cohesion on health. Our findings are consistent with previous studies demonstrating that NSC can directly promote reduced SRD for migrants (Zhang *et al.*, 2021). Many community-based organizations working with Irish migrants deliver programs that aim towards NSC, and our findings provide support for these as universal health-promoting opportunities. Our findings further showed that as risks increase, PNS (and not social support) could directly affect SRD, which indicates a hierarchy of needs for migrants at risk.

Our results indicate that older Irish migrants have higher rates of SRD. This is not in accordance with general population studies, which tend to show that the likelihood of depression reduces with age (Kessler *et al.*, 2010). A number of studies have found that higher PSS is associated with improved mental health in younger but not older adults (e.g., Milner *et al.*, 2016), and our research confirms such a finding. It may be that the functional neighborhood supports are more important earlier in life when migrants need support to access resources. Our results showed that, unlike other groups, older migrants tended to report high depression alongside high levels of social support. Due to snowballing techniques, it may be that the sample is over-represented by older people in poor health who live in supported living settings or in daycare services and perceive high levels of social support due to these environments.

While the data comes from the largest targeted collection of data on the Irish community in the UK, this

sample is not representative. Single-item measures have a relatively poor ability to detect less-than-severe depression (Blozik *et al.*, 2013) and as such, it is likely that the effects found in this study relate to more severe depression. While within tolerance, the moderate Cronbach alpha level of the OSSS-3 is a limitation. Finally, as this was a cross-sectional study, we are not able to determine the direction of associations and cannot rule out reserve causality. This is a common limitation of social cohesion research and there is a need for longitudinal research to further explore and confirm our findings.

5. Conclusions

NSC may promote mental well-being for Irish migrants. Of the components of NSC, our results indicate that PSS was promotive in low-risk settings, whereas PNS promotes mental health in universal and high-risk settings. Age had a significant moderating effect, indicating that NSC promoted improved SRD for younger and middle-aged migrants but not older migrants. Longitudinal research is needed to interrogate these findings.

Acknowledgments

None.

Funding

None.

Conflict of interest

The authors declare no conflicts of interest.

Author contributions

Conceptualization: Jeff Moore, Mary Tilki
Formal analysis: Jeff Moore, Mary Tilki
Investigation: Jeff Moore, Mary Tilki
Writing – original draft: Jeff Moore, Mary Tilki
Writing – review and editing: Jeff Moore, Mary Tilki

Ethics approval and consent to participate

Ethical approval for this study was obtain from Middlesex University Research Ethics Committee. All study participant provided written consent to participate and to publish the study.

Consent for publication

All study participant provided written consent to participate and to publish the study.

Availability of data

Data sharing is not consistent with the terms of consent signed by participants.

References

Bennett, D.A. (2001). How can I deal with missing data in my study? *Australia and New Zealand Journal of Public Health*. 25(5): 464–469.

Block, M., Stern, D.B., Raman, K., Lee, S., Carey, J., Humphreys, A.A., Mulhern, F., Calder, B., Schultz, D., Rudick, C.N., Blood, A.J., & Breiter, H.C. (2014). The relationship between self-report of depression and media usage. *Frontiers in Human Neuroscience*, 8: 712.

https://doi.org/10.3389/fnhum.2014.00712

Blozik, E., Scherer, M., Lacruz, M.E., & KORA Study Group. 2013. Diagnostic utility of a one-item question to screen for depressive disorders: Results from the KORA F3 study. *BMC Family Practice*, 14: 198.

https://doi.org/10.1186/1471-2296-14-198

Bøen, H., Dalgard, O.S., & Bjertness, E. (2012). The importance of social support in the associations between psychological distress and somatic health problems and socio-economic factors among older adults living at home: A cross sectional study. *BMC Geriatrics*, 12: 27.

https://doi.org/10.1186/1471-2318-12-27

Bujang, M.A., Sa'at, N., Sidik, T.M.I.T.A.B., & Joo, L.C. (2018). Sample size guidelines for logistic regression from observational studies with large population: Emphasis on the accuracy between statistics and parameters based on real life clinical data. *The Malaysian Journal of Medical Sciences*, 25(4): 122–130.

https://doi.org/10.21315/mjms2018.25.4.12

Chen, J., & Chen, S. (2015). Mental health effects of perceived living environment and neighborhood safety in urbanizing China. *Habitat International*, 46: 101–110.

https://doi.org/10.1016/j.habitatint.2014.11.002

Delaney, L., Fernihough, A., & Smith, J.P. (2013). Exporting poor health: The Irish in England. *Demography*, 50(6), 2013–2035.

https://doi.org/10.1007/s13524-013-0235-z

Hayes, A.F. (2012). PROCESS: A Versatile Computational Tool for Observed Variable Mediation, Moderation, and Conditional Process Modeling [White Paper]. Available from: https://www.afhayes.com/public/process2012.pdf [Last accessed on 2023 Feb 15].

Hickman, M.J., & Walter, B. (1997). Discrimination and the Irish Community in Britain. London: Commission for Racial Equality.

Holmes, L.M., & Marcelli, E.A. (2020). Neighborhood social cohesion and serious psychological distress among Brazilian immigrants in Boston. *Community Mental Health Journal*, 56(1), 149–156.

https://doi.org/10.1007/s10597-019-00468-8

Jang, H., Pilkauskas, N.V., & Tang, F. (2022). Age at immigration

and depression: The mediating role of contemporary relationships with adult children among older immigrants. *The Journals of Gerontology Series B*, 77(2): 413–423.

https://doi.org/10.1093/geronb/gbaa209

Kemmak, A.R, Nargesi, S., & Saniee, N. (2021). Social determinant of mental health in immigrants and refugees: A systematic review. *Medical Journal of the Islamic Republic of Iran*, 35: 196.

https://doi.org/10.47176/mjiri.35.196

Kessler, R.C., Birnbaum, H., Bromet, E., Hwang, I., Sampson, N., & Shahly, V. (2010). Age differences in major depression: results from the National Comorbidity Survey Replication (NCS-R). *Psychological Medicine*, 40(2): 225–237.

https://doi.org/10.1017/S0033291709990213

Kim, E., Hawes, A., & Smith.J. (2014). Perceived neighbourhood social cohesion and myocardial infarction. *Journal of Epidemiology and Community Health*. 68(11), 1020–1026.

https://doi.org/10.1136/jech-2014-204009

Mallery, G. (2003). SPSS for Windows Step by Step: A Simple Guide and Reference. Boston: Allyn and Bacon.

Milner, A., Krnjacki, L., & LaMontagne, A.D. (2016). Age and gender differences in the influence of social support on mental health: A longitudinal fixed-effects analysis using 13 annual waves of the HILDA cohort. *Public Health*, 140: 172–178.

https://doi.org/10.1016/j.puhe.2016.06.029

Moore, J. (2019). Perceived functional social support and self-rated health: The health promoting effects of instrumental support for the Irish community in London. *Journal of Immigrant Minority Health*, 21: 1004–1011.

https://doi.org/10.1007/s10903-018-0831-5

Moore, J., Tilki, M., Clarke, L., & Waters, E. (2018). The moderating effect of functional social support on the association between unfair treatment and self-rated health: A study of the resilience of a community-based sample of Irish migrants in London. *Irish Journal of Sociology*, 26(3): 267–288.

https://doi.org/10.1177/0791603518811775

Oberndorfer, M., Dorner, T.E., Leyland, A.H., Grabovac, I., Schober, T., Šramek, L., Bilger, M. (2022). The challenges of measuring social cohesion in public health research: A systematic review and eco-metric meta-analysis, *SSM Population Health*, 17: 101028.

https://doi.org/10.1016/j.ssmph.2022.101028

Ryan, L., Leavey, G., Golden, A., Blizard, R., & King, M. (2006). Depression in Irish migrants living in London: Case-control study. *The British Journal of Psychiatry: The Journal of Mental Science*, 188: 560–566.

https://doi.org/10.1192/bjp.188.6.560

Sandal-Önal, E., Bayad, A., Zick, A., & Düzen, N.E. (2022). Transnational influences on migrant identities and social cohesion: A study protocol. *Genealogy*, 6(1): 9.

https://doi.org/10.3390/genealogy6010009

Smith, K., Bhui, K., & Cipriani, A. (2020). COVID-19, mental health and ethnic minorities. *Evidence-Based Mental Health*, 23: 89–90.

http://dx.doi.org/10.1136/ebmental-2020-300174

Turon, H., Carey, M., Boyes, A., Hobden, B., Dilworth, S., & Sanson-Fisher, R. (2019). Agreement between a single-item measure of anxiety and depression and the hospital anxiety and depression scale: A cross-sectional study. *PLoS One*, 14(1): e0210111.

https://doi.org/10.1371/journal.pone.0210111

Zhang, L., Jiang J., & Wang, P. (2021). Social cohesion associated with health mediated by emotional experience and life satisfaction: Evidence from the internal migrants in China. *Applied Research in Quality of Life*, 16: 1285–1303.

https://doi.org/10.1007/s11482-020-09818-1

ACCSCIENCE PUBLISHING

International Journal of Population Studies

PERSPECTIVE ARTICLE

A note on the Düsseldorfer Model for counting homeless people in a German city

Anne van Rießen[1]*, Julia Thissen[2], and Reinhold Knopp[3]

[1]Faculty of Social Sciences and Cultural Studies, University of Applied Sciences Düsseldorf, Germany

[2]Association for Research and Practice Transfer in Social and Cultural Work, Düsseldorf, Germany

[3]Faculty of Social Sciences and Cultural Studies, University of Applied Sciences Düsseldorf, Germany

Abstract

This article describes the Düsseldorfer Model which was developed for the city's homeless census in 2021. It allows focusing on the number as well as living situations of homeless people with the objective of analyzing their needs to derive concrete recommendations for action. A complete quantitative count of homeless people in the city on a key date was performed according to principles developed together with the actors of the homeless support system in Düsseldorf. Beyond that, qualitative interviews afforded insights into the living situation of homeless people from the user's perspective. Along with the research methodology, major results are briefly presented in the article, followed by an outlook with recommendations for action.

Keywords: Full count; Germany; Homelessness; Homeless people counts; Night counts

***Corresponding author:**
Anne van Rießen
(anne.van_riessen@hs-duesseldorf.de)

Citation: van Rießen, A., Thissen, J., & Knopp, R. (2023). A note on the Düsseldorfer Model for counting homeless people in a German city. *International Journal of Population Studies,* 9(1):58-68. https://doi.org/10.36922/ijps.397

Received: October 21, 2022

Accepted: April 2, 2023

Published Online: April 13, 2023

1. Introduction

There are different approaches to count homeless persons across different countries. For example, in the United States, homelessness has regularly been documented nationwide since 2003, known as a "point-in-time census." The U.S.-wide count covers homeless persons living "on the streets" without any shelter and homeless persons temporarily housed in emergency shelters and transitional housing facilities (U.S. Department of Housing and Urban Development, 2020). Persons without a permanent address who stay with acquaintances, in a hospital, or in police custody on the key date of the count are not included in the study. Moreover, the count takes place at the end of January, a time of year when homeless people are likely to seek protection in various places and therefore cannot be counted either on the street or in shelters (National Law Center on Homelessness and Poverty, 2017).

However, in Germany, until 2022, the number of homeless people had been counted in different ways but without any uniform nationwide approach for a long time. In addition to the documentation system on homelessness of the Federal Association for Homelessness (Bundesarbeitsgemeinschaft Wohnungslosenhilfe) and the resulting annual statistical reports and estimates (Lotties, 2021), there are in particular state surveys in North Rhine-Westphalia (among others, on hidden homelessness and the homeless without accommodation (Brüchmann *et al.*, 2022). With the introduction of the Homeless Persons Report Act, regular statistics on homeless people are expected to be available from 2022 onward (BMAS, 2022). A solid database on homelessness in

Germany will be soon provided with the statistics for the first time in the near future (BMAS, 2022).

Since the previous estimates of homeless persons in Germany are subject to major uncertainties, estimates are based on the observation of changes in immigration, the housing and labor markets, and social welfare needs, as well as the local surveys of states and municipalities (Jordan, 2018), only limited statements on homelessness in Germany have been possible up to this point. In 2020, the total annual number of homeless people in Germany excluding recognized refugees was estimated to be 256,000 and with recognized refugees to be 417,000 (BAG Wohnungslosenhilfe, 2021). In comparison to previous years' numbers, the estimates in recent few years are increasing (BAG Wohnungslosenhilfe, 2019; 2021).

Nevertheless, the subgroup of "homeless people," that is, those who are affected by houselessness but who are not institutionally housed, is not counted in regular surveys, and is thus often not taken into account statistically. To capture this gap, various surveys are currently being conducted in a few cities at the municipal level, with the first citywide count in Berlin in 2020 being a case in point (Senatsverwaltung für Integration, Arbeit und Soziales Berlin, 2020). However, in those surveys, various methods (e.g., on-the-street censuses, questionnaire surveys in relevant drop-in centers for people who are homeless, data analysis by professionals at day centers and teams of street workers, and food banks) are used in an attempt to record the number of homeless people (Busch-Geertsema, 2019; Hermans & Pleace, 2020).

Another particularly difficult challenge in counting homeless people in Germany arises due to the definition of people who are counted. The experience of other European counts reveal that in Ireland, for example, "rough sleepers" are counted as people who "were either already asleep or had lain down to sleep on the street, in public places, or in dwellings not intended for human habitation on [the] key date night" (Busch-Geertsema, 2019, p. 39), while people "about to be bedded down" for instance, sitting on a sleeping bag or bench, have additionally been counted in the United Kingdom since 2010 (Busch-Geertsema, 2019). The treatment of individuals who spend the night in emergency shelters is not uniform either. They often do not belong to the so-called people living on the street.

Even though homelessness is not only perceived but also addressed differently in every country, the European Federation of National Organizations Working with the Homeless, commonly known as "FEANTSA," developed a European Typology of Homelessness and Housing Exclusion (ETHOS) in 2005 to offer a comprehensive framework for data collection, policymaking, and monitoring purposes (FEANTSA, 2017). ETHOS differentiates four main categories of living situations: rooflessness, houselessness, insecure housing, and inadequate housing. The definition has been adopted for this research and is based on that same broad understanding of homelessness. In this research, houseless is used to refer to people who do not have their own home but who have a place to stay and thus a shelter (e.g., with acquaintances or in emergency shelters). By contrast, rough sleepers, representing rooflessness, are individuals who (have to) spend their lives "outside" and who "make a living" (FEANTSA, 2017). That criticism of ethics regarding the definition of the target group is accompanied by a criticism of power, because it is neither made clear who defines which group of people to be counted and for what reasons nor whether the people counted have any control over their categorization, in other words, "about whether someone should be categorized, or tagged, as "homeless" by research, or administrative process, over which they cannot exercise any control" (Hermans & Pleace, 2020, p. 47). Thus, despite various criticisms of common counting practices, the numbers clearly have a relevant function for lobbying (Hermans & Pleace, 2020) as well as for political decisions and public administration. Often, using the numbers is the only sufficient way in which economic resources can be made available to offer support. The numbers provide the basis for preventive concepts as well.

In the city of Düsseldorf, the Düsseldorfer Model was developed with actors of the homeless support system to perform the first full, citywide count of homeless individuals on October 28, 2021 (van Rießen *et al*., 2021). Although a biennial night count had been conducted by municipal order since 1994, it was only based on quantitative data in specific parts of the city (Plitt, 2021). The full citywide count was further developed in 2019 on behalf of the Department for Migration and Integration and a working group of actors in the field. The Association for Research and Practice Transfer in Social and Cultural Work was also assigned to provide scientific support and assistance in conducting a study that addresses two questions: (i) How many people are homeless in Düsseldorf on the selected key date? How can they be counted? (ii) In which living situations do homeless people live in Düsseldorf?

Taken together, we aim to investigate these questions in this article. The following sections of this article first present an empirical approach of collecting data, which is based on the establishment of a coordination group that represents homeless support institutions and actors in Düsseldorf. Within the framework of the group, the principles and research design were developed, which are herein described along with the major results of the count and a brief summary of the qualitative study. The article

concludes by providing an outlook with recommendations for action. Although the results provide a justification for the establishment and funding of support services for homeless people, a comprehensive count of homeless individuals in Düsseldorf remains needed, for a key date count provides only a momentary picture and was a limitation of the study.

2. Empirical approach

To date, research on homelessness has focused on people who are either homeless and live on the street or (have to) spend the night in emergency shelters. As a result, neither "people who are homeless and have no contact with the institutions of the municipalities and providers of homeless assistance" (Busch-Geertsema *et al*., 2020, p. 488) nor those who live in unacceptable housing conditions (e.g., sleeping in a car, temporarily staying with acquaintances, or living in cheap boarding houses) are included in the study. From a scientific perspective, it is necessary to empirically as well as qualitatively analyze the perspectives of those people, who have categorically been neglected so far.

As a basis for the count, a workshop was organized to which all actors of the Düsseldorf homeless support system (DHSS) were invited to agree on the realization of the count and the standards as well as principles that would guide it. The developed principles enabled the count to be called "qualified." In contrast to other counts, the actors in the field were involved in the development of the research design, and professionals and previously qualified people were a part of the count.

In the workshop with actors of the DHSS, the results of a literature-based analysis of previous counting procedures were presented, namely with experiences from Berlin, Dublin, Hamburg, and Paris. Based on these findings and the specific subjective experiences of the actors in DHSS, a concept was jointly developed for the count of homeless people: The Düsseldorfer Model. It was decided that the objective of the count in 2021 would be, firstly, to perform a count on a key date, with the purpose of analyzing the needs per a full count of Düsseldorf (i.e., "night count") and a supplementary survey of relevant institutions and actors in clinics, police, job centers, and shelters to obtain and analyze information available on the key date. This means that the number of people who are homeless, in clinics or police custody, as well as the number of people who receive social support benefits for being unemployed from Germany's job centers but do not pay for housing, as well as their registered postal addresses at homeless support institutions, were collected on the key date. Those relevant institutions and actors were identified together with actors in DHSS. Nevertheless, it must be mentioned that any count can only ever be a momentary snapshot. Even though many counting teams assisted and various housing support institutions as well as hospitals and police custody were taken into account, it must be mentioned that any count can only ever be a snapshot. Second, the key date survey was complemented by a qualitative study, in which 30 people who are homeless as defined by the ETHOS typology participated in semistructured interviews aimed at gaining insight into their living conditions. This method enabled to include people on the verge of losing housing and ones who live in more insecure housing situations (e.g., "couch-surfers," people temporarily housed by friends and acquaintances, as well as women who are dependent on male housing providers).

2.1. Quantitative study

2.1.1. Counting principles

For the night count of homeless people in Düsseldorf, Germany, the following principles were defined to ensure a standard of quality characteristics by the group of actors from the homeless support system:

2.1.1.1. Principle of ethics

During the night count, only people who seem or are homeless were to be counted. People were not to be woken up or interviewed at "their" place or "home," so to speak. The people who were institutionally connected or known to the homeless support system were informed in advance by the street workers to reduce fear and worry about criminalization and/or registration. No offensive advertising or public announcement was broadcast in the local media to prevent self-appointed counters from joining the count unauthorized and thereby creating further dangers and uncertainties (e.g., knowledge of people's hidden overnight locations and threats of violence). The count personnel involved were aware that it is ethically difficult to count the homeless and to thus categorize people as homeless without involving them. However, following the existing definitions, it was decided to mark people as being homeless in the night count if they were in public places (e.g., on the street, in parks, or under bridges), building entrances or other private spaces (e.g., bus stations, train stations, and ATM lobbies at banks), or dwellings that were not or no longer intended for continuous human habitation, and if they were already sleeping there, had lain down to sleep there, or were preparing to spend the night there (e.g., with sleeping bags, sitting on cardboard or benches, or even standing, sitting, or moving with other people and/or dogs). Meanwhile, places were counted if it appeared that they had been used in the past 24 h.

2.1.1.2. Principle of professionalism

The social authorities and all agencies of the independent homeless support system were continuously and consistently involved throughout the process of preparing, implementing, and interpreting the results (e.g., information on the current status of the scientific monitoring gathered at regular meetings and by distributing the protocol). To that purpose, a coordination group was initiated that was open to all actors involved. The count was planned within the group, while all other actors were consistently informed at regular meetings. All counters participated in an information-sharing and training session before the count. In that way, the quality of the count was guaranteed. Again, all persons involved in count were made aware of the count's objective and thus that not the number analyzed but instead the follow-up perspectives resulting from it were what mattered. By extension, both the quantitative and qualitative results were analyzed by a group of the homeless support system, and needs for improving the living conditions of homeless people were identified, along with recommendations for the further development of the support system.

2.1.1.3. Principle of the full count

The night count completely covered the city of Düsseldorf, which was divided into count areas based on the city's sociospatial structure (Landeshauptstadt Düsseldorf, 2017). The sociospatial knowledge of the professionals in the homeless support system and street workers was the basis of mapping to mark places within the count areas where homeless people usually stay. Those places were color-coded on the counting documents issued, for example, maps, so that personnel performing the count knew that those places were locations where homeless people can typically be found. Assigned count areas with more than one of those places were walked or driven past by personnel familiar with the target group or who were experienced in interacting with them. Each count area was walked or driven past by pairs of counters containing a professional and a volunteer.

2.1.2. Quantified count supplemented by the numbers in institutions on a key date

To enable a full coverage count of homeless people in Düsseldorf, a key date was set for the count: October 28, 2021. That date was chosen for two reasons. First, it is in the fall and thus neither too cold nor too hot, unlike in summer or winter when homeless people tend to choose various different overnight locations; and second, the yearly count conducted in some parts of the city since 1994 had also been conducted in late October (Plitt, 2021). On that key date, counting in all 179 social areas of Düsseldorf was organized along with the collection of the number of people staying in institutions (i.e., hospitals, police stations, and shelters). Depending on their size, the social areas were walked or driven through by a team of two people. Each team consisted of a professional – a street worker or a specialist from the homeless support system or the social administration – and a volunteer. The volunteers were not sought through public appeals or volunteer agencies but were approached individually by the participating institutions.

Count personnel were qualified to engage in the context of information events, equipped with count-related folders, and received a telephone number of the count office for emergencies. In the information-sharing event offered at various times both on-site and online, the counters were informed about the counting method, their assignment to the count areas, and the precautions to be taken during the count. Among other things, counters were instructed to take a flashlight, not put themselves in danger, and take care of themselves by wearing warm clothing and taking warm beverages with them. They were also advised, if possible, to familiarize themselves with the count area in advance, in daylight, to aid their recognition at night. Counters could also ask questions concerning their task. Each pair of counters was given a folder with maps showing the specific area for which they were responsible. Each folder also contained a count sheet asking the counters to report how many people had been counted. The gender and age group of each person counted could also be recorded on the sheet based on estimates. It was also possible to indicate how many of the people counted were encountered in a couple and/or with dogs. However, no exact information was provided on the location of the person recorded if they were more than 18 years old and medical intervention was not required. Contact persons were available by telephone throughout the count.

In addition to the number of people counted, the numbers of postbox addresses were collected on the key date by the 10 homeless support institutions in Düsseldorf that provide postbox addresses. Postbox addresses serve as registration addresses for homeless people that are made available to them by such institutions as long as they regularly retrieve the mail. In Germany, unlike in other countries, the authorities are unwilling to accept an email address as a means of contact; instead, a registration address is generally required. Furthermore, the number of people receiving "unemployment benefit II" (ALG II) without housing costs was collected on the key date. Within the framework of basic security for job seekers, the German Social Welfare Act II stipulates that, under certain conditions, people can receive benefits for integrating into work as well as for securing their basic needs. ALG II is

intended to enable people who are capable of working to meet their basic material needs, insofar as they cannot cover those expenses with their own resources or with the help of others. The purpose of ALG II is to grant eligible individuals benefits that enable them to live in dignity. The number of postal addresses and the number receivers of ALG-II were expected be similar to the numbers counted and were used as control numbers.

2.2. Qualitative study from the user's perspective

Conducting a qualitative survey from the subjective perspective of users allowed to clarify the conditions of the use or non-use of spaces at both social and institutional levels. Thus, the focus was which spaces enable a specific use for users of social work contexts, on the one hand, and, on the other, which location-specific behavior is associated with it. Such sociospatial user-based research allows focusing on "which (non-)benefits the social work services have from the perspective of the users (content level) and how the users make use of the social work services (process level)" (van Rießen, 2022a).

Following the approach of sociospatial user research, 30 users of the homeless support system participated in semistructured interviews (Helfferich, 2011) to gain insight into the living situations of homeless people, which allow interviewees to speak as freely as possible to approximate an open conversation. The guidelines used in the interviews enabled setting thematic emphases to similar extents and ensured the comparability of the interviews (Gläser & Laudel, 2010). The interview guideline developed based on Susanne Gerull's (2018) first systematic life situation study, considers the multidimensionality of different areas of life as well as their interactions and thus enables "a holistic view of people's life situation" (Gerull, 2018, p. 3). The starting point was therefore the empirically analyzed perspective of users on the topics of their material situation, employment, housing, health, security, social participation, and social networks, along with a question about their hopes for the future. Those life situation areas were extended with questions about the reasons for the interviewees' homelessness, their everyday life, and recent changes in life due to the COVID-19 pandemic. Other possible categories could not be considered in this study. The transcribed guided interviews were analyzed using content-structuring analysis following Kuckartz (2018).

The interviews were conducted not only with people who are homeless but also with people who spend their nights in various settings (e.g., with friends or in inpatient facilities) because they do not have their own residence. Because the interviews could be conducted only with users of the homeless support system, only people who were interested and users of the homeless support system could be reached. The interviews were arranged by the professionals but conducted by employees of the association responsible for this study. Nevertheless, the setting of the homeless support system, given the institutional context, could have biased interviewees toward giving answer socially desirable responses. To minimize that potential influence as well as to reach diverse users, interviews were available to be conducted at different times of day, and interviewees could be interviewed wherever they wanted and with interviewers of whichever gender they preferred.

3. Key findings

3.1. Results of the quantitative key date survey

The counting was performed on October 28, 2021, between 10:30 p.m. and 1:00 a.m. During that time, all 179 social areas of Düsseldorf were walked or driven through by 70 teams, for a total of 141 counters. Table 1 presents the results of the night count. Ultimately, 239 people who were or seemed to be homeless were recorded by the teams during the night count: 186 men, 31 women, and 22 people of unknown gender. Furthermore, 22 people with no permanent address were reported by the clinics, and no one without a permanent address was in police custody. On the key date, 198 people — 124 men and 74 women — were accommodated in Düsseldorf's shelters.

In addition, 2241 postbox addresses (1620 men, 620 women, and 1 other) were provided on the key date by the ten homeless support institutions in Düsseldorf that enable postbox addresses. The job center also reported 461 people who were receiving ALG-II without housing costs on the key date. Those figures were collected as control figures. Table 2 shows the number of postbox addresses and the number of recipients of ALG-II without housing costs.

The high number of people with postbox addresses was discussed with actors in the homeless support system, who determined that the number indicates the large population living in precarious housing conditions. Examples include postal delivery workers living in their cars, people living in inadequate housing or houses without official postal addresses, or people living in precarious housing conditions that prevent them from providing such addresses as their postal addresses.

3.2. Results of the qualitative study

From September 21 to November 24, 2021, semistructured interviews were conducted with 30 people who are homeless. The qualitative study reached 30 homeless people, all 24–60 years old, 23 of whom were men, and seven of whom were women. Although the use of the category "person with migration background" is often

Table 1. Results of the night count

	Men	Women	Other	Unknown	Total	Couples included	Families including	Dogs*
I. People living on the street and accompanied by dogs								
Total	186	31	0	22	239	6	0	8
II. Persons staying in institutions and accompanied by dogs on the night of October 28-29, 2021								
Hospitals	16	6	0	0	22	0	0	0
Police Stations	0	0	0	0	0	0	0	0
Shelters	124	74	0	0	198	4	1	2
Total (1–3)	140	80	0	0	220	4	1	2

Note: *Information about dog ownership was gathered in this study due to the challenges that it poses for users of the homeless support system because only certain institutions allow dogs.

Table 2. Number of postbox addresses and number of recipients of ALG-II without housing costs

	Men	Women	Other	Unknown	Total
III. Postbox addresses					
Total	1,620	620	1	0	2,241
IV. Total number of recipients of ALG-II without costs for housing					
Total					461

Note: ALG-II refers to unemployment benefit II.

criticized, especially for its implied homogenization of diverse life experiences and situations in relation to a specific criterion (e.g., Stošić, 2017; Castro Varela, 2013), the criterion was collected to make those experiences visible. Based on the definition of *migration background* from the perspective of the person interviewed, 11 people with such a background provided qualitative data. The summary results of the empirical analysis are presented in the following based on the themes of their life situations identified and the supplementary questions of the interview guidelines.

3.2.1. Reasons for homelessness

The loss of personal and family relationships as well as long-term drug addiction, often dating back to adolescence or criminal offenses and imprisonment, had resulted in instability and the loss of housing. Other reasons for homelessness mentioned were the loss of a job, the shame of seeking support, and the lack of integration into the labor market. In some cases, psychological burden in the context of separation and custody disputes had led to the loss of employment and, in turn, the loss of housing. Eviction lawsuits, the demolition of residential buildings, housing auctions, or the termination of leases were other reasons for the loss of housing. Gender-specific reason for homelessness mentioned from almost half of the women interviewed was violence in their intimidate relationships. By nationality, persons not of German nationality additionally reported a lack of structural conditions that would prevent homelessness, including the impossibility of obtaining a work permit.

3.2.2. Everyday life structure

Most interviewees reported living an everyday life structured mostly by the structure of the help system and regular appointments for food distribution, for housing viewings, and with authorities and doctors. Women in the sample mentioned the importance of finding a warm, safe place, and being at an emergency shelter as early as possible in the evening. Meanwhile, individuals being rehabilitated for drug abuse with substitute drugs reported seeking overnight accommodations as close as possible to the site of their medical care.

3.2.3. Relevance of participation and social networks

There is barely any contact with past contacts due to the fact that the networks had "grown apart" because of unemployment and that leisure activities had changed or are no longer financial possible. While for about one-third of the interviewees, new romantic relationships, and a new group of friends play an important role in terms of their own social network and provide cohesion, other interviewees lack social contact and feel lonely. If contacts do exist, they are often with "homeless acquaintances." The intensity of contact with parents and other family members is heterogeneous and ranges from daily contact to no contact. All interviewees experience varying degrees of support from social institutions, social workers, and probation officers. In shelters, contacts are described as "superficial" due to the lack of common rooms.

3.2.4. Safety

Most interviewees reported experiencing highly threatening situations, ranging from robberies, threats of violence, and being pepper-sprayed in their sleeping bags to injuries due to beer bottles, knives, fights, and even being doused with oil while sleeping. Among the interviewees, women reported more instances of sexual assault than men. Regarding safety in shelters, the lack of rooms with

locks and secure places for belongings was also mentioned. Factors reported to reinforce a sense of security were having a residence of one's own, the prospect of a job, and, at least for some interviewees, knowledge of self-defense skills. To avoid attention and involvement in dangerous situations, the interviewees also mentioned trying to "always be neat and tidy" and evading contact with other people whose center of life is the street and to thereby "not get involved in their problems."

3.2.5. Health

Although nearly all interviewees have health insurance, the use of medical services is a major hurdle for two-thirds of the interviewees due to embarrassment as well as the challenge of fixed appointments or bad experiences with doctors in the past. There are hardly any fixed contacts with general practitioners or dentists, which also means, among other things, that "doctors are not visited as often as they should be." On the other hand, the medical care center and outreach services are mentioned positively and are used. All interviewees rated their own health as poor. The health complaints can primarily be classified into three categories: Dental health, addiction-related complaints, and consequences of exposure to cold.

3.2.6. The relevance of housing

The interviewees stated that they stay with friends, in shelters. or on the streets. The shelter facilities are evaluated heterogeneously: Although the "roof over one's head" and not being in the cold are described as positive, the lack of privacy is criticized. The need for a home of one's own, "a door that you can close behind you" is expressed from everyone and often related to the idea of "having a normal life." According to the interviewees, the challenge of finding an apartment can be attributed to stereotypes of landlords, lack of social housing, and high costs.

3.2.7. Employment

Most of the interviewees reported being unemployed and living on social benefits. Whereas some older respondents had various work experiences characterized by different levels of education, a wide variety of fields, and diverse employment relationships, a few of the younger interviewees stated that they were even working for temporary employment agencies or in illegal sectors of the economy. To be able to afford their own residences, they greatly aspired for employment.

3.2.8. Material situation

The interviewees also reported receiving social benefits. However, because the benefits are insufficient, several of the interviewees have resorted to "scrounging," selling newspapers, or collecting donations. For the interviewees, buying clothes, making unplanned purchases, and engaging in leisure activities are hardly possible due to their limited financial means. Therefore, the many different offerings of social work institutions in Düsseldorf, including of breakfast and clothing, are regularly sought.

3.2.9. Impact of the COVID-19 pandemic

The interviewees predominantly evaluated their experiences and restrictions during the COVID-19 pandemic negatively. The limited opening hours of public institutions due to the risk of infection have meant that spaces to escape the elements or engage in activities have been rare – for example, libraries are closed, and public transportation has to be avoided to prevent infection. Beyond that, services offered by institutions for people who are homeless have changed or been reduced, and legally imposed curfews have been difficult for people without housing to obey. The interviewees also reported perceiving an increased potential for violence and changes in interpersonal relationships while living on the streets.

3.2.10. Future

When asked about their life situations in a year's time, nearly half of the interviewees mentioned the desire and basic goal of having their own home. That wish was accompanied by the imagination of having "a totally normal life again." A family or stable relationship was also desired, along with employment, which together were thought make such a life is possible. However, regarding the salary and cost of living in the city, one interviewee also stated, "Düsseldorf is too expensive for normal people. Housing is luxury in this city."

4. Concluding remarks

The Düsseldorfer Model of counting homeless people allows focusing on the number and situation of homeless people in Düsseldorf, both within the framework of a quantitative count (i.e., a complete night count of the city's areas according to specific criteria and a key date survey of actors involved in the homeless support system) and a qualitative survey. Only following the qualitative approach, however, was it possible to ascertain how many people are homeless and to reveal their living situations. Analogous to experiences reported in other cities, such quantitative analyses of the number of homeless people and qualitative supplements of their living situations are prerequisites for deriving concrete recommendations for action (e.g., Arbeitskreis Wohnraum für junge Menschen, 2021; Busch-Geertsema, 2019; City of Paris, 2021; Hermans & Pleace, 2020; Gerull, 2019). Based on the empirical findings, recommendations for action for homeless support institutions are as follows.

4.1. Interpretation of the number of homeless people with postbox addresses

The high number of people with postbox addresses may indicate a high number of people who are not yet homeless but who live in precarious housing situations. However, more detailed analyses and interpretations of their numbers are necessary to learn who exactly is behind the postbox addresses and what support services they need. With such information, it is possible to provide specific services to the target group. Indeed, the high number of postbox addresses found in this study shows a need for action.

4.2. Consideration of diverse life situations

Even if DHSS is characterized by an array of services, whether current services comprehensively address the diverse, living situations of homeless people remains unclear. The empirical analyses of the interviews suggest that people who are homeless are not a homogeneous group and that their specific life situations have to be considered in a highly open-minded way. That need raises the questions of not only whether services are sufficient for specific situations (e.g., women and couples) but also who uses the services, who does not, and why they do not. Those questions bring into focuses of the institutional barriers and limitations that lead to homeless people not using them. For instance, as the empirical analyses showed, shelters do not afford privacy. In response, single and double rooms need to be part of the future standard to enable security, autonomy, and privacy.

4.3. Analyses of (non-)users

Because the conducted qualitative research using interviews in facilities for homeless people, only individuals who were institutionally connected were reached. For that reason, people with psychological handicaps, who generally do not access the services of homeless support, were not reached (Bäuml *et al.*, 2017). Thus, groups of people do not or cannot use the help system need to be identified, as do the services specifically for them that should be developed or expanded.

4.4. Importance of own housing for social participation

The importance of having one's own housing became specifically clear in the empirical analyses of living situations as an essential element of comprehensive social participation. Without one's own housing, incidents with violence and theft remain unavoidable, both on the street and, in some cases, in shelters. Newer models of homeless support such as Housing First (Tsemberis, 2010), which understands homeless people as active subjects and thus seeks to develop and realize perspectives beyond homelessness, therefore needing to be in sharper focus. In addition, whether a quota exists for the construction for Housing First residences needs to be determined so that sufficient living space is available for homeless people.

4.5. Access to work

The empirical analyses revealed that the interviewees want to work. In that light, it would be relevant to develop job offerings after housing is created. In addition to creating offerings for employment, services that structure day-to-day life can provide the kinds of orientation and support that enable integration into the labor market.

4.6. Sociospatial-related social work

The empirical analyses additionally captured the experiences of exclusion that homeless people experience daily. Thus, added to the recommendations mentioned here, the question of spatial exclusion should be investigated in the context of sociospatial social work (e.g., Deinet 2009; Knopp & van Rießen 2020). It is also necessary to create solutions with the people themselves, as well as the professionals, the administration, and policymakers, that do not perpetuate displacement and that account for the fact that people who are homeless also need structure and places to stay.

4.7. Organization of the support system

According to the empirical analyses, entry into the support system, especially at shelters, should be organized so that people take the help offered and are accompanied when they leave the system, which should happen as soon as possible. By offering housing within the framework of Housing First projects and enabling everyday structure, systems can enable them to change and improve their living conditions in the long term.

4.8. Challenges caused by the COVID-19 pandemic

Needless to say, the pandemic has exacerbated the homelessness crisis in many parts of the world due to job losses, rising living cost, other financial hardships, and reduced social services caused by the pandemic (U.S. Department of Housing and Urban Development, 2021; Watts *et al.*, 2022). Counting the number of homeless people has becomes more challenging than before as the case of Düsseldorfer due to increased undercounting, hidden homelessness, and people who are not regularly in contact with support services, and the situations will likely continue in the years to come. A more refined comprehensive method is clearly warranted to count the homeless population more accurately, especially in the crises, such as the pandemic.

All in all, the aspects mentioned herein show that the support system for homeless people has to be developed not only for but also with the people. The empirical analyses of the qualitative interviews especially highlight the need to understand homeless people as experts of their own lives and to enable them to build a foundation so that they can sustainably improve their living conditions. In social work, the subject orientation as a normative principle guiding action thus offers an opportunity to focus on the people themselves and to promote perspectives on autonomy and self-determination (van Rießen, 2020; 2022b).

Acknowledgments

The Office for Migration and Integration of the state capital Düsseldorf assigned the Streetwork Coordination of franzfreunde – Franziskanische Sozialwerke Düsseldorf gGmbH – to coordinate a count that covers the entire city area. The Association for Research and Practice Transfer in Social and Cultural Work, Düsseldorf was assigned to provide scientific support.

Funding

The project was supported with 20790 Euro by the city of Düsseldorf.

Conflict of interest

The authors have no conflicts of interest to declare.

Author contributions

Conceptualization: Reinhold Knopp, Anne van Rießen
Formal analysis: Anne van Rießen, Reinhold Knopp
Investigation: Kymon Ems, Bettina Nabbefeld, Reinhold Knopp, Anne van Rießen
Methodology: Reinhold Knopp, Anne van Rießen
Writing – original draft: Anne van Rießen, Julia Thissen, Reinhold Knopp
Writing – review & editing: Anne van Rießen, Julia Thissen, Reinhold Knopp

Ethics approval and consent to participate

The study was guided by the research ethics code of the German Society for Social Work, which includes research ethics principles and scientific standards for social work research.

Consent for publication

Not applicable.

Availability of data

Not applicable.

References

Arbeitskreis Wohnraum Für Junge Menschen. (2021). Couchsurfing-verdeckte Wohnungslosigkeit bei unter 27-jährigen im Bezirk Hamburg-Wansdsbek der hamburger arbeit GmbH [Courchsurfing-hidden homelessness among under 27-year-olds in Hamburg's Wansdsbek district]. *Forum für Kinder-und Jugendarbeit*, 37(3/4.): 82-83. [Article in German].

BAG Wohnungslosenhilfe. (2019). Wohnungslosigkeit: Kein Ende in Sicht. BAG Wohnungslosenhilfe Stellt Aktuelle Schätzung Für das Jahr 2018 vor. [Homelessness: No End in Sight. BAG Homeless Support Presents Current Estimate for 2018]. Available from: https://www.bagw.de/fileadmin/bagw/me-dia/doc/prm/prm_2019_11_11_schaetzung_zahl_der_wohnungslosen.pdf. [Last accessed on 2021 Dec 12]. [Article in German].

BAG Wohnungslosenhilfe. (2021). Steigende Zahl Wohnungsloser im Wohnungslosensektor, Wohnungslosigkeit Anerkannter Geflüchteter Sinkt [Increasing Number of Homeless in the Homeless Sector, Homelessness of Recognized Refugees Decreasing]. Available from: https://www.bagw.de/de/themen/zahl-der-wohnungslosen/index.html [Last accessed on 2022 May 10]. [Article in German].

Bäuml, J., Brönner, M., Baur, B., Pitschel-Walz, G., & Jahn, T. (2017). Die SEE-WOLF-Studie. Seelische Erkrankungsrate in den Einrichtungen der Wohnungslosenhilfe im Großraum München. [The SEE-WOLF Study: Mental Illness Rates in Facilities for the Homeless in the Greater Munich Area]. Freiburg: Lambertus. [Article in German].

BMAS (GISS/Kantar). (2022). Empirische Untersuchung Zum Gegenstand Nach §8 Abs. 2 und 3 WoBerichtsG. Forschungsbericht 605. [Empirical Study of the Subject Matter According to §8 (2) and (3) WoBerichtsG. Research Report 605]. Available from: https://www.bundesregierung.de/breg-de/service/publikationen/empirische-untersuchung-zum-gegenstand-nach-8-absatz-2-und-3-wohnungslosenberichterstattungsgesetz-2129794 [Last accessed on 2023 Jan 15]. [Article in German].

Brüchmann, K., Busch-Geertsema, V., Henke, J., Schöpke, S., & Steffen, A. (2022). Wohnungslose Ohne Unterkunft und Verdeckt Wohnungslose in NRW. Ergebnisse Einer Befragung. Im Auftrag des MAGS NRW. [Homeless without Shelter and Hidden Homeless in NRW. Results of a Survey. On Behalf of the MAGS NRW]. Available from: https://broschuerenservice.mags.nrw/mags/shop/wohnungslose_ohne_unterkunft_und_verdeckt_wohnungslose_in_nrw/0 [Last accessed on 2023 Jan 15]. [Article in German].

Busch-Geertsema, V. (2019). Ansätze zur zählung von obdachlosen auf der straße in Deutschland, Europa und anderen ländern der welt-ein überblick. [Approaches to counting homeless people on the street in Germany, Europe and other countries of the world-an overview]. *Wohnungslos*, 19: 37-42. [Article in German].

Busch-Geertsema, V., Henke, J., & Steffen, A. (2020). Wohnungslosigkeit in Deutschland. Ergebnisse einer bundesweiten Studie. [Homelessness in Germany. Results of a nationwide study 2020]. *Deutscher Verein für Öffentliche und Private Fürsorge*, 11: 487-491. [Article in German].

Castro Varela, M. (2013). Ist Integration Nötig? [Is Integration Necessary?]. Eine Streitschrift. Freiburg: Lambertus. [Article in German].

City of Paris. (2021). Nuit de la Solidarité 2021: Le Bilan Détaillé´ [Night of Solidarity 2021: The Detailed Report]. Actualité. Available from: https://www.paris.fr/pages/nuit-de-la-solidarite-2021-17285 [Last accessed on 2021 Dec 12]. [Article in French].

Deinet, U. (2009). Methodenbuch Sozialraum [Spatial Social Work Method Book]. Wiesbaden: Springer.

https://doi.org/10.1007/978-3-531-91363-6 [Book in German].

European Federation of National Organisations Working with the Homeless. (2017). European Typology of Homelessness and Housing Exclusion. Available from: https://www.feantsa.org/download/ethos248421574874823988 8.pdf [Last accessed on 2022 Dec 11].

Gerull, S. (2018). Forschungsbericht: 1. Systematische Lebenslagenuntersuchung Wohnungsloser Menschen [Research Report: 1st Systematic Life Situation Study of Homeless People]. Eine Studie der ASH Berlin in Kooperation Mit EBET. Available from: https://opus4.kobv.de/opus4-ash/frontdoor/deliver/index/docid/246/file/ash+ebet_lebenslagenuntersuchung_2018.pdf [Last accessed on 2021 Dec 12]. [Research Report in German].

Gerull, S. (2019). Berlin will wohnungslose menschen auf der Straße zählen. Geplantes vorgehen und herausforderungen [Berlin wants to count homeless people on the street: Planned approach and challenges]. *Wohnungslos*, 2(19): 52-55. [Article in German].

Gläser, J., & Laudel, G. (2010). Experteninterviews und Qualitative Inhaltsanalyse als Instrumente Re-konstruierender Untersuchungen [Expert Interviews and Qualitative Content Analysis as Instruments of Reconstructive Research]. Wiesbaden: Springer. [Book in German].

Helfferich, C. (2011). Die Qualität qualitativer Daten. Manual für die Durchführung Qualitativer Interviews [The Quality of Qualitative Data: Manual for Conducting Qualitative Interviews]. Weinheim: Beltz.

https://doi.org/10.1007/978-3-531-91858-7 [Book in German].

Hermans, K., & Pleace, N. (2020). Counting all homelessness in Europe: The case for ending separate enumeration of 'hidden homelessness. *European Journal of Homelessness*, 14(3): 35-62.

Jordan, R. (2018). Dokumentation und Statistik [Documentation and Statistics]. In: Specht,T., Rosenke, W., Jordan, R., & Giffhorn, B. (eds.). Handbuch der Hilfen in Wohnungsnotfällen: Entwicklung Lokaler Hilfesysteme und lebenslagenbezogener Hilfeansätze. Berlin: BAG W-Verlag, p.113-124. [Article in German].

Knopp, R., & van Rießen, A. (2020). Das Handlungsfeld Sozialraum aus der Perspektive Sozialer Arbeit. Gemeinwesenarbeit-Sozialraumarbeit-Quartiersmanagement [The Field of Spatial Social Work from the Perspective of Social Work: Community Work-sociospatial Work-neighborhood Management]. In: Burmester, M., Friedemann, J., Funk, S.C., Kühnert, S., & Zisenis, D. (eds.). Die Wirkungsdebatte in der Quartiersarbeit. Wiesbaden: Springer, p.3-17.

https://doi.org/10.1007/978-3-658-30539-0_1 [Article in German].

Kuckartz, U. (2018). Qualitative Inhaltsanalyse. Methoden, Praxis, Computerunterstützung [Qualitative Content Analysis: Methods, Practice, Computer Support]. Weinheim: Beltz. [Book in German].

Landeshauptstadt Düsseldorf. (2017). Sozialräumliche gliederung. Fortschreibung 2017 [Sociospatial Structure: CONTINUATION 2017]. In: Statistik & Stadtforschung (56). Available from: https://www.duesseldorf.de/fileadmin/Amt12/statistik/stadtforschung/download/Sozialraeumliche_Gliederung_Fortschreibung_2017.pdf [Last accessed on 2021 Dec 12].

Lotties, S. (2021). Statistikbericht. Zu Lebenslagen wohnungsloser und von Wohnungslosigkeit bedrohter Menschen in Deutschland-lebenslagenbericht [Statistical Report. on the Living Conditions of Homeless People and People Threatened by Homelessness in Germany-living Conditions Report]. Berichtsjahr 2019. Available from: https://www.bagw.de/fileadmin/bagw/media/doc/dok/bagw_statistikbericht_2019.pdf [Last accessed on 2021 Dec]. [Article in German].

National Law Center on Homelessness and Poverty. (2017). Don't Count on it: How the HUD Point-in-time Count Underestimates the Homelessness Crisis in America. United States: National Law Center on Homelessness and Poverty. Available from: https://homelesslaw.org/wp-content/uploads/2018/10/hud-pit-report2017.pdf [Last accessed on 2022 Dec 11].

Plitt, J. (2021). Vorwort [Preface]. In: van Rießen, A., Knopp, R., Ems, K., Nabbefeld, B., & Thissen, J. (eds). Qualifizierte Zählung von Menschen, die Obdachlos Sind, in der Landeshauptstadt Düsseldorf. Available from: https://www.franzfreunde.de/fileadmin/user_upload/downlaodbereich/fv_220402_abschlussbericht_qualifizierten_zaehlung_obdachloser_menschen_in_duesseldorf.pdf [Last accessed on 2022 June 23]. [Article in German].

Senatsverwaltung für Integration, Arbeit und Soziales. (2020). Nacht der Solidarität-Erste Ergebnisse [Night of Solidarity-first Results]. Berlin. Available from: https://www.berlin.de/nacht-der-solidaritaet/_assets/nacht-der-soli-daritat_berlin_erste-ergebnisse_07-02-2020.pdf [Last accessed on 2021 Dec 12]. [Article in German].

Stošić, P. (2017). Kinder Mit Migrationshintergrund. Zur

Medialisierung Eines Bildungsproblems [Children with Migration Background: On the Medialization of an Education Problem]. Wiesbaden: Springer.

https://doi.org/10.1007/978-3-658-17173-5 [Book in German].

Tsemberis, S. (2010). Housing First: The Pathways Model to end Homelessness for People with Mental Illness and Addiction. Center City: Hazelden Information and Educational Services.

U.S. Department of Housing and Urban Development. (2020). The 2019 Annual Homeless Assessment Report (AHAR) to Congress. Available from: https://www.huduser.gov/portal/sites/default/files/pdf/2019-ahar-part-1.pdf [Last accessed: 2022 Dec 11].

U.S. Department of Housing and Urban Development. (2021). The 2020 Annual Homeless Assessment Report (AHAR) to Congress. Available from: https://www.huduser.gov/portal/sites/default/files/pdf/2020-ahar-part-1.pdf [Last accessed on 2023 March 28].

Van Rießen, A. (2020). Subjekt-und Ressourcenorientierung [Subject and Resource Orientation]. In: Wendt, P.U. (eds). Soziale Arbeit in Schlüsselbegriffen. Weinheim, Basel: Beltz Juventa, p. 78-83. [Article in German].

Van Rießen, A. (2022a). Die Forschungsperspektive der sozialräumlichen nutzer innenforschung [The research perspective of sociospatial user research]. In: Gille, C., Jepkens, K. (eds). Zivilgesellschaftliches Engagement: Ausschlüsse und Teilhabe. Sonderband Voluntaris.

https://doi.org/10.5771/9783748928942-160. [Article in German].

Van Rießen, A. (2022b). Subjektorientierung [Subject-orientation]. In: Bleck, C., & van Rießen, A. (eds.). Soziale Arbeit Mit Alten Menschen. Ein Studienbuch zu Hintergründen, Theorien, Prinzipien und Methoden. Wiesbaden: Springer.

https://doi.org/10.1007/978-3-658-37573-7_29 [Article in German].

Van Rießen, A., Knopp, R., Ems, K., Nabbefeld, B., & Thissen, J. (2021). Qualifizierte Zählung von Menschen, die Obdachlos Sind, in der Landeshauptstadt Düsseldorf. [Qualified Count of People who are Homeless in the State Capital of Düsseldorf]. Available from: https://www.franzfreunde.de/fileadmin/user_upload/downlaodbereich/fv_220402_abschlussbericht_qualifizierten_zaehlung_obdachloser_menschen_in_duesseldorf.pdf [Last accessed on 2022 Sep 05]. [Research report in German].

Watts, B., Bramley, G., Fitzpatrick, S., McMordie, L., Pawson, H., & Young, G. (2022). The Homelessness Monitor: Great Britain 2022. Available from: https://www.crisis.org.uk/media/248458/the-homelessness-monitor-great-britain-2022_exec-summary_final.pdf [Last accessed on 2023 Mar 28].

ACCSCIENCE PUBLISHING

International Journal of Population Studies

RESEARCH ARTICLE

The role of the COVID-19 pandemic and economic crisis in insomnia and post-traumatic stress symptoms in the Lebanese population: A cross-sectional assessment

Aline Hajj[1,2,3,4], Danielle A. Badro[1,5], Carla Abou Selwan[1,6], Hala Sacre[1], Randa Aoun[1], Chadia Haddad[1,7,8,9]*, and Pascale Salameh[1,9,10,11]

[1]Institut National de Santé Publique, d'Épidémiologie Clinique et de Toxicologie-Liban, Beirut, Lebanon

[2]Laboratoire de Pharmacologie, Pharmacie Clinique et Contrôle de Qualité des Médicament, Faculty of Pharmacy, Saint Joseph University of Beirut, Beirut, Lebanon

[3]Faculté de Pharmacie, Université Laval, Québec, Canada

[4]Oncology Division, CHU de Québec Université Laval Research Center, Québec, Canada

[5]Faculty of Health Sciences, American University of Science and Technology. Beirut, Lebanon

[6]Science PRO, Medical and Marketing Solutions, Jal el Dib, Lebanon

[7]Research Department, Psychiatric Hospital of the Cross, Jal Eddib, Lebanon

[8]School of Health Sciences, Modern University for Business and Science, Beirut, Lebanon

[9]School of Medicine, Lebanese American University, Byblos, Lebanon

[10]Faculty of Pharmacy, Lebanese University, Hadath, Lebanon

[11]Department of Primary Care and Population Health, University of Nicosia Medical School, 2417, Nicosia, Cyprus

***Corresponding author:**
Chadia Haddad
(chadia_9@hotmail.com)

Citation: Hajj A, Badro DA, Selwan CA, *et al*., (2023). The role of the COVID-19 pandemic and economic crisis in insomnia and post-traumatic stress symptoms in the Lebanese population: A cross-sectional assessment. *International Journal of Population Studies*. 9(1):69-81. https://doi.org/10.36922/ijps.440

Received: January 5, 2023

Accepted: March 27, 2023

Published Online: April 10, 2023

Abstract

Based on an online cross-sectional survey, this study aimed to evaluate the role of the coronavirus disease 2019 (COVID-19) pandemic and economy-related factors in post-traumatic stress symptoms (PTSSs) and sleep in a sample of the general Lebanese population using the post-traumatic stress disorder checklist. The online survey was conducted between May 10, and May 20, 2020, and 502 Lebanese adults who have access to the internet were enrolled. Results highlighted that positive correlates of PTSS were fear of COVID-19, female gender, and waterpipe smoking; negative correlates were higher family satisfaction, higher financial wellness, older age, having access to healthcare, and never having to work. When including insomnia as an independent variable to explain PTSS, the model did not substantially change. Positive correlates of insomnia included fear of poverty, fear of COVID-19, violence at home, the number of dependent children, having a job, and having a chronic disease. Conversely, higher family satisfaction and financial wellness were associated with lower likelihood of insomnia. When entering PTSS, insomnia remained positively associated with fear of poverty, PTSS, and violence at home. However, fear of COVID-19 was no longer associated with insomnia. We concluded that both the fear of COVID-19 and the economic crisis are correlated with PTSS and insomnia.

Keywords: Coronavirus disease 2019; Economic crisis; Post-traumatic stress symptoms insomnia; Sleep disorders; Financial well-being; Lebanon

1. Introduction

The novel coronavirus has rapidly impacted the world with deleterious consequences on mental health, particularly in countries with financial hardships and preexisting mental health conditions induced by war or socioeconomic difficulties (Abou Hassan *et al.*, 2023; Sacre *et al.*, 2022; Salameh *et al.*, 2020; the United Nations Office for the Coordination of Humanitarian Affairs, 2022). Lebanon, a Middle Eastern developing country, falls within this category (El Khoury-Malhame *et al.*, 2023; Farran, 2021). It has been shattered by local and regional religious, political, and social conflicts, including a 15-year-long civil war, political instability, military tensions at the borders (Farran, 2021), and the inflow of Syrian refugees since the declaration of the war in Syria in 2012 (the United Nations High Commissioner for Refugees, 2023). All these factors, combined with corruption and mismanagement of resources, have crippled Lebanon's economy and resulted in both a downgrade by the World Bank from a high-income to upper-middle-income country and an unprecedented socioeconomic crisis, with massive demonstrations, strikes, and temporary bank closures (Arezki *et al.*, 2018; Harake & Abou Hamde, 2019).

Since the first positive case of coronavirus disease 2019 (COVID-19) was reported in Lebanon on February 21, 2020, the government implemented several measures to curb the spread of the disease, including a sanitary lockdown on March 15, 2020 (Rossi *et al.*, 2020). Such actions further deepened the currently collapsing economy, and households started experiencing more job losses, long-term unemployment, salary cuts, and mortgage payment difficulties (Abou Hassan *et al.*, 2023; Bizri *et al.*, 2021; Farran, 2021). In this economic and sanitary double hit, Lebanese people may have been exposed to death and suffered from severe illnesses due to COVID-19 infection, especially in an exhausted and overwhelmed healthcare system (Fleifel & Abi Farraj, 2022; Zahreddine *et al.*, 2022). The economic crisis made things much more complicated due to the medications and medical supply shortages (mainly oxygen and ventilators) and the inability to subsist in scarce resources (Bizri *et al.*, 2021; Koweyes *et al.*, 2021). Thus, Lebanese experienced various mental adverse outcomes, including increased stress and irritability, uncertainty, nightmares, emotional distress, hypervigilance, sadness, anxiety, isolation, and grief (El Khoury-Malhame *et al.*, 2023; Sacre *et al.*, 2022; Salameh *et al.*, 2020; Younes *et al.*, 2022), which may trigger post-traumatic stress symptoms (PTSS) or disorders (PTSD) (American Psychiatric Association, 2015; Hawryluck *et al.*, 2004; Sprang & Silman, 2013) as well as sleep difficulties that are already highly prevalent among the Lebanese population (estimated to be 17.9% using the Lebanese Insomnia Scale-18 scale [Hallit *et al.*, 2019] and 47.1% using the Athens Insomnia Scale [Al Karaki *et al.*, 2020]).

PTSS is likely to occur "after exposure to a potentially traumatic event that is beyond a typical stressor; events that may lead to it include, but are not limited to, violent personal assaults, natural or human-caused disasters, accidents, combat, and other forms of violence." The previous reports among the Lebanese population shed light on the prevalence of PTSD among adolescents, adult victims of cluster munitions, and habitants of South Lebanon who have endured years-long conflicts and multiple traumatic events (Fares *et al.*, 2017; Farhood *et al.*, 2016; Shaar, 2013). Furthermore, studies have found a close interaction between PTSD and sleep patterns. Sleep disturbances have often been identified as core symptoms of PTSD; they increase psychiatric comorbidity, including substance use disorder, and decrease quality of life in PTSD (Richards *et al.*, 2020). Additional research published during COVID-19 pandemic supported this hypothesis and pinpointed perceived stress as a critical factor in sleep outcomes (Wu *et al.*, 2021; Wu *et al.*, 2020).

While several studies have assessed the impact of the current pandemic on PTSS occurrence (Liu *et al.*, 2020; Rossi *et al.*, 2020) and quality of sleep (Huang & Zhao, 2020; Rossi *et al.*, 2020; Voitsidis *et al.*, 2020) in the general population worldwide, none, to our knowledge, has evaluated the combined association of the economy and COVID-19 on PSTD and insomnia. Such an assessment would identify the predictors for the co-occurrence of these disorders and is essential information for mental-health providers when establishing appropriate rescue plans and care. Therefore, the objective of this study was to evaluate the association of COVID-19 and economy-related factors on PTSS and sleep in a sample of the general Lebanese population.

2. Data and methods

2.1. Study design and sampling

An online cross-sectional survey was conducted between May 10, and 20, 2020, and 502 participants were recruited through snowball sampling due to the government-mandated sanitary lockdown. A questionnaire, which required 15 – 20 min to be completed, was created on Google Forms and shared with participants on social media platforms and WhatsApp groups. All individuals over 18 years of age with access to the internet were eligible to participate.

2.2. Sample size

The minimum sample size was calculated using the G-Power software, version 3.0.10. The calculated effect

size was 0.0526, expecting a squared multiple correlation of 0.05 (R_2 deviation from 0) related to the Omnibus test of multiple regression. The minimum necessary sample was $n = 454$, considering an alpha error of 5%, a power of 80%, and allowing 25 predictors to be included in the model.

2.3. Questionnaire

The online questionnaire was available in Arabic (Part A in Supplementary File), the native language in Lebanon. It consisted of three parts. The first part assessed the sociodemographic features of the participants, such as age, gender (female vs. male), marital status (single, married, and widowed/divorced), educational level categories, employment status (works vs. others), region (Lebanese governorates), household size, number of dependent children, number of rooms, violence at home (verbal, physical, sexual, or no violence), and current monthly household income. This part also included questions about medical coverage (yes vs. no), smoking (cigarette and waterpipe) and alcohol consumption (previous, none, occasional, regular), self-perception of the financial situation, having been infected or in contact with people infected with coronavirus (yes vs. no), and physical activity before and during the COVID-19 pandemic (yes vs. no).

The second part of the questionnaire assessed the impact of the economic crisis and the COVID-19 pandemic on the status of current employment using 20 work-related questions addressed to working people and those seeking employment. More details can be found in Part B in Supplementary File.

The last part of the questionnaire included the following validated scales:

2.3.1. The post-traumatic stress disorder checklist for DSM-5 (PCL-5)

This 20-item self-report tool evaluates the 20 DSM-5 symptoms of PTSD in the past month. It is available in Arabic and validated in Syria (Ibrahim *et al.*, 2018). Responses are rated on a five-point Likert scale from 0 (not at all) to 4 (extremely). The total symptom severity score (range 0 – 80) is obtained by summing the responses to all items. Higher scores reflect higher symptoms resulting from a stressful experience. Several PCL-5 cutoff scores have been suggested for an optimal diagnosis of probable PTSD (between 31 and 33); the 33-cutoff point was adopted as previously described for the COVID-19-induced PTSS (Liu *et al.*, 2020) ($\alpha_{Cronbach} = 0.971$). Since online questionnaires do not allow an accurate PTSD diagnosis but rather the PTS symptoms, in this manuscript, "PTSS" is used to refer to this evaluation. The PCL-5 was later dichotomized into PTSS versus no PTSS, according to 33-cutoff point.

2.3.2. The Lebanese insomnia scale (LIS-18)

This self-reported 18-item tool, recently validated in Lebanon (Hallit *et al.*, 2019), is used to screen for insomnia. Answers are graded on a five-point Likert scale from 1 (never) to 5 (always), with higher scores indicating higher insomnia ($\alpha_{Cronbach} = 0.847$). The LIS-18 was later dichotomized according to its median (45) into insomnia versus no insomnia.

2.3.3. The fear of COVID-19 (FOC) scale

This 7-item tool is used to measure the extent of fear of COVID-19 (FOC) in adult people (Ahorsu *et al.*, 2020). It is scored on a five-point Likert scale from 1 (strongly disagree) to 5 (strongly agree). The total score (range 1 – 35) is calculated by summing the answers to all questions. Higher scores indicate a greater FOC ($\alpha_{Cronbach}$=0.893).

2.3.4. The family Adaptation, Partnership, Growth, Affection, and Resolve (APGAR) index

This short self-reported instrument evaluates the satisfaction with global family function (Good *et al.*, 1979). It consists of five questions, each corresponding to a component of family function, that is, APGAR. All five items are scored on a three-point Likert scale: 0 (hardly ever), 1 (some of the time), and 2 (almost always). The total score ranging from 0 to 10 is obtained by summing the answers to all items. The higher the scores, the higher the satisfaction with family function ($\alpha_{Cronbach} = 0.927$).

2.3.5. The InCharge financial distress/financial well-being scale (IFDFW)

This tool includes eight items assessing the perceived financial distress/financial well-being on a 1 – 10 linear scale (Prawitz *et al.*, 2006). Lower scores reflect higher financial distress and lower well-being ($\alpha_{Cronbach} = 0.925$). Since this tool is copyrighted, written permission was obtained from the authors to use it and validate it in Lebanon.

2.4. Translation procedure and piloting

All the scales used were translated into Arabic, except for PCL-5 and LIS-18 already validated and available in this language. Three authors performed the forward translation, and the other three did the backward translation. Discrepancies between the original English versions and translated ones were resolved by consensus. The final questionnaire was pilot-tested on ten people unfamiliar with the study; answers were not included in the final dataset.

2.5. Statistical analysis

Data were collected using Google Forms, a tool that automatically generates an Excel database, then transferred

to IBM SPSS® version 23.0 for analysis. Following the practice in other populations in the literature (e.g., Huang & Zhao, 2020), the database was weighted to match the population distribution according to gender, age, and dwelling region based on the Central Administration of Statistics, Lebanon. In the descriptive analysis, frequency and percentage were used for categorical variables, while mean and standard deviations were used for quantitative variables. For the dependent variables (PCL-5 for PTSS and LIS-18 for insomnia), the median and interquartile regions were presented as well; the distribution of these variables was considered normal using visual inspection of the histogram, while the skewness and kurtosis were lower than 1. These conditions are deemed compatible with normality in a sample size higher than 300 (Mishra *et al.*, 2019).

For the bivariate analysis of continuous variables, the Student's t-test and analysis of variance (ANOVA) were used to compare the means between two groups and three groups or more, respectively, after checking for homogeneity of variances using the Levene's test. When variances were not homogeneous, the corrected t-test and the Kruskal–Wallis's test were used, respectively. *Post hoc* analyses were conducted after ANOVA and Kruskal–Wallis comparisons using Bonferroni adjustment. A Spearman's correlation coefficient was used to correlate between continuous variables. The gamma coefficient was calculated to assess the association between ordinal variables (quartiles of continuous variables). In all cases, $P < 0.05$ was considered significant.

For the multivariable analysis, two logistic regression models were used, taking PTSS and insomnia as dichotomous dependent variables, respectively. A stepwise method was used to reach the most parsimonious model. Independent variables included in the models had $P < 0.1$ in the bivariate analysis, taking into account the maximum allowed number of variables according to the sample size; hence, sociodemographic, family, health, FOC, and economy-related variables were introduced as appropriate. The exponential of beta coefficient (the adjusted OR), its 95% confidence interval, and p-value were reported. Moreover, two additional multiple regressions were conducted: one using PTSS as a dependent variable (dichotomized variable) and introducing insomnia as an independent variable, and the other using insomnia (dichotomized variable) as a dependent variable and the PTSS as an independent variable, aiming to assess how these maneuvers would affect the models.

In addition, to check the dose-effect relationship, four multiple linear regression models were conducted to assess the correlates of dependent variables in the whole sample, after checking the residues' normality, the linearity of the relationship, the absence of multicollinearity, and the homoscedasticity assumptions. The beta coefficient, its 95% confidence interval, and *p*-value were reported in all models.

3. Results

3.1. Sociodemographic characteristics, PTSS, and insomnia

In this sample of the general Lebanese population, the mean PCL-5 score was 17.64 (standard deviation [SD] = 17.0) (median = 13, IQR = 3 – 28), while the mean LIS-18 score was 44.61 (SD = 11.24) (median = 44, IQR = 35 – 53]. The prevalence of PTSS was 21.68% (n = 109; 95% CI [18.07%; 25.30%]), and that of insomnia 11.48% (n = 58; 95% CI [8.58%; 14.25%]).

The PCL-5 score was divided into quartiles: 141 (28%) had a score lower than 4, 133 (26.5%) between 4 and 16, 110 (21.9%) between 17 and 29, and 129 (23.7%) scored 30 or more. The insomnia score was also divided into quartiles: 143 (28.5%) had a score <37, 139 (27.6%) between 37 and 45, 103 (20.5%) between 46 and 53, and 117 (23.3%) scored 54 and more. The PTSS and insomnia scores had a correlation coefficient $r = 0.418$ ($p < 0.001$), while the association between quartiles yielded a gamma coefficient of 0.563 ($p < 0.001$) (Figure 1).

A higher PCL-5 score was associated with the female gender and smokers (cigarette and waterpipe). Participants who reported physical and other forms of violence in their household, who were older, and who had higher APGAR family scores had significantly lower levels of PCL-5 score (Table 1). Moreover, a higher insomnia score was associated with being married, having a higher number of dependent children, being a past alcohol or waterpipe consumer, living with violence at home (verbal, physical, sexual, or other), being employed or looking for employment, being a housewife/never working, and having higher APGAR family scores (Table 1). Additional results are detailed in Part C in Supplementary File (Table S1).

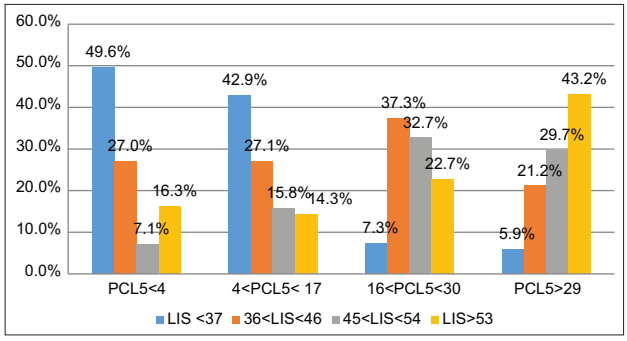


Figure 1. Association between PTSS and insomnia quartiles in the Lebanese population
Note: PTSS: Post-traumatic stress symptoms. $N = 502$; gamma = 0.563; $p < 0.001$.

Table 1. Sample distribution by sociodemographic characteristics, PTSS, and insomnia

Characteristics	Frequency (%) N=502 (100%)	PTSS mean (SD)	*p*-value	Insomnia mean (SD)	*p*-value
Gender			<0.001		0.114
Male	237 (47.3)	13.57 (14.77)		43.77 (11.60)	
Female	265 (52.7)	21.29 (18.04)		45.36 (10.87)	
Marital status			0.430		0.024
Single	189 (37.6)	18.85 (18.08)		42.85 (10.73)	Ref
Married	290 (57.8)	17.02 (16.37)		45.70 (11.31)	0.020
Widowed/Divorced	23 (4.6)	15.57 (15.63)		45.41 (11.24)	0.894
Number of dependent children			0.988		0.007
None	207 (41.2)	17.88 (17.33)		42.63 (10.61)	Ref
1 child	46 (9.1)	17.99 (16.21)		47.11 (12.38)	0.085
2 children	132 (26.3)	17.48 (18.31)		45.26 (11.01)	0.206
3 or more	118 (23.4)	17.26 (15.29)		46.41 (11.66)	0.020
Number of rooms			0.081		0.174
<5 rooms	167 (33.2)	18.05 (16.54)		44.33 (11.13)	
5 rooms	138 (27.6)	16.16 (16.65)		45.92 (12.24)	
6 rooms	109 (218)	15.22 (13.78)		45.02 (10.83)	
7 or more	87 (17.4)	22.25 (20.94)		42.58 (10.08)	
Alcohol consumption			0.141		<0.001
Previous	14 (2.8)	8.96 (15.85)		54.33 (06.17)	Ref
None	197 (39.3)	18.78 (17.30)		43.82 (10.89)	<0.001
Occasional	248 (49.3)	17.66 (16.88)		45.17 (11.44)	<0.001
Regular	44 (8.7)	15.13 (16.09)		41.94 (11.30)	<0.001
Cigarette smoking			0.002		0.139
Previous	21 (4.1)	7.71 (13.48)	Ref	47.05 (12.98)	
None	334 (66.6)	17.11 (16.10)	0.001	44.15 (11.31)	
Occasional	87 (17.4)	21.57 (20.10)	0.001	46.72 (11.12)	
Regular	60 (11.9)	18.33 (16.73)	0.001	43.25 (10.07)	
Waterpipe smoking			0.005		<0.001
Previous	27 (5.3)	12.82 (12.73)	0.034	51.46 (7.15)	Ref
None	363 (72.3)	16.57 (16.58)	0.008	43.75 (11.45)	<0.001
Occasional	79 (15.7)	19.66 (16.82)	Ref	45.27 (11.43)	0.001
Regular	33 (6.7)	23.32 (19.02)	1.000	46.01 (10.47)	0.005
Violence at home[a]					
Verbal violence versus no	30 (5.9)	15.07 (17.65)	0.469	53.89 (12.84)	<0.001
Physical violence versus no	8 (1.6)	12.98 (11.24)	0.009	55.86 (9.48)	0.006
Sexual violence versus no	7 (1.4)	0	<0.001	54.16 (7.30)	0.024
Other violence versus no	8 (1.6)	12.98 (11.24)	0.008	55.86 (9.48)	0.005
No violence	472 (94.1)	17.41 (16.89)	Ref	43.84 (11.14)	Ref
Professional status			0.775		0.015
Works/looking for a job	361 (71.9)	17.55 (16.42)		45.15 (11.29)	0.022
Housewife/never work	52 (10.3)	16.18 (12.79)		46.33 (09.86)	0.037
Student	50 (9.9)	18.37 (19.42)		40.22 (11.54)	Ref
Retired	40 (7.9)	19.47 (23.18)		43.00 (11.03)	1.000
	Mean (SD)	**Unadjusted correlation coefficient (r)**	***p*-value**	**Unadjusted correlation coefficient (r)**	***p*-value**
Age in years	42.47 (14.06)	−0.146	0.001	0.070	0.118
APGAR family	7.81 (2.72)	−0.263	<0.001	−0.227	<0.001

Note: [a]More than one answer is possible. PTSS: Post-traumatic stress symptoms; APGAR: Adaptation, Partnership, Growth, Affection, and Resolve.

3.2. Economic characteristics, PTSS, and insomnia

Higher socioeconomic quartiles and financial wellbeing (IFDWF) scores were significantly associated with a lower PCL-5 score, while a greater fear of poverty was associated with a higher PCL-5 score. Lower insomnia score was associated with a poor socioeconomic class before the COVID-19, with middle and low classes after the pandemic, high household income, and high IFDWF

score, while fear of poverty was associated with a higher insomnia score (Table 2).

3.3. Exposure to COVID-19, health characteristics, PTSS, and insomnia

As for health-related matters, a lower PCL-5 score was associated with being in contact with a COVID-19 patient or knowing someone infected with COVID-19, while a higher PCL-5 score was associated with worrying about a family member becoming infected with the virus and fear of the virus. Physical activity during confinement was significantly associated with lower insomnia, while FOC was associated with higher insomnia (Table 3). Additional results are detailed in in Part C in Supplementary File (Table S2).

3.4. Multivariable analyses: correlates of PTSS and insomnia

In the multivariable analysis, positive correlates of PTSS were FOC, fear of poverty score, the female gender, and current cigarette smoking; negative correlates were a higher APGAR family score, older age, and never having to work (mainly retired, housewives, and students). Adding insomnia as an independent variable to the model did not substantially change it, and insomnia was positively associated with PTSS.

Positive correlates of insomnia included fear of poverty, FOC, physical violence at home, number of dependent children, and being afraid of not having access to treatment. In contrast, having a higher APGAR family score was associated with lower insomnia. When PTSS was additionally included in the model, the majority associations of these variables did not change, and PTSS was positively associated with insomnia. However, the fear of the COVID-19 scale was not associated anymore with insomnia (Table 4). Results from sensitivity analysis of the multiple linear regressions confirmed the above relationships (Part C in Supplementary File; Table S3).

Table 2. Economic characteristics, PTSS, and insomnia

	Frequency (%) N=502 (100%)	PTSS mean (SD)	*p*-value*	Insomnia mean (SD)	*p*-value*
Subjective assessment of economic status before COVID			0.673		<0.001
No answer	5 (1.0)	15.11 (18.08)		55.38 (12.65)	0.282
Rich	30 (6.1)	16.66 (18.70)		48.18 (13.47)	0.013
Middle class	448 (89.2)	17.85 (16.91)		43.93 (1.97)	<0.001
Middle to low	11 (2.1)	19.25 (15.16)		47.74 (8.82)	0.002
Below poverty line	8 (1.6)	9.24 (18.52)		57.89 (3.33)	Ref
Subjective assessment of economic status after COVID			0.526		<0.001
No answer	14 (2.8)	16.82 (16.57)		47.55 (14.68)	0.282
Rich	5 (1.1)	21.95 (22.19)		49.66 (10.20)	0.013
Middle class	327 (65.1)	16.99 (17.21)		42.65 (10.60)	<0.001
Middle to low	137 (27.2)	19.54 (15.68)		48.24 (11.24)	0.002
Below poverty line	19 (3.8)	14.51 (21.23)		48.67 (12.01)	Ref
Current health coverage			0.064		0.006
No health coverage	53 (10.5)	22.92 (15.36)		45.41 (11.26)	0.121
Private insurance	205 (40.8)	18.41 (16.49)		45.88 (11.04)	0.005
Social security	155 (30.9)	16.29 (17.01)		45.07 (11.69)	0.019
Other public coverage	90 (17.8)	16.30 (18.30)		40.90 (9.84)	Ref
Household income			0.072		0.001
<675,000 LP	15 (2.9)	21.21 (15.88)		46.43 (11.32)	0.892
675,000 – 1,500,000 LP	64 (12.8)	19.63 (17.81)		46.53 (08.79)	Ref
1,500,000 – 3,000,000 LP	149 (29.7)	19.76 (17.93)		45.96 (10.70)	0.776
More than 3,000,000 LP	274 (54.5)	15.82 (16.20)		43.32 (11.90)	0.003
Socioeconomic quartile			0.002		0.231
Quartile 1	134 (26.6)	18.64 (16.27)	Ref	45.75 (10.38)	
Quartile 2	142 (28.3)	21.75 (19.79)	0.135	43.80 (11.24)	
Quartile 3	119 (23.7)	13.78 (15.57)	0.014	45.49 (11.76)	
Quartile 4	101 (20.1)	14.52 (13.85)	0.199	43.25 (11.80)	
	Mean (SD)	**Unadjusted correlation (r)**	***p*-value****	**Unadjusted correlation (r)**	***p*-value****
Fear of poverty	6.90 (2.65)	0.314	<0.001	0.326	<0.001
IFDWF financial wellbeing scale	39.9 (17.33)	-0.329	<0.001	−0.299	<0.001

Note: APGAR: Adaptation, Partnership, Growth, Affection, and Resolve; IFDFW: The InCharge financial distress/financial well-being scale; PTSS: Post-traumatic stress symptoms. **p*-values were based on ANOVA test (and *post hoc* with Bonferroni adjustment). ***p*-values were based on Spearman's correlation test.

Table 3. Exposure to COVID-19, health characteristics, PTSS, and insomnia

Factor	Frequency (%) N=502 (100%)	PTSS Mean (SD)	*p*-value*	Insomnia mean (SD)	*p*-value*
Contact with COVID-19			0.035		0.439
Yes (work, family, store)	18 (3.5%)	11.27 (11.75)		42.58 (11.29)	
No	484 (96.5%)	17.87 (17.12)		44.69 (11.24)	
Knows someone infected			0.004		0.339
Yes	145 (28.8%)	14.47 (15.01)		43.86 (11.02)	
No	357 (71.2%)	18.92 (17.60)		44.92 (11.33)	
Physical activity			0.057		0.001
Yes	321 (64.0%)	16.55 (17.11)		43.32 (11.41)	
No	181 (36.0%)	19.57 (16.66)		46.91 (10.57)	
Having a chronic disease			0.524		0.057
Yes	103 (20.5%)	16.69 (16.02)		46.49 (12.24)	
No	399 (79.5%)	17.89 (17.25)		44.13 (10.93)	
Receiving regular treatment			0.755		0.044
Yes	127 (25.4%)	17.54 (16.67)		46.76 (11.62)	Ref
No	40 (8.0%)	15.78 (16.20)		44.05 (10.49)	0.545
Does not apply	334 (66.6%)	17.91 (17.25)		43.86 (11.10)	0.040
Fear no access to treatment			0.062		<0.001
No	153 (30.5%)	19.78 (15.01)		48.94 (10.87)	Ref
Yes	136 (27.0%)	15.16 (16.73)		42.59 (10.51)	<0.001
Does not apply	213 (42.4%)	18.06 (18.20)		43.31 (11.29)	<0.001
Fear to go out get treatment			0.119		0.074
No	217 (43.2%)	15.36 (15.02)		44.60 (11.53)	
Yes	77 (15.4%)	20.06 (17.82)		47.11 (10.78)	
Does not apply	208 (41.4%)	19.11 (18.37)		43.69 (11.01)	
Worried for family member			0.002		0.442
No	96 (19.1%)	12.72 (14.06)	Ref	45.81 (11.24)	
Yes	268 (53.4%)	19.96 (18.14)	0.001	44.12 (11.29)	
Does not apply	138 (27.4%)	16.55 (15.78)	0.037	44.74 (11.14)	
	Mean (SD)	**Unadjusted correlation (r)**	***p*-value****	**Unadjusted correlation (r)**	***p*-value****
Fear of COVID-19	11.35 (6.03)	0.424	<0.001	0.229	<0.001

Note: *Yes versus no modalities comparison. APGAR: Adaptation, Partnership, Growth, Affection, and Resolve; PTSS: Post-traumatic stress symptoms. **p*-values were based on ANOVA test (and post hoc with Bonferroni adjustment). ***p*-values were based on Spearman's correlation test.

4. Discussion

This study was carried out 3 months after the first case of COVID-19 was confirmed in Lebanon and 2 months after the national sanitary lockdown was declared. It revealed relatively high prevalence of PTSS (21.7%) as evaluated by the PCL-5 scores and moderate prevalence of insomnia (11.5%) among a sample of the general Lebanese population. The prevalence of insomnia in this study was higher than that reported in other populations (Rossi *et al.*, 2020; Zhou *et al.*, 2021) but lower than what was previously published in Lebanon (using the LIS-18 score: 17.9%) (Hallit *et al.*, 2019) and in other countries (Huang & Zhao, 2020; Kokou-Kpolou *et al.*, 2020; Voitsidis *et al.*, 2020). Discrepancies may be due to the use of different assessment tools and differences in demographic profiles of populations. Notably, the prevalence of PTSS was higher than that reported in China during the pandemic (4.6 and 7%) (Liu *et al.*, 2020; Sun *et al.*, 2020). Such a disparity could be related to the cumulation of stressful events experienced by the Lebanese population, including the current pandemic, past and prevailing local and regional wars, political instability, and the economic crisis. Interestingly, the PTSS prevalence found in this study was similar to the one reported in Lebanon (21.6%) immediately after "The Grapes of Wrath" war (South Lebanon, 1996). Therefore, in major life-threatening disease outbreaks occurring in societies already struggling with economic difficulties, understanding the interplay of factors on mental health is crucial to design detection and intervention strategies.

4.1. COVID-19, PTSS, and insomnia

Our results showed that FOC was the main factor impacting both PTSS and insomnia. Even if several studies have assessed PTSS (Liu *et al.*, 2020; Rossi *et al.*, 2020)

Table 4. Multivariable analyses: Correlates of PTSS and insomnia

Model 1: Correlates of PTSS symptoms (Nagelkerke R^2=0.332; Omnibus test <0.001; HL *p*-value=0.845)				
Factor	***p*-value**	**ORa**	**95% confidence interval of the ORa**	
Fear of COVID score	<0.001	1.114	1.065	1.165
Female versus male gender	<0.001	2.965	1.732	5.077
Current cigarette smoking	0.016	2.302	1.167	4.539
Never works versus others	0.004	0.213	0.075	0.601
APGAR score	<0.001	0.833	0.763	0.909
Age in years	0.001	0.967	0.948	0.987
Fear of poverty score	<0.001	1.218	1.086	1.366
Model 2: Correlates of PTSS symptoms, including insomnia as an independent variable (Nagelkerke R^2=0.392; Omnibus test <0.001; HL *p*-value=0.08)				
Factor	***p*-value**	**ORa**	**95% confidence interval of the ORa**	
Fear of COVID score	<0.001	1.135	1.080	1.194
Female versus male gender	<0.001	3.233	1.821	5.739
Current cigarette smoking	0.022	2.321	1.128	4.776
Current waterpipe smoking	0.020	2.911	1.180	7.182
Never works versus others	0.002	0.186	0.064	0.542
Afraid of not accessing treatment	0.029	0.501	0.269	0.933
APGAR score	<0.001	0.852	0.775	0.937
Age in years	<0.001	0.961	0.940	0.982
Income level	0.019	1.563	1.076	2.271
IFDWF wellness score	<0.001	0.968	0.949	0.986
Insomnia (yes vs. no)	<0.001	3.368	1.923	5.900
Model 3: Correlates of Insomnia (Nagelkerke R^2=0.247; Omnibus test <0.001; HL *p*-value=0.488)				
Factor	***p*-value**	**ORa**	**95% Confidence Interval of the ORa**	
Fear of COVID score	0.006	1.049	1.014	1.086
Number of children at your responsibility	0.029	1.201	1.019	1.415
Physical violence at home (yes vs. no)	0.006	20.292	2.354	174.947
APGAR score	<0.001	0.863	0.801	0.930
Fear of poverty score	<0.001	1.220	1.124	1.325
Being afraid of not accessing treatment (yes vs. no)	0.006	1.920	1.209	3.047
Sports during confinement (yes vs. no)	0.007	0.564	0.373	0.854

(Cont'd...)

Table 4. ***(Continued)***

Model 4: Correlates of Insomnia, including PTSS as an independent variable (Nagelkerke R^2=0.276; Omnibus test <0.001; HL *p*-value=0.173)				
Factor	***p*-value**	**ORa**	**95% confidence interval of the ORa**	
Number of children at your responsibility	0.009	1.250	1.057	1.477
Physical violence at home (yes vs. no)	0.015	14.398	1.674	123.809
APGAR score	0.004	0.892	0.826	0.964
Fear of poverty score	<0.001	1.202	1.106	1.305
Being afraid of not accessing treatment (yes vs. no)	<0.001	2.269	1.424	3.616
Sports during confinement (yes vs. no)	0.014	0.588	0.385	0.898
PTSS (yes vs. no)	<0.001	3.295	1.949	5.571

Note: PTSS scale added in the model as an independent variable. PTSS: Post-traumatic stress symptoms, APGAR: Adaptation, Partnership, Growth, Affection, and Resolve; IFDFW: The InCharge financial distress/financial well-being scale.

or sleep disorders (Huang & Zhao, 2020; Kokou-Kpolou *et al.*, 2020; Rossi *et al.*, 2020; Voitsidis *et al.*, 2020) in the general population during this pandemic, none has evaluated the direct relationships between the fear of the virus and PTSS and insomnia using a validated scale. Some authors even pointed out that they could not identify which of the fear of the disease or the restrictive measures imposed by governments were the direct causing factors of mental health-related issues (Casagrande *et al.*, 2020). FOC could also be related to the concern of contracting the disease or that it infects loved ones, in addition to fears of stigmatization and social exclusion in case of confirmed infection, being quarantined, losing one's job, etc. (Brooks *et al.*, 2020) All these smothering ideas and fear experiences, further fueled by media overflow of information and misinformation, could potentially lead to irrational and unclear thoughts, which, in turn, would exacerbate underlying mental health problems and be significant predictors of PTSS and insomnia.

4.2. Economy, PTSS, and insomnia

In Lebanon, FOC was magnified by the fear of uncertainties related to the economy. Indeed, our results showed that financial hardship was significantly associated with higher levels of PTSS and insomnia, similar to previous findings showing that people from low household incomes were more likely to exhibit PTSS (Hawryluck *et al.*, 2004). Increased sleep difficulties were associated with fear of

poverty and having more dependent children in this study. Employed people also displayed higher PTSS levels compared to those who never worked (mainly retired, housewives, and non-working students). Indeed, these persons were highly preoccupied with the wilting economy and the consequences of the COVID-19 pandemic and subsequent lockdown on their work. They were unable to resume their regular professional activities; they also faced unexpected expenses and could not anticipate the long-term detrimental impacts of the pandemic on the economy. Therefore, people who feared poverty and worried about not being able to secure their children's needs experienced uncontrollable cognitive arousal, which is known to affect the quality of sleep (Brooks *et al.*, 2020).

Finally, those who feared not being able to access treatment had higher levels of PTSS, which is directly related to the fear of contracting the virus and not being able to afford treatment and isolation measures. Even if human rights call for the "right to health," especially during this pandemic, granting access to health-care services and social security are hard to manage in economically crippled countries such as Lebanon (Armocida *et al.*, 2020; WHO, 2020).

4.3. Sociodemographic factors, PTSS, and insomnia

PTSS was associated with some sociodemographic factors, such as gender, age, and waterpipe/cigarette smoking status; it was higher among women and current smokers but inversely correlated with older age. Our results are consistent with existing literature showing that gender and age were predictors of PTSD during previous infectious disease outbreaks (Xu *et al.*, 2011) or the current pandemic (Casagrande *et al.*, 2020; Liu *et al.*, 2020). Indeed, women usually exhibit higher stress, anxiety, and helplessness than men, which could be related to the higher reactivity of fear-associated neural networks in women's brains (Felmingham *et al.*, 2010).

Regarding smoking status, a recent review of the literature revealed that smokers were approximately twice more likely to have PTSD than non-smokers in the general population and that individuals with PTSD were about twice as likely to be current smokers. These outcomes could be partly explained by the expectation that smoking would reduce the detrimental consequences of PTSD symptoms, which, in turn, would increase the smoking rate and nicotine dependence (Kearns *et al.*, 2018).

As for insomnia, patients suffering from violence (physical) were more prone to insomnia, in agreement with a recent review that identified an overall relationship between interpersonal violence and poor quality of sleep (Gallegos *et al.*, 2019). Moreover, higher levels of insomnia were perceived by patients who feared not being able to access treatment or not having enough money to afford medications and disease management (Kumar Kar *et al.*, 2020).

Finally, PTSS and insomnia levels were higher in individuals with lower family support (lower APGAR scores), consistent with the previous studies showing that loneliness was positively correlated with mental health issues during the COVID-19 pandemic (Kokou-Kpolou *et al.*, 2020; Voitsidis *et al.*, 2020) and that family support promoted positive mental health status (Zhang & Ma, 2020).

4.4. PTSS, fear of COVID-19, and insomnia

Regarding the correlation between PTSS and insomnia, our results showed that each of these disorders could be a predictive factor of the other after adjustment for potential confounders. This outcome was expected since previous studies widely explored their relationships (Casagrande *et al.*, 2020; Sun *et al.*, 2020), revealing that poor quality of sleep is linked to both onset and maintenance of PTSS (Brooks *et al.*, 2020), regardless of FOC. Interestingly, when including PTSS as an independent variable in the model with insomnia as a dependent variable, FOC was no longer associated with insomnia; this was not the case for economy-related variables that would be independently associated with insomnia. To the best of our knowledge, these results have never been described previously.

A recent review evidenced overlapping clinical characteristics between sleep disturbance and anxiety-related disorders, including PTSS, with a bidirectional relationship between both disorders (Richards *et al.*, 2020). The authors discussed that sleep disorders and nightmares occurred at a high frequency following trauma and/or in PTSS (Mysliwiec *et al.*, 2018; Mysliwiec *et al.*, 2014). One possible explanation is that FOC could lead to panicked awakenings, increased physical movement during sleep, and nightmares. These symptoms are typically observed following trauma, which explains the association of PTSS with insomnia (Richards *et al.*, 2020). Some authors call it "trauma-associated sleep disorder" (Mysliwiec *et al.*, 2018; Mysliwiec *et al.*, 2014). Additional studies are needed to elucidate the underlying mechanisms between FOC, PTSS, and insomnia.

4.5. Limitations and strengths

Our study presents some limitations, mainly due to the study design and online data collection that consists of a small cross-sectional non-randomized analysis without baseline evaluation. Furthermore, most participants were university graduates, had appropriate computer literacy, and access to the Internet, and we used a snowball technique for data; thus, selection bias might have

occurred, and our sample might not be representative of the whole population. However, education did not affect the overall outcomes of our study. Indeed, the sample size had adequate power to assess correlations, and the multivariate analysis was performed with appropriate adjustment on multiple potential confounders, including education; all these elements are expected to decrease the effect of the selection bias on the results. Furthermore, the cross-sectional design of the study precludes causality inferences. In addition, although multiple potential confounders were taken into account through the multivariable analysis, there is still a risk of residual confounding. However, the quantitative exposure-effect relationships found after multivariable analyses might limit this problem (results shown in multiple linear regression models – in Part C in Supplementary File; Tables S3).

Moreover, despite using validated scales with very good to excellent reliability, information bias cannot be ruled out as the questionnaire was self-reported. Nevertheless, this bias could be non-differential and direct the results towards the null, underestimating the magnitude of the associations found. However, this study is relatively large with acceptable methodology in the current circumstances, allowing the evaluation of the combined impact of COVID-19 and a collapsing economy on PTSS and insomnia. Additional robust studies using larger-size and more representative samples would help confirm these findings. Based on these results, decision-makers need to acknowledge that economic hardship and the pandemic can together impact mental health detrimentally. They need to define strategies to better screen for these disorders while identifying triggering factors, thus implementing individualized management plans when similar circumstances resurge.

5. Conclusion

This study revealed that the fear of COVID-19 and the economic crisis are correlated with PTSS and insomnia. Moreover, the association between the fear of COVID-19 and insomnia showed to be related to PTSS symptoms. Additional studies are needed to confirm our findings and allow a better generalization of the results.

Acknowledgments

The authors would like to thank all the persons who helped distribute the questionnaire, particularly Dr. Fady Farhat, Dr. Zahraa Shaitly, Mrs. Joumana Sleilaty, and Mr. Jihad Gerges.

Funding

None.

Conflict of interest

The authors declare no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Author contributions

Conceptualization: Hala Sacre
Methodology: Pascale Salameh
Formal analysis: Pascale Salameh
Writing – original draft: Aline Hajj, Danielle A. Badro, Carla Abou Selwan
Writing – review & editing: Hala Sacre, Randa Aoun, Chadia Haddad, Pascale Salameh

Ethics approval and consent to participate

The Institutional Review Board of the American University of Science and Technology approved this study protocol (AUST-IRB-20200527-01), as this work has been performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki and its later amendments. The topic was explained to all participants in the introductory section of the survey and consent to participate was implicit. Anonymity of participants was guaranteed throughout the process of data collection and analysis.

Consent for publication

Not applicable.

Availability of data

The datasets used and/or analyzed during the current study are available from the Figshare repository: https://figshare.com/s/939d0fc0032c7af0b8c9.

References

Abou Hassan, F.F., Bou Hamdan, M., Ali, F., & Melhem, N.M. (2023). Response to COVID-19 in Lebanon: Update, challenges and lessons learned. *Epidemiology and Infection,* 151: e23.

https://doi.org/10.1017/S0950268823000067

Ahorsu, D.K., Lin, C.Y., Imani, V., Saffari, M., Griffiths, M.D., & Pakpour, A.H. (2022). The fear of COVID-19 scale: Development and initial validation. *International Journal of Mental Health and Addiction*, 20(3), 1537–1545.

https://doi.org/10.1007/s11469-020-00270-8

Al Karaki, G., Hallit, S., Malaeb, D., Kheir, N., Sacre, H., Salameh, P., & Hallit, R. (2020). Prevalence and factors associated with insomnia among a representative sample of the lebanese population: Results of a cross-sectional study. *Journal of Epidemiology and Global Health,* 10(2): 124-130.

https://doi.org/10.2991/jegh.k.200117.001

American Psychiatric Association (APA). (2015). Diagnostic and Statistical Manual of Mental Disorders (DSM-5). Available from: https://www.psychiatry.org/psychiatrists/practice/dsm [Last accessed on 2020 Aug 04].

Arezki, R., Mottaghi, L., Barone, A., Fan, R.Y., Harb, A.A., Karasapan, O.M., Matsunaga, H., Nguyen, H., & de Soyres, F. (2018). A New Economy in Middle East and North Africa. Middle East and North Africa Economic Monitor. Available from: http://documents1.worldbank.org/curated/en/331081537883965003/pdf/130143-WP-REVISED-PUBLIC.pdf [Last accessed on 2020 May 22].

Armocida, B., Formenti, B., Palestra, F., Ussai, S., & Missoni, E. (2020). COVID-19: Universal health coverage now more than ever. *Journal of Global Health,* 10(1): 010350.

https://doi.org/10.7189/jogh.10.010350

Bizri, A.R., Khachfe, H.H., Fares, M.Y., & Musharrafieh, U. (2021). COVID-19 pandemic: An insult over injury for Lebanon. *Journal of Community Health,* 46(3): 487-493.

https://doi.org/10.1007/s10900-020-00884-y

Brooks, S.K., Webster, R.K., Smith, L.E., Woodland, L., Wessely, S., Greenberg, N., & Rubin, G.J. (2020). The psychological impact of quarantine and how to reduce it: Rapid review of the evidence. *Lancet,* 395(10227): 912-920.

https://doi.org/10.1016/S0140-6736(20)30460-8

Casagrande, M., Favieri, F., Tambelli, R., & Forte, G. (2020). The enemy who sealed the world: Effects quarantine due to the COVID-19 on sleep quality, anxiety, and psychological distress in the Italian population. *Sleep Medicine*, 75: 12-20.

https://doi.org/10.1016/j.sleep.2020.05.011

El Khoury-Malhame, M., Rizk, R., Joukayem, E., Rechdan, A., & Sawma, T. (2023). The psychological impact of COVID-19 in a socio-politically unstable environment: Protective effects of sleep and gratitude in Lebanese adults. *BMC Psychology,* 11(1): 14.

https://doi.org/10.1186/s40359-023-01042-4

Fares, J., Gebeily, S., Saad, M., Harati, H., Nabha, S., Said, N., Kanso, M., Abdel Rassoul, R., & Fares, Y. (2017). Post-traumatic stress disorder in adult victims of cluster munitions in Lebanon: A 10-year longitudinal study. *BMJ Open,* 7(8): e017214.

https://doi.org/10.1136/bmjopen-2017-017214

Farhood, L.F., Fares, S., Sabbagh, R., & Hamady, C. (2016). PTSD and depression construct: Prevalence and predictors of co-occurrence in a South Lebanese civilian sample. *European Journal of Psychotraumatology*, 7: 31509.

https://doi.org/10.3402/ejpt.v7.31509

Farran, N. (2021). Mental health in Lebanon: Tomorrow's silent epidemic. *Mental Health and Prevention,* 24: 200218.

https://doi.org/10.1016/j.mhp.2021.200218

Felmingham, K., Williams, L.M., Kemp, A.H., Liddell, B., Falconer, E., Peduto, A., & Bryant, R. (2010). Neural responses to masked fear faces: Sex differences and trauma exposure in posttraumatic stress disorder. *Journal of Abnormal Psychology*, 119(1): 241-247.

https://doi.org/10.1037/a0017551

Fleifel, M., & Abi Farraj, K. (2022). The Lebanese healthcare crisis: An infinite calamity. *Cureus,* 14(5): e25367.

https://doi.org/10.7759/cureus.25367

Gallegos, A.M., Trabold, N., Cerulli, C., & Pigeon, W.R. (2019). Sleep and interpersonal violence: A systematic review. *Trauma, Violence and Abuse*, 22: 359-369.

https://doi.org/10.1177/1524838019852633

Good, M.J., Smilkstein, G., Good, B., Shaffer, T., & Arons, T. (1979). The family APGAR index: A study of construct validity. *The Journal of Family Practice,* 8(3), 577-582.

Hallit, S., Sacre, H., Haddad, C., Malaeb, D., Al Karaki, G., Kheir, N., Hajj, A., Hallit, R., & Salameh, P. (2019). Development of the Lebanese insomnia scale (LIS-18): A new scale to assess insomnia in adult patients. *BMC Psychiatry,* 19(1): 421.

https://doi.org/10.1186/s12888-019-2406-y

Harake, W., & Abou Hamde, N. (2019). Lebanon economic monitor: So when gravity beckons, the poor don't fall. In: Global Practice for Macroeconomics, Trade and Investment Middle East and North Africa Region. Available from: http://documents.worldbank.org/curated/en/349901579899850508/pdf/Lebanon-Economic-Monitor-So-When-Gravity-Beckons-the-Poor-Dont-Fall.pdf [Last accessed on 2020 Mar 24].

Hawryluck, L., Gold, W.L., Robinson, S., Pogorski, S., Galea, S., & Styra, R. (2004). SARS control and psychological effects of quarantine, Toronto, Canada. *Emerging Infectious Diseases,* 10(7): 1206-1212.

https://doi.org/10.3201/eid1007.030703

Huang, Y., & Zhao, N. (2020). Generalized anxiety disorder, depressive symptoms and sleep quality during COVID-19 outbreak in China: A web-based cross-sectional survey. *Psychiatry Research,* 288: 112954.

https://doi.org/10.1016/j.psychres.2020.112954

Ibrahim, H., Ertl, V., Catani, C., Ismail, A.A., & Neuner, F. (2018). The validity of Posttraumatic Stress Disorder Checklist for DSM-5 (PCL-5) as screening instrument with Kurdish and Arab displaced populations living in the Kurdistan region of Iraq. *BMC Psychiatry,* 18(1): 259.

https://doi.org/10.1186/s12888-018-1839-z

Kearns, N.T., Carl, E., Stein, A.T., Vujanovic, A.A., Zvolensky, M.J., Smits, J.A.J., & Powers, M.B. (2018). Posttraumatic stress disorder and cigarette smoking: A systematic review. *Depression and Anxiety,* 35(11): 1056-1072.

https://doi.org/10.1002/da.22828

Kokou-Kpolou, C.K., Megalakaki, O., Laimou, D., & Kousourid, M. (2020). Insomnia during COVID-19 pandemic and lockdown: Prevalence, severity, and associated risk factors in France population. *Psychiatry Research*, 290: 113128.

https://doi.org/10.1016/j.psychres.2020.113128

Koweyes, J., Salloum, T., Haidar, S., Merhi, G., & Tokajian, S. (2021). COVID-19 pandemic in Lebanon: One year later, what have we learnt? *mSystems,* 6 (2): e00351-21.

https://doi.org/10.1128/mSystems.00351-21

Liu, N., Zhang, F., Wei, C., Jia, Y., Shang, Z., Sun, L., Wu, L., Sun, Z., Zhou, Y., Wang, Y., & Liu, W. (2020). Prevalence and predictors of PTSS during COVID-19 outbreak in China hardest-hit areas: Gender differences matter. *Psychiatry Research,* 287: 112921.

https://doi.org/10.1016/j.psychres.2020.112921

Mishra, P., Pandey, C.M., Singh, U., Gupta, A., Sahu, C., & Keshri, A. (2019). Descriptive statistics and normality tests for statistical data. *Annals of Cardiac Anaesthesia,* 22(1): 67-72.

https://doi.org/10.4103/aca.ACA_157_18

Mysliwiec, V., Brock, M.S., Creamer, J.L., O'Reilly, B.M., Germain, A., & Roth, B.J. (2018). Trauma associated sleep disorder: A parasomnia induced by trauma. *Sleep Medicine Reviews,* 37: 94-104.

https://doi.org/10.1016/j.smrv.2017.01.004

Mysliwiec, V., O'Reilly, B., Polchinski, J., Kwon, H.P., Germain, A., & Roth, B.J. (2014). Trauma associated sleep disorder: A proposed parasomnia encompassing disruptive nocturnal behaviors, nightmares, and REM without atonia in trauma survivors. *Journal of Clinical Sleep Medicine,* 10(10): 1143-1148.

https://doi.org/10.5664/jcsm.4120

Prawitz, A., Garman, E.T., Sorhaindo, B., O'Neill, B., Kim, J., & Drentea, P. (2006). Incharge financial distress/financial well-being scale: Development, administration, and score interpretation. *Financial Counseling and Planning,* 17(1): 34-50.

https://doi.org/10.1037/t60365-000

Richards, A., Kanady, J.C., & Neylan, T.C. (2020). Sleep disturbance in PTSD and other anxiety-related disorders: An updated review of clinical features, physiological characteristics, and psychological and neurobiological mechanisms. *Neuropsychopharmacology,* 45(1): 55-73.

https://doi.org/10.1038/s41386-019-0486-5

Rossi, R., Socci, V., Talevi, D., Mensi, S., Niolu, C., Pacitti, F., Di Marco, A., Rossi, A., Siracusano, A., & Di Lorenzo, G. (2020). COVID-19 pandemic and lockdown measures impact on mental health among the general population in Italy. *Frontiers in Psychiatry*, 11: 790.

https://doi.org/10.3389/fpsyt.2020.00790

Sacre, H., Hajj, A., Badro, D.A., Abou Selwan, C., Haddad, C., Aoun, R., & Salameh, P. (2022). The combined outcomes of the COVID-19 pandemic and a collapsing economy on mental well-being: A cross-sectional study. *Psychological Reports*, 332941221110545.

https://doi.org/10.1177/00332941221110545

Salameh, P., Hajj, A., Badro, D.A., Abou Selwan, C., Aoun, R., & Sacre, H. (2020). Mental health outcomes of the COVID-19 pandemic and a collapsing economy: Perspectives from a developing country. *Psychiatry Research,* 294: 113520.

https://doi.org/10.1016/j.psychres.2020.113520

Shaar, K.H. (2013). Post-traumatic stress disorder in adolescents in Lebanon as wars gained in ferocity: A systematic review. *Journal of Public Health Research,* 2(2): e17.

https://doi.org/10.4081/jphr.2013.e17

Sprang, G., & Silman, M. (2013). Posttraumatic stress disorder in parents and youth after health-related disasters. *Disaster Medicine and Public Health Preparedness,* 7(1): 105-110.

https://doi.org/10.1017/dmp.2013.22

Sun, L., Sun, Z., Wu, L., Zhu, Z., Zhang, F., Shang, Z., Jia, Y., Gu, J., Zhou, Y., Wang, Y., Liu, N., & Liu, W. (2021). Prevalence and risk factors of acute posttraumatic stress symptoms during the COVID-19 outbreak. *J Affect Disord*, 283: 123-129.

https://doi.org/10.1016/j.jad.2021.01.050

The United Nations High Commissioner for Refugees (UNHCR). (2023). UNHCR Lebanon at a Glance. Available from: https://www.unhcr.org/lb/at-a-glance [Last accessed on 2020 Mar 24].

The United Nations Office for the Coordination of Humanitarian Affairs (OCHA). (2022). Lebanon. Available from: https://www.acaps.org/country/lebanon/crisis/socioeconomic-crisis [Last accessed on 2020 Mar 24].

Voitsidis, P., Gliatas, I., Bairachtari, V., Papadopoulou, K., Papageorgiou, G., Parlapani, E., Syngelakis, M., Holeva, V., & Diakogiannis, I. (2020). Insomnia during the COVID-19 pandemic in a Greek population. *Psychiatry Research,* 289: 113076.

https://doi.org/10.1016/j.psychres.2020.113076

WHO. (2020). Human Rights and Health. Available from: https://www.who.int/news-room/fact-sheets/detail/human-rights-and-health [Last accessed on 2020 Jun 02].

Wu, D., Yang, T., Hall, D.L., Jiao, G., Huang, L., & Jiao, C. (2021). COVID-19 uncertainty and sleep: The roles of perceived stress and intolerance of uncertainty during the early stage of the COVID-19 outbreak. *BMC Psychiatry,* 21(1): 306.

https://doi.org/10.1186/s12888-021-03310-2

Wu, L., Guo, X., Shang, Z., Sun, Z., Jia, Y., Sun, L., & Liu, W. (2020). China experience from COVID-19: Mental health in mandatory quarantine zones urgently requires intervention. *Psychol Trauma,* 12(S1): S3-S5.

https://doi.org/10.1037/tra0000609

Xu, J., Zheng, Y., Wang, M., Zhao, J., Zhan, Q., Fu, M., Wang, Q., Xiao, J., & Cheng, Y. (2011). Predictors of symptoms of posttraumatic stress in Chinese university students during the 2009 H1N1 influenza pandemic. *Medical Science Monitor,* 17(7): PH60-PH64.

https://doi.org/10.12659/msm.881836

Younes, S., Safwan, J., Rahal, M., Hammoudi, D., Akiki, Z., & Akel, M. (2022). Effect of COVID-19 on mental health among the young population in Lebanon. *Encephale,* 48(4): 371-382.

https://doi.org/10.1016/j.encep.2021.06.007

Zahreddine, N.K., Haddad, S.F., Kerbage, A., & Kanj, S.S. (2022). Challenges of coronavirus disease 2019 (COVID-19) in Lebanon in the midst of the economic collapse. *Antimicrobial Stewardship and Healthcare Epidemiology,* 2(1): e67.

https://doi.org/10.1017/ash.2021.244

Zhang, Y., & Ma, Z.F. (2020). Impact of the COVID-19 pandemic on mental health and quality of life among local residents in Liaoning Province, China: A cross-sectional study. *International Journal of Environmental Research and Public Health,* 17(7): 2381.

https://doi.org/10.3390/ijerph17072381

Zhou, Y.G., Shang, Z.L., Zhang, F., Wu, L.L., Sun, L.N., Jia, Y.P., Yu, H.B., & Liu, W.Z. (2021). PTSD: Past, present and future implications for China. *Chinese Journal of Traumatology,* 24(4): 187-208.

https://doi.org/10.1016/j.cjtee.2021.04.011

ACCSCIENCE PUBLISHING

International Journal of Population Studies

REPORT

An assessment of the impact of formal and informal messages about COVID-19 on the knowledge and practices for prevention and control among rural and urban communities in Ecuador

Karina Pisco[1]*, Fernando Ortega[2], Pilar Martin[3], Chinedu Obioha[3], and Denice Curtis[4]

[1]Spay Project, Quito, Pichincha, Ecuador

[2]Department of Health Sciences, Universidad San Francisco de Quito, Pichincha, Ecuador

[3]College of Nursing and Public Health, Adelphi University, Garden City, New York, United States

[4]Department of Public Health, University of West Florida, Pensacola, Florida, United States

Abstract

This study was conducted to evaluate the impact of formal and informal messages transmitted to urban and rural communities in Ecuador, on the knowledge of prevention and control of the SARS-CoV-2 pandemic. Six focus groups were carried out with six to eight people per group through Zoom platform, from August 2020 to April 2021; NVivo 12 software was used for the thematic analysis of the data. Thirty-nine people, including male and female, participated in the study with mean age 39 years. Main outcomes included: use of alternative medicine for prevention and control of COVID-19; religious acceptance; impact of COVID-19 on mental health; lack of understanding and knowledge of the disease; and the mixed messages shared through official and unofficial channels about virus prevention and control. The study demonstrates the importance of using formal channels of communication to transmit accurate information, to reach people regardless of their geographical location.

Keywords: COVID-19; Pandemic; Disinformation infodemic; Culture; Informative messages

***Corresponding author:**
Karina Pisco
(karina.pisco@gmail.com)

Citation: Pisco, K., Ortega, F., Martin, P. *et al*,. (2023). An assessment of the impact of formal and informal messages about COVID-19 on the knowledge and practices for prevention and control among rural and urban communities in Ecuador. *International Journal of Population Studies.* 9(1):82-88. https://doi.org/10.36922/ijps.406

Received: November 12, 2022

Accepted: April 6, 2023

Published Online: April 18, 2023

1. Introduction

The SARS-CoV-2 outbreak – later dubbed COVID-19 – has represented a massive threat to global health and shattered the world's economy (Barua *et al.*, 2020). COVID-19 was first identified in China in December 2019, and spread rapidly around the world within weeks (Chen & Yu, 2020). With over 118,000 cases in 114 countries and about 4291 deaths in just 2 weeks, the World Health Organization (WHO) quickly classified the outbreak as a pandemic (the WHO, 2020a; Cucinotta & Vanelli, 2020). Rapid communication through technology and social media allowed the entire world to quickly realize the magnitude of the pandemic. However, there was also proliferation

of misinformation and misconceptions about the disease, a situation the WHO described as a "disinformation infodemic" (the WHO, 2020b; Cuan-Baltazar *et al.*, 2020). False information, conspiracy theories, and erroneous messages circulated like wildfire with the use of social media platforms such as Twitter, Facebook, Instagram, and TikTok, causing a global health crisis, and a severe risk to public health (Roozenbeek *et al.*, 2020; Casanova, 2021).

The first case of COVID-19 in Ecuador was identified on February 29, 2020. As with other countries, the outbreak rapidly became an epidemic with transmission, hospitalization, and mortality rates escalating across the country (Inca & Inca, 2020). In response to this, Ecuador started a campaign called "*Quédate en Casa*" (Stay at Home), which worked well at first. However, people gradually stopped adhering to isolation guidelines, thus increasing transmission rates exponentially. As occurred in many other countries, the COVID-19 misinformation in Ecuador not only resulted in anxiety and fear but also promoted dangerous, unsanitary, and ineffective home practices that may have slowed down the containment of the virus and may have resulted in worse physical and mental health outcomes, and even death (Tasnim *et al.*, 2020; Herrera *et al.*, 2021; Taylor, 2020; Asanza & Moreno, 2020; Diazgranados, 2020).

The objectives of this study were (i) to understand participants' perspectives of the COVID-19 disease; (ii) to examine the reasons for particular behaviors in depth; and (iii) to understand the participants' cultural experiences when deciding what treatment to follow. This study assessed the association between the type of information (formal and informal messages) received by Ecuadorians in urban and rural communities and their knowledge of COVID-19 prevention and control.

2. Data and methods

2.1. Sites

Six focus groups were conducted in six Ecuadorian communities, with approximately six to eight (6–8) individuals in each group. Four of them took place in urban neighborhoods (Pedestales, Guamaní, Tumbaco, and Atucucho) and the remaining two in rural and indigenous Andean areas (Tingo Pucará and La Esperanza).

2.2. Participants

Using purposive convenience sampling, the leaders of each community recruited adult participants aged 18 years and over from urban neighborhoods and from rural areas that had been heavily impacted by the pandemic by word-of-mouth.

2.3. Developing the focus groups questions

To develop the questions for the focus groups, we reviewed the literature about the natural history of COVID, risk factors, modes of transmission, diagnosis, and prevention measures. The questions followed a logical sequence and were carefully crafted to ensure their application to the diverse community contexts. The questions were developed following the framework provided by John Hopkins University in their COVID-19 contact tracing training (Gurley, 2020). The research received Institutional Review Board (IRB) approval from the University of San Francisco de Quito IRB Protocol 2020-048M.

2.4. Data collection procedures

The interviews were conducted in Spanish from August 2020 until April 2021 through Zoom. The informed consent was read at the beginning of each of the focus groups. Participants were advised that they could withdraw from the session at any time, and that they were free to not answer any questions that could make them feel uncomfortable. Participants were also assured that their names would not be included in any part of the study, and that their opinions were anonymous and confidential. Two moderators conducted each session, and two recorders took notes of the responses and inserted probing questions when needed. The interviews were digitally recorded and transcribed verbatim and each focus group lasted on average 1 h.

2.5. Data analysis

A deductive-inductive approach was used to code for themes using NVivo 12. Information supporting the preliminary framework was searched for and coded into pre-determined categories (nodes) and subcategories (subnodes) during the narrative coding. Themes were organized into general understanding of COVID-19 (risk factors, symptoms, and prevention methods), communication of messages (formal and informal sharing of messages), use of traditional and non-traditional medicine (use of home remedies, herbs and other types of treatments), and impact of COVID-19 on physical and mental health (isolation, grieving, and stress). Informed consent was read to all the participants before each session.

3. Results

Thirty-nine individuals participated in the study. The average age was 39 years (R = 18 – 55). The sample was evenly split by gender (50%) and majority of the participants came from urban areas. The main topics identified in this study are shown in Table 1.

Table 1. Major themes identified in the focus groups

General understanding of COVID-19
Communication of messages
Use of traditional and non-traditional medicine
Impact of COVID-19 on physical and mental health

3.1. General knowledge about COVID-19

General knowledge about COVID-19 varied between geographic areas. Individuals living in rural areas seemed to have less understanding of the virus and its consequences. One of the participants who lived in a rural community indicated: "In the school, they told us that this was a new disease that looked like a crown;" another one stated: "COVID was created by world powers and businesses that produce sanitizers, masks, alcohol, etc., have used this to take advantage of the pandemic." Many agreed that at the beginning, there was a lack of understanding and knowledge about the virus and the guidelines for prevention and social distance (Table 2).

3.2. Knowledge about mode of transmission

Most of the participants, regardless of geographical distribution, understood the modes of transmission of the virus which may attest to the accuracy of formal and informal messages received. Common modes of transmission shared by the participants included: "Taking public transportation, direct contact with persons, time of exposure, not using protection masks, not washing hands, attending parties, and use of the same food utensils" (Table 2).

3.3. Methods for message sharing

The messages about COVID-19 were shared through formal sources such as municipalities, Ministry of Health, television, and radio news. Most of the participants, however, stated that they received their information through social media such as WhatsApp, Facebook, and others.

The participants found some of the information received from both formal and informal sources confusing and contradictory. One participant stated: "the information was not clear and precise, especially through social media. This created chaos and a feeling of panic." Another participant stated: "people do not trust the information received from the government because it is contradictory; people rather investigate about the disease through the internet" (Table 2).

3.4. Impact of COVID-19 on mental health

The participants, particularly from urban areas, complained about the impact of COVID-19 on the mental health of their families and communities. One participant stated: "the pandemic has affected particularly the children; they feel isolated and spend most of their time in front of their computers." Another participant indicated that she felt stressed, because her husband, son, and daughter in-law got COVID-19 and they had to cover the cost of the tests and medicines. She stated: "The ministry of health only called once" (Table 2).

3.5. Alternative medicine

The use of alternative medicine for both prevention and control dominated the conversation throughout the focus groups, regardless of geographical distribution. Participants indicated using homeopathic medicine and home remedies to prevent and cure COVID-19. Some of the home remedies used included sugar cane juice, orange juice with an egg, *matico* (Aristeguietia glutinosa, ASTERACEAE), cypress, *tilo* (Sambucus nigra L. ADOXACEAE), nettle (Urtica dioica L. URTICACEAE), onion, garlic, chamomile (Matricaria chamomille L. ASTERACEAE), *marco* tea (Ambrosia arborescens Mill. ASTERACEAE), eucalyptus (Eucalyptus globulus Labill. MYRTACEAE), concentrate of parsley, celery, cucumber, curcuma, ginger, and mint tea among others. They firmly believed that these herbs prevented them from becoming sick and going to the hospital unlike people in the big cities who did not use these herbs and plants (Haboud *et al.*, 2019; De la Torre *et al.*, 2008; Ortega *et al.*, 2020) (Table 2).

4. Discussion

This study showed the impact of formal and informal messages on individuals' understanding of COVID-19. The lack of general information about this novel disease took the world by surprise. Prevention and control messages as well as the risk factors for the disease were not well understood and were not shared in a timely manner creating confusion and conflicting messages. Furthermore, there was an evolving learning curve among the scientific community as the virus mutated by the week, making the reliability of any official announcement temporary at best. Unfortunately, this situation created "inconsistent messaging and it eroded trust and credibility" (Holmes 2020).

Official messages provided by institutions such as the Ministry of Health were supposed to broadcast specific recommendations to instill public trust in scientific evidence; however, conditions changed so rapidly that scientific information issued in 1 day could be old and inaccurate within a few days, therefore eroding public trust and contributing to a broad health emergency worldwide. In fact, the lack of information through official channels and the inaccurate information shared through unofficial

Table 2. Knowledge, attitudes, and perceptions about COVID-19

Urban area	Rural area
Theme 1: General knowledge about COVID-19	
"We know the virus is in the air and if we open our windows, we can get it." "We have to take our shoes and our clothes before we get into our house. Some of us also use a biosecurity suit as this is CDC protocol." "We can get COVID through direct contact with people (i.e., grocery stores); the time of exposure and the number of people you have contact with is also important for transmission of the virus." "It is important not to use the same food utensils, avoid crowding, and use the mask appropriately."	"This is a virus that increases family violence and it is also hard on children. We have a lot of families that had migrated to the city and have come back to the community without a job. This has generated fear in the community as people are afraid of getting the virus. In the community, we are using traditional medicine such as chamomile and matico teas and eucalyptus vaporizations." "In our community, we were told that the virus was in China and looked like a crown, hence its name. They told us it would not come to the rural areas because it was a new disease; however, after a couple of weeks we were all in quarantine."
Theme 2: Knowledge about mode of transmission	
"Taking the trolley is concerning because there is no social distancing." "The virus can be transmitted by not washing the hands and by going to family reunions." "We can get the virus when we are in closed quarters or when we go to discotheques."	"A family member died of COVID and we all went to the funeral and got the virus; that is when I learned two things: transmission occurs from person to person and there is no cure for the disease." "The transmission happens person to person through the saliva." "There are people who are symptomatic and asymptomatic. There are many people who are asymptomatic. We must follow the advice from the authorities, keep social distance and be careful in public spaces, when using public transportation and when going to school as children can also transmit the disease."
Theme 3: Methods for message sharing	
"We learned about COVID through the news, television, radio, newspaper, social media, official channels, and relatives." "The information was not clear and was alarming, particularly in social media." "I heard about COVID through the municipality, the health department, and What's up. I do not trust the information provided by the government, because it is contradictory. I rather use the internet." "Some of the confusing messages were spread because there was not an understanding of the disease. For example, at the beginning people would not share the sidewalk for fear to get the virus."	"We use community radio stations to transmit important information. It is transmitted in our own dialect. Those who do not know how to read and write, listen to the radio. The youth use social media. We also use megaphones and community fairs to share the information."
Theme 4: Impact of COVID-19 on mental health	
"I had COVID. I was very stressed due to the isolation and because I was not able to take care of my family." "I just got a COVID test and I am afraid of getting the results because I would have to isolate myself and I need to work. I have a dilemma, if I go out I can get the virus, but if I do not go out I may starve. When people have had COVID they are isolated by the community."	"My family and the entire community was very sad and very scared because we thought we all were going to die. We put our trust in God but at the same time I had to go to the field to work and I did not know when I was going to get COVID and if I was going to die."
Theme 5: Alternative medicine	
"I treated myself with a mix of home remedies (i.e., sugar cane juice) and western medicine." "My friends had COVID. They did salt and water gargles. One person was cured after 51 days, another one died." "My doctor recommended to do salt and water gargles with water from the ocean. He also recommended to take acetaminophen and vitamin C."	"I took ivermectin and acetaminophen for 5 days, I used a nebulizer with eucalyptus and chamomile as well." "My doctor recommended to use home remedies such as orange juice with ginger and to use a nebulizer." "I ate a mix of chocolate, orange juice and egg for three nights and my cough was gone."

channels created an environment of skepticism, distrust and conspiracy, which generated a series of unfounded concerns about the origin of the virus and its spread (World Health Organization, 2020).

Our study that was conducted from August 2020 to April 2021 was able to identify people's level of dissatisfaction with the messages received through official channels because they did not accurately reflect what was happening in the country in terms of the number of cases with COVID-19, positivity rate on testing, the number of people in intensive care units, and mortality rate and which way all of these indicators were trending which would have given a snapshot of the severity of the disease in the country.

Proven preventive public health measures such as mask-wearing, social distancing, frequent handwashing and disinfection, and the lockdown measures were not immediately accepted due to an avalanche of inaccurate

and/or false information shared by unofficial channels such as social media and some mass media which affected the veracity and credibility of the public health messages. However, as shown by the results of our study, it became apparent that several months after the onset of the pandemic, the knowledge about how the disease is transmitted through the use of public transportation, lack of mask usage, overcrowding or prolonged time of exposure, not washing hands frequently or not using hand sanitizer had increased among the population, which may have demonstrated that, at least in theory, the official messages had been understood and accepted.

The impact of COVID-19 on the mental health of the population was brought up by several participants. The fact that the economy was almost shut down in a country that is already struggling economically, combined with the locked down which prevented people from working in what is a predominantly small business economy contributed to a sense of isolation, despair and poor mental health.

Other common themes found in this study included the impact of religious faith which determines how people approached the disease as if it were beyond their control and in the hands of a higher power, and the use of folk medicine to prevent and treat COVID-19. The traditional medicine of their ancestors is based on a long period of accumulated knowledge and experiences that have identified certain medicinal properties in the local plants (natural or cultivated) to reduce these symptoms. They trust in their own experience and give authenticity to their own medicine when pharmaceutical medicine discredits their cultural values or is unable to provide a cure.

Interestingly, our study demonstrated that medicinal plants were not only used to treat the symptoms of COVID-19 in rural indigenous communities, but also in several neighborhoods in the city. We believed that these ancestral practices are an integral part of our culture and were used as a mechanism to deal with mild symptoms as no treatment was offered by pharmaceutical medicine, not only in Ecuador, but also among other indigenous communities all over the world. (Ganjhu *et al.*, 2015; Iloanusi *et al.*, 2021)

5. Conclusions

Promoting changes in knowledge, attitudes, norms, beliefs, and behaviors are not a simple task. We need to recognize that adopting some new collective behaviors can create some resistance and opposition to the implementation of basic preventive practices such as frequent handwashing and use of masks. Policies and regulations must take into consideration the socioeconomic and cultural environment of the communities when promoting, for example, frequent handwashing with soap and water. In Ecuador, as in other parts of the world, many rural communities are unable to access water easily, and soap can be a high commodity. The same applies to the use of face masks when there is lack of financial resources or implementing social distance when five or more family members live in a poorly constructed shelter.

Identifying barriers and motivators to behavior change and understanding how communities acquire their knowledge about prevention and treatment of infectious diseases is crucial to design a comprehensive set of tailored interventions to promote a desired collective behavior and to better channel formal messages to prevent misinformation.

Acknowledgments

The authors want to thank all the focus group participants. Their contribution and insights were very valuable and we are forever grateful for sharing their practices, struggles, and traditions.

Funding

None.

Conflict of interest

We declare that there are no conflicts of interest in this study.

Author contributions

Conceptualization: Denice Curtis, Fernando Ortega, Karina Pisco
Formal analysis: Denice Curtis
Investigation: Karina Pisco, Denice Curtis, Fernando Ortega, Pilar Martin
Methodology: Fernando Ortega
Writing – original draft: Karina Pisco, Pilar Martin, Chinedu Obioha
Writing – review & editing: Chinedu Obioha, Pilar Martin

Ethics approval and consent to participate

Ethical Approval from the University of San Francisco de Quito IRB Protocol 2020-048M.

Consent for publication

The informed consent was obtained at the beginning of each of the focus groups. Participants were advised that they could withdraw from the session at any time, and that they were free to not answer any questions that made them feel uncomfortable. Participants were also assured that their names would not be included in any part of

the study, and that their opinions were anonymous and confidential.

Availability of data

The transcripts of the focus group sessions can be shared on request from the corresponding author. All focus group sessions were recorded.

References

Asanza, M., & Moreno, V. (2020). Fake News in Times of Crisis: Approach to its Recognition and Perception during the Confinement by COVID-19 in Ecuador. UCSG Digital Repository. Available from: https://www.201.159.223.180/handle/3317/15070 [Last accessed on 2022 Jan 27].

Barua, Z., Barua, S., Aktar, S., Kabir, N., & Li, M. (2020). Effects of misinformation on covid-19 individual responses and recommendations for resilience of disastrous consequences of misinformation. *Progress in Disaster Science*, 8: 100119

https://doi.org/10.1016/j.pdisas.2020.100119

Casanova, M. (2021). Challenges of Ecuadorian Journalism in Times of Covid-19. Technical University of Ambato Repository: Home Page. Available from: https://repositorio.uta.edu.ec/handle/123456789/32353 [Last accessed on 2022 Jan 27].

Chen, X., & Yu, B. (2020). First two months of the 2019 Coronavirus disease (Covid-19) epidemic in China: Real-time surveillance and evaluation with a second derivative model. *Global Health Research and Policy*, 5(1): 7.

https://doi.org/10.1186/s41256-020-00137-4

Cuan-Baltazar, J.Y., Muñoz-Perez, M.J., Robledo-Vega, C., Pérez-Zepeda, M.F., & Soto-Vega, E. (2020). Misinformation of COVID-19 on the internet: Infodemiology study. *JMIR Public Health and Surveillance*, 6(2): e18444.

https://doi.org/10.2196/18444

Cucinotta, D., & Vanelli, M. (2020). WHO declares COVID-19 a pandemic. *Biomedical Act Atenei Parmensis*, 91: 157-160.

https://doi.org/10.23750/abm.v91i1.9397

De la Torre, L., Navarrete, H., Muriel, P., Macía, M., & Balslev, H. (2008). Encyclopedia of Useful Plants of Ecuador. Digital Library. Available from: https://bibdigital.rjb.csic.es/records/item/16016-enciclopedia-de-las-plantas-utiles-del-ecuador [Last accessed on 2021 Oct 27].

Diazgranados, H. (2020). 70% of Latin Americans do not know how to Detect Fake News. Daily Spanish LatAm Latamkasperskycomblog. Available from: https://latam.kaspersky.com/blog/70-de-los-latinoamericanos-desconoce-como-detectar-una-fake-news/17015 [Last accessed on 2022 Jan 27].

Ganjhu, R.K., Mudgal, P.P., Maity, H., Dowarha, D., Devadiga, S., Nag, S., & Arunkumar, G. (2015). Herbal plants and plant preparations as remedial approach for viral diseases. *VirusDisease*, 26(4): 225-236.

https://doi.org/10.1007/s13337-015-0276-6

Gurley (2020). COVID-19 contact tracing online course, Coursera. Available from: https://www.coursera.org/learn/covid-19-contact-tracing

Haboud, M., Ortega, F., Farinango, E., & Farinango, A. (2019). Encyclopedia of Useful Plants of Ecuador. Digital Library. Available from: https://bibdigital.rjb.csic.es/records/item/16016-enciclopedia-de-las-plantas-utiles-del-ecuador [Last accessed on 2021 Oct 27].

Herrera, D., Altamirano, C.T., & Gaus, D. (2021). Covid-19 in Ecuador: Imported control strategies without context in a challenged healthcare system. *The American Journal of Tropical Medicine and Hygiene*, 104(2): 414-415.

https://doi.org/10.4269/ajtmh.20-1347

Holmes, B. (2020). Speaking of Pandemics: The Art and Science of Risk Communication. Medscape. Available from: https://www.medscape.com/viewarticle/933729?nlid=136379_440&src=WNL_mdplsfeat_200714_mscpedit_publ&uac=317408EG&spon=42&impID=2460501&fa f=1#vp_3 [Last accessed on 2021 Jul 27].

Iloanusi, S., Mgbere, O., Iloanusi, N.J.R., Yunusa, I., & Essien, E.J. (2021). Covid-19 related misconceptions and prevention practices among residents of a populous commercial city in Nigeria. *International Journal of Translational Medical Research and Public Health*, 5: 149-159.

https://doi.org/10.21106/ijtmrph.362

Inca, G., & Inca, A. (2020). Evolution of the Coronavirus disease (covid-19) in Ecuador. *Science at the Service of Health and Nutrition*, 11(1): 5-15.

https://doi.org/10.47244/cssn.vol11.iss1.441

Ortega, F., Haboud, M., Farinango, E., & Farinango, A. (2020). From local ancestral practices to universal antiviral uses: Medicinal plants used among indigenous communities in Ecuadorian highlands. *American International Journal of Contemporary Research*, 10: 48-56.

https://doi.org/10.30845/aijcr.v10n2p7

Roozenbeek, J., Schneider, C.R., Dryhurst, S., Kerr, J., Freeman, A.L.J., Recchia, G., van der Bles, A.M., & van der Linden, S. (2020). Susceptibility to misinformation about COVID-19 around the world. *Royal Society Open Science*, 7(10): 201199.

https://doi.org/10.1098/rsos.201199

Tasnim, S., Hossain, M.M., & Mazumder, H. (2020). Impact of rumors and misinformation on Covid-19 in social media. *Journal of Preventive Medicine and Public Health*, 53(3): 171-174.

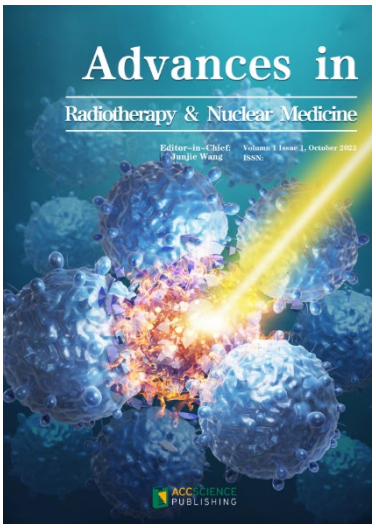
https://doi.org/10.3961/jpmph.20.094

Taylor, L. (2020). Covid-19 misinformation sparks threats and violence against doctors in Latin America. *BMJ*, 370: m3088. https://doi.org/10.1136/bmj.m3088

World Health Organization. (2020a). Available from: https://www.who.int/director-general/speeches/detail/who-director-general-s-opening-remarks-at-the-media-briefing-on-covid-19---11-march-2020.

World Health Organization. (2020b). Fighting Misinformation in the Time of Covid-19, One Click at a Time. Geneva: World Health Organization. Available from: https://www.who.int/news-room/feature-stories/detail/fighting-misinformation-in-the-time-of-covid-19-one-click-at-a-time [Last accessed on 2021 Oct 28].

Our Journals



Advances in Radiotherapy & Nuclear Medicine (ARNM) is a peer-reviewed and open-access journal that aims to publish and disseminate novel research in the breadth of neurology and neuroscience.

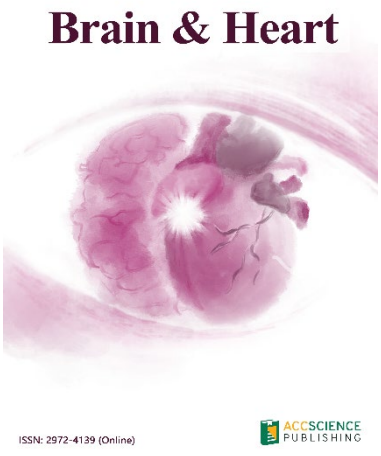
ARNM covers subject areas, including but not limited to the following:

- Conventional Radiotherapy (CR)
- Stereotactic Body Radiation Therapy (SBRT)
- Brachytherapy (BT)
- Boron Neutron Capture Therapy (BNCT)
- Particle Therapy (proton and heavy ions) (PT)
- Targeted and Immunotherapy (TI)
- Combined Modality Therapy (Heat therapy, electric field therapy, nursing, technology) (CMT)
- Radiation Biology (RB)
- Radiation Physics (RP)
- Innovative Radiation Technology (IRT)
- Positron Emission Tomography (PET)
- Radiopharmaceuticals and Radio-tracer (RR)
- Molecular Imaging and Radionuclide Therapy (MI & RT)
- Single-photon Emission Computed Tomography (SPETCT)

Brain & Heart focuses on neurocardiology, a neurology and cardiology-based interdisciplinary subject that studies the circulatory mechanism of the human body, as well as the mechanisms of the interplay between the cardiovascular system and the nervous system. The journal's scope includes:

Clinical and basic research on diseases related to the circulatory and nervous systems, such as: orthostatic dizziness, orthostatic hypotension, autonomic dysfunction, and the relationship between the autonomic nervous system and the circulatory function in cerebral degeneration;

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.



Start a new journal

Write to us via email if you are interested to start a new journal with AccScience Publishing. Please attach your CV, professional profile page and a brief pitch proposal in your email. We shall inform you of our decision whether we are interested to collaborate in starting a new journal.

Contact: info@accscience.com

https://accscience.com/journal/IJPS

Contact
www.accscience.com
9 Raffles Place, Republic Plaza 1 #06-00 Singapore 048619
Email: editorial@accscience.com
Phone: +65 8182 1586