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RESEARCH ARTICLE

What's in a word? Language and self-assessed health in the National Health and Nutrition Examination Survey

Meredith Van Natta[1] and Zachary Zimmer[2]*

[1]Department of Social and Behavioral Sciences, University of California San Francisco, San Francisco, California, 94108, USA

[2]Department of Family Studies and Gerontology, Mount Saint Vincent University, Halifax, Nova Scotia, B3M 2J6, Canada

Abstract: This study examines the extent to which the Spanish language influences the way in which respondents report health using the ubiquitous self-assessed health (SAH) outcome. We account for citizenship status, ethnicity, and a series of other covariates. The study uses the 2003-2016 national health and nutrition examination survey (NHANES) (*n*=39,107). Analyses treat SAH as non-ordered categorical and employ multinomial regressions. Results indicate that those answering in Spanish are considerably and significantly more likely to rate health as "fair/regular" ceteris paribus. Non-U.S. citizens and naturalized citizens are significantly more likely to rate their health favorably in comparison to U.S.-born; those identifying as Hispanic, Black, and other/multiracial are likely to rate health less favorably than others regardless of citizenship or interview language. A model that examines only foreign-born and accounts for years lived in the U.S. shows Spanish language still strongly predicted SAH outcomes, but years spent in the U.S. did not, a finding that does not support notions of acculturation. The study concludes that there is a language bias in the standard SAH measure typically used national-level health surveys and national-level surveys such as NHANES should adjust the question translation to better understand the health of immigrants.

Keywords: *self-assessed health; citizenship status; immigrant health; National Health and Nutrition Examination Survey; survey language*

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Zachary Zimmer, Department of Family Studies and Gerontology, Mount Saint Vincent University, Halifax, Nova Scotia, B3M 2J6, Canada. zachary.zimmer@msvu.ca

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1. Introduction

This paper contributes to literature aiming to understand how language influences how health is reported and subsequently interpreted, and how the intersection of language, citizenship, and ethnicity shape perceptions of immigrants' health in the U.S. Uncertainty surrounding health status and health-care utilization of immigrant populations in the U.S. amidst today's shifting health and immigration policies makes these issues particularly timely and salient for health researchers and policymakers alike. Because immigrants from Mexico and Central America represent the largest proportion of foreign-born individuals living in the U.S., understanding the health status and challenges facing the nation's Hispanic communities – one-third of whom were born abroad (Pew, 2016) – is especially important. (We use the term "Hispanic" rather than Latinx, Chicano/a, or specific national origins because it follows the ethnicity categories provided in the National Health and Nutrition Examination Survey (NHANES) and suits analysis of the Spanish survey language.) Further, additional barriers to health care access may exist among foreign-born Hispanics who do not speak English; yet only 34% of foreign-born Hispanics report speaking English proficiently (Pew, 2015).

Specifically, this study looks at whether an evaluation of someone's health status, using a self-assessed health (SAH) survey question as a health outcome measure, varies if the SAH question is asked in Spanish versus in English. The topic of this study gains significance given earlier research that has exposed a "Hispanic paradox" in which Hispanic immigrants experience better health relative to U.S.-born citizens of similar socioeconomic status (Markides and Coreil, 1986). Yet this paradox is increasingly subject to debate on multiple counts (Abraído-Lanza, Dohrenwend, Ng-Mak *et al.*, 1999; Franzini, Ribble, and Keddie, 2001; Palloni and Arias, 2004; Markides and Eschbach, 2005; Smith and Bradshaw, 2006; Rubalcava, Teruel, Thomas *et al.*, 2008). There is also evidence of poorer health among Hispanics born in the U.S. or who have resided in the U.S. at length (Cho, Frisbie, Hummer *et al.*, 2004; Vega, Rodriguez, and Gruskin, 2009). Further, research has indicated that the intersecting characteristics of being an immigrant, becoming racialized as a U.S. minority, and having limited English proficiency have consequences for health (DuBard and Gizlice, 2008; Vega, Rodriguez and Gruskin, 2009).

This line of inquiry into health disparities across categories of ethnic and citizenship status involves considerable debate over how to best measure the health status of immigrants, particularly those who do not speak English or do not speak it well (Finch, *et al*., 2002; DuBard and Gizlice, 2008; Lee and Schwartz, 2014; Sanchez and Vargas, 2016). A number of standard health measures – such as mortality, service utilization, and birth weight – involve statistical and practical challenges among migrating populations. These include the likelihood of multiple border crossings and return migration, unavailability of birth and death records, inconsistent measurement of Hispanic populations, misclassification of Hispanic deaths, and mistranslation of healthy surveys (Abraído-Lanza, Dohrenwend, Ng-Mak *et al.,* 1999; Franzini, Ribble and Keddie, 2001; Palloni and Arias, 2004; Markides and Eschbach, 2005; Smith and Bradshaw, 2006; Rubalcava, Teruel, Thomas *et al.*, 2008).

SAH, based on a survey question that asks someone to simply rate their health overall on a simple scale from excellent to poor, has become standard on health surveys (Chirinda, Saito, Gu and Zungu, 2018). This global snapshot survey item may address some of the challenges involved in measuring migrant population health. SAH is commonly considered to be an economical, simple, quick to administer, and easily translatable indicator that can be validly and reliably employed across languages and cultures (Maddox and Douglass, 1973; Mossey and Shapiro, 1982; Kaplan and Camacho, 1983; Idler and Benyamini, 1997). SAH has been found to accurately predict mortality, even when controlling for demographic, socioeconomic, other health, and psychological factors (DeSalvo, Bloser, Reynolds, *et al*., 2005; Idler and Benyamini, 1997). Given that SAH is thought to be a valid global health measure, it may not be subject to the same population-level measurement challenges as other indicators. Its advantages mean SAH could be a helpful gauge for studying inequalities across heterogeneous populations that vary by primary language.

Nevertheless, the degree to which SAH can be used in comparative research is unclear. Studies have suggested that SAH may be differentially perceived across cultures, ethnicities, and languages such that people with similar objective health measures may subjectively assess their health differently (Angel and Guarnaccia, 1989; Jylhä, Guralnik, and Ferrucci, 1998; Shetterly, Baxter, Mason *et al.*, 1996; Lee and Schwartz, 2014). Attitudes, perceptions, and interpretations of health vary across time and individual characteristics such as age, sex, and education (Ren and Amick, 1996; Zajacova and Dowd, 2011). Thus, it may be difficult to make cross-country and cross-linguistic assessments of health disparities using SAH (Jylhä, 2009; Zimmer, Natividad, and Lin *et al.,* 2000).

A small number of recent studies has explored the likelihood that immigrants who take a health survey in Spanish interpret the SAH scale differently, and these suggest reasons to be cautious. Shetterly, Baxter, Mason *et al.* (1996) analyzed a small sample of 419 Hispanic and 583 non-Hispanic white respondents of the San Luis Valley Health and Aging Study and found that when controlling for health conditions, Hispanics were 3.6 times more likely to report fair to poor health than non-Hispanic white respondents. (Notably, however, their study collapsed the "fair" and "poor" category.) Bzostek, Goldman, and Pebley (2007) examined data from approximately 3000 households from the Los Angeles Family and Neighborhood Survey conducted between 2000 and 2002. Their results suggested that the Spanish interview language, but not Spanish household language, is associated with a worse rating of SAH, suggesting that translational issues influence comparisons of health status. Viruell-Fuentes, Morenoff, Williams *et al.* (2011) analyzed data from the Chicago Community Adult Health Study, collected in 2001-2003, and the Behavior Risk Factor Surveillance System, collected in 2003. Their results showed that adjusting for interview language reduces a gap in SAH between Latino and white respondents. Finally, Sanchez and Vargas (2016) used data from the 2011 Latino Decisions survey to conduct a built-in language experiment comparing multiple translations of SAH in a nationally representative dataset of 1200 Latinos. They demonstrated that there is a problem with the response "fair" SAH when termed as regular in Spanish, which is how key agencies, such as the U.S. Centers for Disease Control (CDC) and Prevention, normally translate the word.

Our study builds on this extant literature in several ways. First, earlier studies (such as Shetterly, Baxter, Mason *et al.*, 1996) commonly dichotomized the measure or considered SAH as an ordered variable. Collapsing categories forces

response with different meanings into a single group. Ordered treatments are problematic if the conceptual distance between categories differs across languages. For example, the conceptual distance English speakers perceive between good and fair may be greater than the difference Spanish speakers perceive between Buena and regular. To address this limitation, the present study models SAH as a nominal measure with multiple categories.

Second, our study addresses "acculturation," which many scholars account for when considering health disparities between immigrants and native-born populations. Acculturation supposedly signals degrees of immigrant integration into the receiving country's characteristic "culture" – including language, behaviors, and social norms. However, the concept has been considered atheoretical and vague (Abraído-Lanza, Armbrister, Flórez *et al.*, 2006), and a systematic review by Hunt, Schneider, and Comer (2004) concludes that its application is highly variable since the constituents of a culture, differences between ethnic and "mainstream" culture, and what cultural adaptation means have not been adequately described. Rather than engaging with ill-defined notions of culture, we follow DuBard and Gizlice (2008) and Kimbro, Gorman, and Schachter (2012) in assessing acculturation by time spent in the U.S.

Third, we examine the phenomenon using a large nationally representative, inclusive and contemporary, dataset associated with the CDC, the NHANES, providing a higher level of statistical power than any such study to date. Earlier studies considered small samples and samples that were generally geographically limited. The large number of observations in our analysis, which spans the years 2003-2016, allows us to divide our sample by survey language, foreign nativity, immigrant status, and years lived in the U.S. to account for the multifaceted nature of immigration and health while maintaining statistical power. Using this dataset, our study asks: (1) Is there a significant association between survey language and SAH? (2) Is the association mediated by citizenship status? (3) Do associations hold when accounting for ethnic variation?

2. Data and Method

2.1 Data

The National Center for Health Statistics conducts NHANES biennially to assess the health and nutrition status of the civilian non-institutionalized U.S. population. Sampling follows a cross-sectional, multistage, stratified, and clustered design. To increase the number of surveys conducted in Spanish and among immigrants, our analysis aggregates data from the 2003 to 2016 surveys. The sample size across these surveys is 39,221 observations age 20 and older, which is reduced to 39,107 valid observations after deleting cases where citizenship status and SAH is unknown. This valid N includes over 3600 interviews conducted in Spanish and over 3400 among non-U.S. citizens. Weights included in NHANES data are applied in this analysis.

2.2 Measures

SAH is registered in NHANES as a response to the question, "would you say your health in general is … ?/¿Diría usted que su salud en general es …?" Responses are scored along the following (English/Spanish) scale: Poor/mala, fair/regular, good/buena, very good/muy buena, and excellent/excelente. Missing responses (including "do not know" or "refused") represented <0.1% of total responses and were therefore excluded. For the remainder of this paper, we use the English terms to describe these categories; however, the Spanish categories are used when the survey language is Spanish.

Across survey waves, NHANES includes four standard responses to the question, "are you a citizen of the United States?": "Citizen by birth or naturalization," "not a citizen of the U.S.," "do not know," and "refused." Those in the latter two categories represented <0.2% of total responses and were therefore removed from the study. Data on country of birth were then used to separate the U.S.-born citizens from naturalized while the non-citizen category remained intact. Unweighted N's for these categories are 28,474 (82.9%); 5012 (7.9%); and 5621 (9.2%), respectively. Citizenship categories were converted into dichotomous variables, with U.S.-born used as the comparison category in multivariate models. Across all survey years examined here, ethnicity/race (NHANES does not distinguish between these constructs) is categorized as: Hispanic, Non-Hispanic white, non-Hispanic black, and other race – including multi-racial. The survey includes two different categories for Hispanic respondents: "Mexican American" and "other Hispanic." Our analysis indicated that results do not differ significantly across these groups; therefore, we consider them together. Survey language is dichotomized into English and Spanish. Time lived in the U.S. is measured categorically in NHANES. For this study, four categories were created: <5 years, 5-10 years, 10-20 years, and 20 or more years.

Models adjust for other demographic and socioeconomic variables. Age was converted into decades to capture any nonlinear association with SAH (20-29, 30-39, 40-49, 50-59, 60-69, and 70+) and treated as a categorical variable. Sex

is dichotomous. Models include marital status (married vs. not married) and whether the respondent has health insurance (measured dichotomously). Income in NHANES is represented by annual family income across 17 categories. These were recorded into approximate terciles and called low, middle, and high. Missing income was included as a separate category. Education is coded in four categories: Less than high school, high school, some college, and completed college.

2.3 Statistical Analysis

The multivariate analysis employs a multinomial logistic regression model that treats each category of SAH as separate and unordered. Doing so avoids collapsing meaningfully different responses and allows for the possibility that responses may not be ordered along a scale with equidistant intervals – a likely outcome of inaccurate translation. In the multinomial model, each category of the outcome variable is compared against a single baseline. SAH is made up of five categories (poor, fair, good, very good, and excellent). The category excellent is chosen as the constant baseline, and the regression procedure compares the likelihood of being in any of the other four categories relative to the baseline, which is relative to excellent. Results are presented as log-odds ratios which center on zero such that negative coefficients indicate a negative association or lower likelihood of being in that category relative to the baseline, and positive coefficients indicate a positive association or higher likelihood. The exponent of the log-odds is the odds ratios. Three regression models are considered. Model 1 examines the association between survey language and SAH. Model 2 adds citizenship status to assess whether and how it mediates the association between survey language and SAH. Model 3 adds ethnicity. The -2LL deviation statistics is used to assess whether the added variables improve predictive capacity. To test for acculturation, a separate analysis, which only includes non-U.S. born respondents (n=6,457), assesses whether time spent in the U.S. influences relationships between survey language and SAH by including a measure for years in the U.S. In general, we report three P-value levels of significance; $0.05<P<0.10$; $0.01<P<0.05$; and $P<0.01$. All procedures are run using SPSS version 25.

3. Results

Table 1 provides distributions for all study variables for the total sample and across citizenship status. The sample consists of about 13% identifying as Hispanic, although about 60% of non-citizens are Hispanic. About 6% of the surveys were conducted in Spanish, but about half of the non-citizens completed the survey in Spanish.

Table 2 shows SAH distributions across the three variables of greatest interest in this analysis: Citizenship, ethnicity, and language of the survey. Chi-square statistics are provided to indicate whether differences in SAH are statistically significant across categories of citizenship status, ethnicity, and survey language. There are substantial differences across categories of these measures. The greatest contrast is seen with respect to language. While there is little difference

in percent rating their health as poor, almost 3 times as many Spanish (37.2%) versus English (13.0%) speakers rate their health as fair, and a greater percentage of those answering the survey in Spanish rate their health as good (40.6% vs. 33.8%). In contrast, far more English speakers rate their health as very good or excellent. Non-citizens are far more likely to rate their health as fair (23.3%) than either U.S. (13.2%) born or naturalized citizens (17.3%). Furthermore, U.S. born citizens are somewhat more likely than others to rate their health as excellent or very good. With respect to ethnicity, Hispanics are far more likely to rate their health as fair in comparison to those in other categories. White respondents rate their health best overall, with higher percentages in the very good and excellent category.

Multinomial models are presented in Table 3. While full models included a series of control variables (sex, age, marital status, insurance status, education, income, and year of survey), only the results that are most pertinent to this analysis are presented for parsimonious reasons: Language of interview, citizenship status, and ethnicity. The SAH category "excellent" is the contrast or baseline across all models, and therefore, all coefficients must be interpreted relative to the contrast category "excellent." Model 1 indicates that in comparison to English speakers, respondents who take the survey in Spanish are significantly more likely to rate their health unfavorably. The most striking difference is in the category fair, which Spanish respondents are much more likely to select (β=+1.086; $p<0.01$) as opposed to excellent. When citizenship status is added in Model 2, the propensity among Spanish respondents to rate their health as "fair" becomes even more pronounced (β=+1.262; $p<0.01$). Yet this model also demonstrates that, when accounting for survey language, non-citizens and naturalized citizens are more likely than the U.S. born to rate their health favorably.

When ethnicity is added in Model 3, the effect of survey language persists. Spanish speakers, as opposed to English speakers, are still far more likely to rate their health as fair (β=+1.187; $p<0.01$). The effect of citizenship status becomes even more pronounced than in Model 2. Non-citizens and naturalized citizens are significantly more likely to report favorable health in comparison to U.S. born when ethnicity is taken into consideration, a strong indication that any relationship

Table 1: Per cent distribution of study variables by citizenship status[1]

Category	Total	U.S. born	Naturalized	Non-citizen
N	39,107	28,474	5,012	5,621
Ethnicity				
Hispanic	13.4	6.1	35.1	60.3
White	68.1	78.3	23.9	13.9
Black	11.4	12.3	8.8	5.8
Other	7.1	3.3	32.2	20.1
Spanish language	6.2	0.3	16.9	49.6
Female	51.9	52.4	53.1	47.0
Age				
20-29	18.9	18.8	11.0	26.0
30-39	18.2	17.0	18.1	29.4
40-49	19.7	19.0	23.2	22.9
50-59	18.2	18.6	20.2	12.5
60-69	12.8	13.6	13.7	5.4
70+	12.2	13.0	13.7	3.8
Not married	44.5	45.6	35.8	41.3
Uninsured	18.1	14.6	16.8	51.2
Income				
Lowest	34.8	33.3	31.9	50.9
Middle	32.0	32.3	32.0	29.0
Highest	29.6	31.4	30.1	13.2
Missing	3.5	2.9	6.1	6.9
Education				
Less than high school	17.3	13.7	22.2	45.6
High school	23.2	24.4	17.6	17.1
Some college	31.4	33.5	26.9	17.0
Completed college	28.1	28.5	33.2	20.3
Survey year				
2003/04	13.4	13.7	10.6	13.2
2005/06	13.7	14.0	10.8	13.2
2007/08	14.0	14.1	13.9	13.0
2009/2010	14.3	14.0	15.5	14.3
2011/2012	14.5	14.4	15.4	14.5
2013/2014	14.9	14.9	17.0	13.4
2015/2016	15.2	15.0	16.7	15.2
Years in the U.S. (among non-U.S. born)				
0-5	14.1	---	1.7	24.8
5-10	14.9	---	5.5	23.0
10-20	27.4	---	22.8	31.3
20+	43.7	---	70.0	20.9

[1]Total N's unweighted; distributions weighted.

Table 2. Percent distribution of self-assessed health by citizenship status, ethnicity and Spanish language.

Category	Poor	Fair	Good	Very good	Excellent	Total
Total	3.5	14.5	34.2	31.2	16.6	100.0
Citizenship status						
U.S. born	3.4	13.2	33.4	33.1	16.9	100.0
Naturalized	3.6	17.3	37.9	24.8	16.4	100.0
Non-citizen	3.9	23.3	38.9	19.9	14.0	100.0
Chi-square			533.3**			
Ethnicity						
Hispanic	4.7	25.7	39.8	18.3	11.5	100.0
White	3.1	11.5	32.3	35.0	18.1	100.0
Black	4.3	19.2	37.6	24.7	14.2	100.0
Other	3.4	14.5	36.9	29.6	15.6	100.0
Chi-square			1428.9**			
Survey language						
English	3.4	13.0	33.8	32.6	17.2	100.0
Spanish	5.1	37.2	40.6	9.6	7.4	100.0
Chi-square			1484.5**			

**$p<0.01$ *$0.01<p<0.05$.

Table 3. Multinomial regression results predicting self-assessed health, showing log odds coefficients[1].

Category	Model 1				Model 2				Model 3			
	Poor	Fair	Good	Very good	Poor	Fair	Good	Very good	Poor	Fair	Good	Very good
	Versus excellent				Versus excellent				Versus excellent			
Spanish language (vs. English)	0.409**	1.086**	0.545**	−0.357**	0.523**	1.262**	0.527**	−0.195†	0.297	1.187**	0.478**	−0.117
Citizenship (vs. US born)												
Naturalized					−0.107	−0.042	0.104†	−0.242**	−0.488**	−0.416**	−0.122†	−0.299**
Non-citizen					0.145	−0.269**	0.007	−0.198**	−0.496**	−0.609**	−0.204**	−0.258**
Ethnicity (vs. white)												
Hispanic									0.716**	0.604**	0.351**	−0.032
Black									0.216*	0.478**	0.230**	−0.107†
Other									0.748**	0.820**	0.487**	0.185**
Deviation statistic[2]	7221.2[3]				7459.8**[4]				12004.6**[4]			

**$p<0.01$ *$0.01<p<0.05$ †$0.05<p<0.10$. [1]All models also control for sex, age, income, insurance status, marital status, education, and year of survey. Full results are available on request, [2]Difference in log-likelihoods X -2, [3]Compared to the intercept only model, [4]Compared to the previous model.

between citizenship and SAH would be misinterpreted if ethnicity was not considered. Hispanic, black, and other/multiracial respondents are far more likely to rate their health in categories poor, fair, and good as opposed to excellent than are white respondents, indicating poorer self-reported health for these groups when citizenship status and language is controlled.

A large number of the other model covariates not shown in tabular form have significant associations with SAH. The notable associations are as follows: Age is significant, generally getting worse with increased age, although the magnitude

of coefficients levels off after about age 50. This suggests that the relationship between age and SAH is not linear; a result is consistent with other research (Rubin and Zimmer, 2015). Income and education are consequential. High education and high income are strongly and significantly associated with a higher likelihood of rating one's health favorably. The opposite trend is true for low education and low income. This finding aligns with the broader literature that finds that socioeconomic status is positively correlated with SAH (van Doorslaer, Wagstaff, Bleichrodt *et al.* 1997; Huisman, van Lenthe, Mackenbach *et al*., 2007). Interestingly, there are some temporal differences in SAH rating in NHANES as well. Compared to 2003/04, respondents in later years increasingly tend to rate their health significantly less favorably. Overall, this suggests a worsening of SAH over time, an issue that is somewhat puzzling but may be important for future research. These additional results are available from the authors on request.

Marginal effects for citizenship status, language, and ethnicity are provided in Table 4. Marginal effects for the comparison categories (U.S. born, English language, and white) are set at zero, and the values for other categories indicate

Table 4. Marginal effects of citizenship status, language, and ethnicity on the probability of being in each category of SAH.

Category	Self-assessed health					
	Poor	Fair	Good	Very good	Excellent	Total
Citizenship						
U.S. born	0.000	0.000	0.000	0.000	0.000	0.000
Naturalized	−0.007	−0.023	+0.029	−0.028	+0.030	0.000
Non-citizen	+0.006	−0.041	+0.008	−0.008	+0.035	0.000
English language	0.000	0.000	0.000	0.000	0.000	0.000
Spanish language	−0.003	+0.155	+0.028	−0.127	−0.053	0.000
Ethnicity						
White	0.000	0.000	0.000	0.000	0.000	0.000
Hispanic	+0.015	+0.054	+0.044	−0.077	−0.035	0.000
Black	+0.002	+0.050	+0.037	−0.069	−0.021	0.000
Other	+0.010	+0.065	+0.038	−0.060	−0.054	0.000
Sample probability	0.024	0.127	0.359	0.312	0.177	1.000

SAH: Self-assessed health.

Table 5. Multinomial regression results for citizenship status, language, ethnicity, and years in the U.S. among non-U.S. born only, showing log odds (n=6457)[1].

Category	Poor	Fair	Good	Very good
	Versus excellent			
Citizenship(vs. naturalized)				
Non-citizen	0.150	0.027	0.000	0.120
Spanish language (vs. English)	0.746**	1.494**	0.642**	0.048
Ethnicity (vs. White)				
Hispanic	−0.053	0.239	0.325*	−0.049
Black	−0.877*	−0.188	−0.040	−0.218
Other	0.000	0.559**	0.514**	0.196†
Years in the U.S.				
0-5	0.436	−0.224	−0.008†	−0.182
5-10	0.417	−0.096	−0.094	−0.144
10-20	0.203	0.008	0.003	−0.101

**p<0.01 *0.01<p<0.05 †0.05<p<0.10. [1]All models also control for sex, age, income, insurance status, marital status, education, and year of survey. Full results are available on request.

the difference in the probability of being in a specific category of SAH relative to that category, all else being equal. For instance, the probability that a naturalized citizen reports poor SAH is 0.007 points (i.e., 0.7 percentage points) lower than the probability for a U.S. born citizen. By design, the marginal effects across categories total zero, and therefore, it is relatively straightforward to determine into which categories of SAH an individual are more likely to be in comparison to the average. The sample probabilities reported in the last row of the table are the predicted probability based on the multinomial model that arises when all variables are set at their means. These are the chances of being in each SAH category for a hypothetical individual that is the most average across all covariates in Model 3 of Table 3.

By far the largest marginal effect is for the probability of a Spanish speaker rating their health as fair. It is fully 0.155 points (i.e., 15.5 percentage points) greater than for an English speaker when controlling for citizenship, ethnicity, and all other covariates. Spanish speakers are also much less likely to report very good or excellent health. In contrast, a non-citizen is more likely than a U.S.-born or naturalized citizen to report excellent health, other things being equal. On balance, citizenship status does not have an overly large impact on SAH, but in combination, excellent health is most often reported by English speaking non-citizens in comparison to any other individuals. Ethnicity is consequential. White respondents are by far the most likely to report very good and excellent health, while Hispanic, black, and other/multi-racial respondents are more likely in the poor, fair, or good category, controlling for other covariates. Finally, there is substantial variation in the probability of reporting excellent health across categories of language, citizenship, and ethnicity.

Turning to the issue of "acculturation," Table 5 examines whether the length of residence in the U.S. weakens associations between language and SAH. As in Table 3, we show only the covariates or most interest, but the models control for other variables. The sample for this table includes only those not born in the U.S.; thus, the sample size is reduced and citizenship status includes only two categories (with naturalized as the comparison). The results show no significant association between years living in the U.S. and SAH. Other coefficients not shown are similar to the coefficients in the previous table. The Spanish language relates to a significantly greater likelihood of reporting fair SAH, while differences between naturalized and non-citizens are non-significant.

Supplementary analyses were performed and due to space limitations are not reported in tabular form. First, a set of analyses entered interaction effects into models. Some of these were statistically significant, but none substantively altered the interpretation of the association of language and health. Second, non-Hispanics do not use Spanish for these surveys, and as such empty cells are present. The models were tested on the population of Hispanics only, leaving ethnicity out of the model completely. The results were substantively the same as those reported. That is, looking only at Hispanics, the Spanish speakers are far more likely to report fair SAH than are English speakers, while non-citizens on balance report better SAH than do naturalize or the U.S. born.

4. Discussion

This paper examines the role of survey language, English or Spanish, in SAH reporting, when taking into account citizenship status, ethnicity, and a number of other demographic characteristics. Building on previous studies, it poses three primary research questions: (1) Is there an association between survey language and SAH? (2) If so, does citizenship status mediate the association between survey language and SAH? (3) Do these associations further hold when accounting for ethnic variation? These questions are addressed by leveraging seven waves of NHANES up to the most recently available. NHANES contains a large, nationwide, representative sample of the U.S. population. The study captures key aspects of immigration – including nativity, survey language, and duration in the U.S. – alongside standard SES variables in multivariate analyses. The analyses avoid pitfalls of prior studies that dichotomized or otherwise collapsed SAH categories or employed an ordered logit analysis of the measure. Instead, our analysis uses multinomial regression to better appreciate potential conceptual distinctions among SAH categories. Furthermore, it addresses ongoing health measurement challenges of migrating populations.

The results confirm that survey language is an extraordinarily critical factor in SAH reporting. When surveys are conducted in Spanish, the likelihood that a respondent will report their health as "fair" increases substantially. Overall, the Spanish language, in addition to non-white ethnicity, has a significant negative effect on a respondent's SAH rating. These findings may not be surprising given the nature of structural health inequalities in the U.S., but the effect of the Spanish language is particularly robust. When ethnicity is added to models that include language, the effect of survey language persists. Being a non-citizen or naturalized citizen appears to have a protective health effect, but taking the survey in Spanish and identifying as Hispanic, black, or other/multiracial markedly offset this advantage. Thus, English-speaking white non-citizens are more likely than any other group to rate their health as excellent. Meanwhile, Spanish-speaking

Hispanic citizens who were born in the U.S. are more likely than other groups to rate their health unfavorably. Finally, and in contrast to our expectations, duration in the U.S. does not mitigate Spanish-speakers' greater likelihood of rating their health unfavorably. On balance then, in answer to our research questions, language does affect SAH, the association between language and SAH is not substantially mediated by citizenship status as results hold when entering citizenship into regression models, and it holds as well when considering ethnic variation.

These analyses are subject to a variety of limitations that could be addressed through future research. One important limitation is the dichotomous nature of NHANES citizenship categories. Our analysis teased out a third category (naturalized citizens) from available data, but information on permanent residence, visa-holder, and undocumented statuses would improve understanding of the citizenship-health association. Pourat, Wallace, Hadler *et al.* (2014) have developed a method of imputing undocumented status using answers to questions about permanent residence and length of time in the U.S., but without such information in NHANES, such imputation is impossible. Future data collection instruments would benefit from more variety in citizenship types, but they do so at the risk of alienating potential survey participants who fear disclosing their legal status – particularly under the current U.S. administration (Wang, 2018).

Another limitation is NHANES' categorization of ethnicity. There is no distinction between "ethnicity" and "race" in this measure. This conflation particularly affects Spanish speakers, who although classified as "Hispanic" may self-identify as any racial category (e.g., white or black) or multiple racial categories (Vega, Rodriguez and Gruskin, 2009). Furthermore, ethnic categories seem to have been determined colloquially rather than critically. In the original NHANES categories, "Mexican American," for example, is not disaggregated between Mexican and Mexican American, despite distinct cultural, and geopolitical meanings. Finally, collapsing multiple ethnicities into "other/multi-racial" sacrifices information, although overall there were very few respondents in this category. Despite these drawbacks, these categorizations reflect important classificatory trends in the U.S., where non-white residents face racial discrimination, tend to occupy lower socioeconomic positions, and report worse SAH than their white counterparts (Ren, Amick, and Williams, 1999; Stuber, Galea, Ahern *et al.*, 2003; Cummings and Jackson, 2008). Future research should allow for a greater variety of ethnicities.

Finally, we recognize that many Hispanic respondents may speak both English and Spanish and that dichotomizing respondents according to the language in which they took the survey may not fully capture the nuance of their bilingual SAH interpretation. The so-called "acculturation" portion of the NHANES includes questions about language spoken at home, as a child, with friends, and while reading, speaking, and thinking, but the utility of these questions for our analysis is limited. Very few people actually responded to these questions, and they are not comprehensive enough to model bilingualism in the kinds of equations we have employed in this analysis. Future research should focus on collecting more robust information on bilingualism and how to model it adequately in relation to constructs such as SAH.

In spite of these limitations, our study has addressed an important issue regarding language and health status. Our analysis supports recent studies (Bzostek, Goldman, and Pebley 2007; Viruell-Fuentes, Morenoff, Williams *et al.*, 2011; Sanchez and Vargas, 2016) in indicating that Spanish speakers are much more likely to rate their health as fair than are others and that this is likely a function of the way in which the ubiquitous SAH item is translated in surveys. Our models followed the examples of Bzostek, Goldman, and Pebley (2007) to include citizenship status and Viruell-Fuentes, Morenoff, Williams *et al*. (2011) to treat SAH as multinomial. We advanced on these previous approaches using a large nationally-representative and more recent dataset (NHANES 2003-2016) that included thousands of observations on the variables of interest. We also include duration in the United States to account for acculturation. Given the likelihood that the commonly used translation of the five SAH categories itself shapes the distribution of SAH responses, alternate translations, such as replacing "regular" with "más o menos" to convey "fair" health (Viruell-Fuentes, Morenoff, and Williams *et al.*, 2011; Sanchez and Vargas, 2016), should be implemented in future survey design. Such validity questions must be addressed if SAH is to be translated and employed across linguistic groups.

Other findings address issues that are so far underdeveloped in literature. Despite numerous barriers to health access on the basis of legal status (Castañeda, Holmes, Madrigal *et al.*, 2014; Martinez, Wu, Sandfort *et al.*, 2015), our analysis in fact finds that in some cases being a non-citizen or naturalized citizen increases one's odds of a favorable health rating. The positive contribution of the "healthy immigrant effect" is outweighed by the effect of being racialized as non-white in the U.S., however, which associates with a less favorable SAH rating.

From a policy perspective, these results present a complex picture of immigrant health. Our study underscores the need to critically examine interrelated factors of survey language, citizenship status, and ethnicity to understand the health context of a large part of the U.S. population. It is crucial that large national level surveys of health meant to inform health-care policy consider novel measures that overcome challenges faced in assessing the health of migrating, heterogeneous populations. In particular, survey language may be a problem at the level of survey data collection and analysis, and the effects of citizenship status should be considered alongside ethnicity to capture the role that ethnic minority status has in

undermining the previously hypothesized immigrant health advantage. In addition to survey language, these intersecting factors, which are difficult to measure with precision, are very likely underlying the effects we see in our models. Future research should consider these complex factors when drawing conclusions regarding immigrant health in the U.S.

5. Conclusions

Spanish speakers are more likely than others to rate their health as "fair." This result concurs with earlier studies that used much smaller samples and, as opposed to our study, examined data that were either cross-sectional or spanned a short period of time. Acculturation, or years spent in the U.S. among immigrants, does not attenuate the association. Earlier research has indicated that being an immigrant and having limited English proficiency has negative consequences for health. While our study does not negate this, it does suggest that some perceived health disadvantage among immigrants could be a function of differences in the way in which health is expressed across languages.

Authors' Contributions

Both authors contributed to all aspects of the manuscript, including conceptualization, analysis, interpretation, and writing.

Ethics

The de-identified NHANES datasets used in this paper were downloaded by the first author as de-identified, publicly available files through the U.S. CDC and Prevention. Ethical approval for original data collection was provided by the National Center for Health Statistics' Ethics Review Board.

Availability of Support Data

All data files for the NHANES waves used in this manuscript are available through the National Center for Health Statistics.

Conflicts of Interest

The authors have no conflicts of interest to disclose.

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RESEARCH ARTICLE

Use of the average age ratio method in analyzing age heaping in censuses: The case of China

Danan Gu[1]*, Qiushi Feng[2]

[1]Population Division, Department of Economic and Social Affairs, United Nations, New York, NY 10017, USA,
[2]Department of Sociology, Centre for Family and Population Research, National University of Singapore, Singapore

ABSTRACT: Based on the methods of the average period age ratio and the average cohort age ratio, this study systematically assesses age heaping or digit preference in all population censuses of China. Our study finds that the overall age heaping was relatively low in the Chinese censuses; however, there was a notable preference for ages ending with zero after age 50 in the first two censuses, despite a weakening trend over time. Our study further shows that age heaping in China's censuses is likely associated with age-related policies such as those on late marriage and retirement. As shown in the study, the average age ratio method can be an alternative of the Whipple's Index and be improved if the size of birth cohort was taken into account when the number of births is generally reliable.

Keywords: Age concentration index; Age heaping; age ratio; Age reporting; Average age ratio; Average period age ratio; Average cohort age ratio; China; Census; Digit preference; Digit avoidance; Whipple's index; Myer's blended index

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***CORRESPONDING AUTHOR**

Danan Gu,
Population Division, Department of Economic and Social Affairs, United Nations, New York, NY 10017, USA.
gudanan@yahoo.com

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1. Introduction

Censuses are foundational data sources for population studies, the accuracy of which determines the validity and reliability of demographic research (Moultrie, Dorrington, Hill *et al*., 2013; United Nations, 1983, 2008). Throughout the procedure of census, errors may occur on many occasions such as age reporting and recording. Age reporting may suffer from two types of errors, intentional and unintentional misreporting. Unintentional misreporting mainly refers to the situation where the interviewee does not know or could not remember the exact birth date. By contrast, intentional misreporting occurs when the interviewee, though knowing the exact birth date, chooses to "avoid" or "prefer" certain digits in reporting of his/her age (commonly known as digit preference), due to personal, cultural, and social considerations (Moultrie, Dorrington, Hill *et al*., 2013; United Nations, 1983). For example, in a society where vital registration is underdeveloped, a young person who has not reached the minimum legal age for marriage may report an older age for marital registration. Due to similar reasons, some young people may report older ages in applications to join the military, and some older adults may exaggerate their ages for the legitimacy of retirement welfare. Unintentional misreporting is mainly random, and thus, it will not cause a severe bias in results. However, intentional misreporting would lead to "age heaping," a situation in which the population at a certain age or an age ended with certain digit significantly outnumbers populations at adjacent ages or ages ended with other digits (Moultrie, Dorrington, Hill *et al*., 2013; Spoorenberg, 2007). This would introduce inaccuracy in the age statistics of population studies. Although the data quality

of age reporting is also affected by census enumerators and the household registration management and archiving, these errors are often systematical biases and thus may not generate "age heaping" in practice.

1.1. Common Methods for Checking Age Heaping

Some common methods to examine the data quality of age reporting in census include the Whipple's Index (Whipple, 1919), the Myers' Blended Index (Myers, 1940), the Bachi's Index (Bachi, 1954), the Carrer's Index (Carrier, 1959), the Ramchandran's Index (Ramachandran, 1965; Shryock and Siege, 1973), and the UN Age-sex Accuracy Index (United Nations, 1952). The Whipple's and Myers' Blended indexes are among the most commonly used methods to check digit preferences or age heaping (Spoorenberg, 2007). The conventional Whipple's Index checks digit preferences for ages ending with digits of 0 and 5, and the modified Whipple's Index could check digit preferences for ages ending digits other than 0 and 5 (Spoorenberg, 2007). The Myers' Blended Index also can be used to check digit preferences. The UN age-sex Accuracy Index is designed to assess the overall quality check of age reporting, not particularly for checking age heaping (United Nations, 1983). The details of these methods and their applications can be found in common demographic textbooks and above literature, and thus, they are not repeated herein.

In the existing literature, the age ratio method is only used in checking a segment of age ranges such as the adjacent five ages, instead of the whole age range at adulthood ages, such as the Whipple's Index, and thus it has not commonly been used to check digit preferences in age-reporting. In this study, we argue that age ratio method may be a good alternative for checking the digit preference or age heaping in age reporting from population censuses, vital registration, and/or sample surveys with large-scale and high representativeness.

1.2. Literature on Age Heaping Studies in China

Age heaping in China's censuses has been frequently considered as one major research theme among Chinese demographers, with a vast majority of studies using the Whipple's Index (Guo and Che, 2008; Li, 2012; Ma, 1984; Qiao, 1993; Qiao and Li, 1993; Li, Qiang and Yang, 1993; Wang, 2012; Wu and Gan, 2013; Yang, 1988; Zha and Qiao, 1993; Zhai, 1987). Most of these studies revealed that the overall age heaping was minor in Chinese censuses, with a few exceptions in the ethnic minorities. Enlighten by Keyfitz's "demographic discontinuity" theory (Keyfitz, 1987), Huang (1993, 2009), and Huang and Xiao (2009) investigated the digit preference through calculating the frequency of distribution of signs (+/-) on each digit based on the age-specific first- or second-order difference in its proportional share of population. The first-order difference in the population proportion for age x is the difference in population between age x and age x+1. One limitation of this method is that a negative sign of a given age x can be due to underreports at age x, or due to overreports at age x+1, or due to both. The second-order difference is the difference between age x, age x+1, and age x+2, which also suffers from the limitation above. Nevertheless, all these previous studies have contributed to our understanding of age heaping and the accuracy of aging reporting in censuses of China.

Except for the Huang's method of differential signs, all methods assume that the changes of the study population are in a stable and smooth manner. For example, both the conventional and modified Whipple's Indexes assume that the population change linearly (Spoorenberg, 2007). If the population changes were not smooth, both the conventional and modified Whipple's Indexes would produce somewhat biased results. However, affected by natural disasters, extreme weathers, and birth planning policies since the 1950s, the population of China witnessed irregular changes in annual births and deaths. Such irregular population changes will bring forward errors in the application of the routine methods and undermine the research validity in demographic analyses. Another limitation of these methods is the lack of validation across multiple censuses. A more effective method is thus needed to investigate digit preferences for populations with irregular changes, and for age heaping in general as well as at some specific ages. This paper proposes an extended age ratio method to fill this gap and uses the census data of China for an empirical illustration and validation.

2. Data and Method

We used an extended age ratio method, consisting of the average period age ratio (APAR) and the average cohort age ratio (ACAR), to examine age heaping for Chinese censuses in the years of 1953, 1964, 1982, 1990, 2000, and 2010. The data of single year of age by sex in these six censuses were obtained from the National Statistical Bureau of China (1983, 1992, 2002, 2012).

2.1. Average Period Age Ratio (APAR)

- Step 1: Calculate the period age ratio

For a given census, we calculate age ratio for a certain age based on the five consecutive single years of age (three, seven, or nine ages are also applicable):

$$AR(x,t) = \frac{5 * P(x,t)}{P(x-2,t) + P(x-1,t), + P(x,t) + P(x+1,t) + P(x+2,t)}, \quad (1)$$

where t is the census year, $P(x,t)$ is the enumerated number of population at the age x in the census year t, and $AR(x,t)$ is the age ratio at the age x in the census year t, also called as the age concentration index. If numbers of births in these five cohorts are similar (or change in a stable manner) and the following changes are even, the age ratio should be equal or close to 1. If the age ratio is larger than one to a significant degree, the population at the age x should exceed populations at the other adjacent four ages (concentration); if the age ratio is smaller than 1 to a significant degree, the population at age x should be smaller than populations at the other adjacent four ages.

However, it is possible in reality that the population at a certain age may vary greatly in size as compared to populations of neighboring ages (e.g. in the baby boom and baby bust periods). That means that the value of the age ratio may deviate from one, even though there is no age misreporting. On the other hand, when age misreporting presents, it is yet possible that the age ratio is close to one at certain ages, because populations at these ages might be lower (or higher) at birth in contrast to other ages. Therefore, in the cases when the number of births varies greatly by cohort and when these data are available, it is better to further adjust the age ratio by the number of births and/or survival rates of the neighboring cohorts:

$$AR'(x,t) = \frac{5 * P(x,t)}{P(x-2,t) + P(x-1,t), + P(x,t) + P(x+1,t) + P(x+2,t)} / C(x), \quad (1a)$$

where

$$C(x) = \frac{5 * B(t-x) * L(x)}{B(t-x+2) * L(x-2) + B(t-x+1) * L(x-1) + B(t-x) * L(x) + B(t-x-1) * L(x+1) + B(t-x-2) * L(x+2)},$$

$B(t-x)$ is the number of births in year $(t-x)$, and $L(x)$ is the number of survivors relative to 100,000 (or survival ratio from birth to age x) for the cohort born x years ago. When there are no epidemics or wars, it is acceptable to assume that survival ratios are the same or very close to each other for neighboring cohorts. If this is the case, $C(x)$ would be fully depending on the size of neighboring birth cohorts; and when the size of birth cohorts is stable or changes smoothly, $AR'(x,t)$ would be very close to $AR(x,t)$. Of course, numbers of births of these cohorts need to be accurate or have the same pattern of under- or over-estimation. As the vital registration system in most developing countries is usually underdeveloped or incomplete, the availability of the number of births may be a challenge. In such cases, the value of such an adjustment would be depreciated. However, this method is still useful as it would not produce substantial biases as long as the coverage of vital registration is stable (or improved gradually) and the quality of data is generally acceptable over time.

If population changes are not even by age (e.g., large scale migration due to epidemics or wars for some specific periods), we may consider further adjustments through adding the parameters of population changes *Z(x)* of each cohort in $C(x)$. Unfortunately, in most cases, such parameters are hard to obtain, particularly in developing societies. Thus, when the number of births at adjacent years is roughly close to each other, and the subsequent population changes did not suffer from a substantial fluctuation, the age ratios without adjustment for births may be considered as acceptable.

- Step 2: Calculate the APAR

For the age range to be studied, we could add up all age ratios of the same ending digit of ages, and calculate APAR for each ending digit:

$$APAR(i) = \overline{PAR(i)} = \frac{AR(x,i) + AR(x+10,i) + \cdots + AR(x+n*10,i)}{n+1}, \quad (2)$$

where i is an ending digit of age, $APAR(i)$ or $\overline{PAR(i)}$ is the APAR for the ending digit i, $(n+1)$ is the number of age ratios with the same ending digit. When numbers of births vary greatly by cohort, we could further adjust the age ratio by the birth size for a more accurate estimation (Equation 1a). Based on our preliminary investigation (see Appendix Figure A), we recommend using the following criteria for assessment of digit preferences or age heaping: A ratio ranging from 0.97 to 1.03 indicates almost no ending digit preference/avoidance of age, a ratio of 0.95-0.97 or 1.03-1.05 indicates a mild digit preference/avoidance, a ratio lower than 0.95 or higher than 1.05 indicates a moderate digit preference/avoidance, and a ratio lower than 0.90 or higher than 1.10 indicates a severe digit preference/avoidance. For a ratio lower than 0.85 or higher than 1.15, it is necessary to adjust and correct the raw data.

For a given census, we could also sum all APARs for a general description of age heaping across all ending digits, namely, the Total Period Age Concentration Index (*ToPACI*):

$$ToPACI = 100 * \sum_{i=0}^{9} \sqrt{(APAR(i)-1)^2}. \quad (3)$$

If *ToPACI* is < 25, age heaping at ending digit could be considered minimal; if *ToPACI* is between 25 and 50, age heaping could be considered mild, between 50 and 100, moderate, between 100 and 200, substantial; and above 200, the aging heaping could be considered severe, calling for an adjustment and a correction on the raw data.

In use of APAR, without information on the number of births by cohort, cautions are needed to assess age heaping in that the irregular births across cohorts may occur due to specific historical events such as wars, natural disasters, fertility policy, and migration. In addition, APAR could only be used for investigating age heaping in a single census. When the data of two and more censuses are available, ACAR to be introduced in the following session could be applied, and APAR and ACAR could be jointly used to compare and verify findings of age heaping in censuses.

2.2. Average Cohort Age Ratio (ACAR)

There are three steps to calculate the ACAR. The first step is to calculate the age ratio, which has been previously described. We thus start with Step 2.

- Step 2: Calculate the cohort age ratio

We could calculate the cohort age ratio by comparing age ratios of the same cohort at the two censuses:

$$CAR(x,t) = \frac{AR(x,t)}{AR(x-k,t-k)}. \tag{4}$$

where t is the current census year, k is the interval of the two censuses under study, $t-k$ is the year of the previous census, x is the age, and $CAR(x,t)$ is the cohort age ratio at the age x and the census year t.

Assume $S(x-k)$ is the survival ratio for individuals aged x-k in the previous census to the current census when the same cohort reaches the age x. If there are no age misreporting and no population migration, $P(x,t)=P(x-k,t-k)*S(x-k)$. $P(x-k,t-k)$ is the number of population at age $x-k$ in the first census in the year $t-k$, and $P(x,t)$ is the number of population at age x in the second census in the year t.

And Equation (4) could be transformed as:

$$CAR(x,t) = S(x-k,t-k) / \left[\frac{\sum_{i=-2}^{2} S(x-k+i,t-k) * P(x-k+i,t-k)}{\sum_{i=-2}^{2} P(x-k+i,t-k)} \right]. \tag{5}$$

Evidently, if $\frac{S(x-k,t-k)}{S(x-k-2,t-k)}$, $\frac{S(x-k,t-k)}{S(x-k-1,t-k)}$, $\frac{S(x-k,t-k)}{S(x-k+1,t-k)}$, and $\frac{S(x-k,t-k)}{S(x-k+2,t-k)}$ are close to one, or the survival rates of adjacent age groups changes evenly, $CAR(x,t)$ should be equal or close to one. That is, if the digit preference/avoidance does not exist, as long as the survival rates of adjacent age groups change similarly, the cohort age ratio should be close to one, even though the birth numbers of these cohorts may show irregularities. To clarify such issues, it is necessary to examine the age ratio, preferably those adjusted by the cohort size (i.e., number of births).

As long as, the survival rates of adjacent age groups change similarly, $CAR(x,t)$ significantly higher or lower than one would indicate the existence of age misreporting, either age heaping in the current census at the age x or age avoidance in the previous census at the age $x-k$. To clarify which case it is, it is suggested to examine the age ratio adjusted by numbers of births if the number of births is available and reliable or by the APAR as introduced in the previous session.

- Step 3: Calculate the ACAR

For the age range to be studied, we could add all the cohort age ratios of the same ending digit of ages, and calculate an ACAR for each ending digit:

$$ACAR(i) = \overline{CAR(i)} = \frac{CAR(x,i) + CAR(x+10,i) + \cdots + CAR(x+n*10,i)}{n+1}, \tag{6}$$

where i is the ending digit of age, $APAR(i)$ or $\overline{PAR(i)}$ is the $ACAR$ for the ending digit i, $(n+1)$ is the number of age ratios with the same ending digit.

As long as, the censual interval is not exactly equal to 10 years and the population change over the censual interval is even (if not evenly, extra data are needed in analyses), with ACARs for certain ending digit being significantly higher or lower than one, it will be relatively easy to evaluate the presence of digit preferences/avoidances. If the censual interval is exactly equal to 10 years and when number of births is not available by cohort or by year, ACAR may be less effective. In this situation, we need to combine the use of the APAR method.

We propose that an ACAR ranging from 0.97 to 1.03 indicates a strong consistency in the digit preference/avoidance at the ending digit, a ratio of 0.95-0.97 or 1.03-1.05 indicates a mild digit preference/avoidance, a ratio lower than 0.95 or higher than 1.05 indicates a moderate digit preference/avoidance, and a ratio lower than 0.90 or higher than 1.10 indicates a severe digit preference/avoidance. For a ratio lower than 0.85 or higher than 1.15, it is necessary to adjust and correct the raw data.

When the number of births of the original cohorts is available, and the quality is good, the ACAR is likely more robust and accurate in identifying age heaping compared with the conventional and modified Whipple's Indexes and the Myers' Index that are based on either a single time point of data or one census. Similar to that for APAR, we could also sum the deviation from one for each ending digit for a general description of age heaping across all ending digits, namely, the Total Cohort Age Concentration Index (*ToPACI*):

$$ToCACI = 100 * \sum_{i=0}^{9} \sqrt{(ACAR(i) - 1)^2}. \quad (7)$$

The criterion of *ToCACI* is the same as that of *ToPACI*.

3. Empirical Validation

The methodology used for calculating APAR is similar to that used for the (modified) Whipple's Index. The difference between these two methods is that APAR calculates age ratio first for a specific age from population counts of its neighboring ages and then averages the ratios for ages with the same ending digit, while the modified Whipple's Index sums population counts first for the same ending digit of ages and then divides by the total population counts of their neighboring ages (for details see Spoorenberg, 2007).

For a stable or a stationary population, mathematically, it can be proved that these two methods produce identical results. In reality, when they are applied to Japan and Sweden, the two countries with the highest data quality of population counts in the world (Thatcher, Kanisto, and Vaupel, 1998), these two methods also produce very close results (Appendix Table A) that compare the APAR method with the modified Whipple's Index for the preferences over ending digits of age for years from 1980 to 2015. These data are obtained from the Human Mortality Database (HMD), which are mainly from censuses and vital registration of these countries (Wilmoth, Andreev, Jdanov *et al*., 2017).

Figure 1 compares the APAR method with the modified Whipple Index for ages 21-64 in male populations for Japan and France (France is a country with very good data quality of population counts) for selected years. The very closeness of the two sets of results indicates that the average age ratio is a valid measure for examining age heaping. However, Figure 1 indicates that both the APAR method and the Whipple's Index misrepresented the true state of age heaping in the Japanese and French male populations in the illustration periods. For example, both indicators suggest that there was a somewhat preference for the ending digit of 1 in Japanese male population in 1980, while there was a digit preference of 7 in 1985. However, this is likely wrong because such fluctuations were mainly due to the post-war baby boomers born in 1948-1949 with the birth numbers of 10% higher than the adjacent ages, who happened to reach the ages of 31 and 32 in 1980, and the ages of 36 and 37 in 1985.

For France, both methods suggest that French population had a preference for ending digits of 5 and 9 in 1950, and then shifted to 4 and 8 in 1959. However, a closer look demonstrates the true reason: After the World War I, in which France was involved from August in 1914 to November 1918, there was a baby boom period in France from 1920 to 1921 with a 20% higher in the number of births than the adjacent years, and these baby boomers reached age 29 in 1950. The sharp decline in births during the war also made the population at age 35 exceeding those of the adjacent ages in 1950 by about 18%. In 1959, those born in 1920-1921 reached the age of 38 while those born in 1914-1915 reached the age of 44. For Japanese male population, the total deviation (*100) was 14.5 and 12.4 for APAR (i.e., ToPACI) and 17.8 and 14.9 for the Whipple's Index 14-18 in 1980 and 1985, respectively. For French male population, the total deviation (*100) was 29.8 and 32.1 for APAR, and 26.8 and 27.9 for the Whipple's Index in 1950 and 1959, respectively.

After adjusting the cohort size and survivorship for APAR [Figure 2] (the results were similar without adjusting survivorship), we found that there was no digit preference of age reporting in Japanese male populations in 1980 and 1985 and French male population in 1950 and 1959. ToAPCI with birth-adjusted APAR for Japanese male population was below 5 for both years, whereas it was around 13 for French males population in 1950 and 1959. The *ToCACI* was <1 for both countries in study years. A couple of approaches were tested to adjust the Whipple's Index by birth cohort size, yet given their complexity and uncertainty, no set of adjustment was presented in the present study.

Figure 3 further presents ACAR for Sweden, France, and Japan for ages 20-90, rather than for the classic age range of 23-62 for Whipple Index or the age range of 21-64 for the modified Whipple's Index. Clearly, between the age of 20 and 80 years, ACAR at each age was very close to 1 (0.99-1.01) for the three countries. After age 80, the ratio at each age declined rapidly due to the high mortality rates. These results indicate that there is no age preference in these three countries and that the age range for calculating APAR and ACAR can go beyond normal adulthood as used for the Whipple's Index.

4. Results of Examination on the Chinese Censuses

Our examination of age heaping in the Chinese censuses focuses on the age range from 10 to 80 years old, rather than from age 0 to age 89 years. This is because mortality underestimation for young children aged 0-5 years and mortality underestimation for the oldest-old population are different from other ages (Guo, Yin, Wang, *et al*., 2015). In other words, the age range to be studied in a given census in the present study is from 20 to 80 years, and the age range in its previous census is correspondingly from 10 to 70 years. In addition, when comparing the census data for 2000 versus 1990, we converted the 2000 census data (November 1) to mid-year data by assuming that the population is evenly distributed across months within a given calendar year.

Figure 4 reveals the modified Whipple Index at each ending digit of age calculated based on the age range of 21-64 each census. The results point out that in the recent three censuses, there seemed to exist a preference on the ending digit of 7 and avoidance on 9. However, this conclusion is not correct as there were a larger number of babies born in 1963-1964, resulted from a baby boom after the feminine in 1959-1961., the cohort born in 1963-1964 aged 27, 37, and 47 years in the 1990, 2000, and 2010 censuses, respectively. Hence, the age heaping on the ending digit of 7 should not indicate an age digit preference as proposed by some scholars (Wu and Gan, 2013), but a result of different sizes of birth cohorts.

Figure 5 presents the birth-adjusted APAR for the 2000 and 2010 censuses in comparison to the modified Whipple's Index. The comparison shows that the preference revealed by the modified Whipple's Index on digits 2 and 7 found in 2000 and on digits 2, 7, and 8 in 2010 and that the avoidance in digits 1, 8, and 9 in 2000 and 9 in 2010 were indeed due to different size of the original birth cohorts. Figure 6 illustrates ACAR for ending digits of age, clearly suggesting that

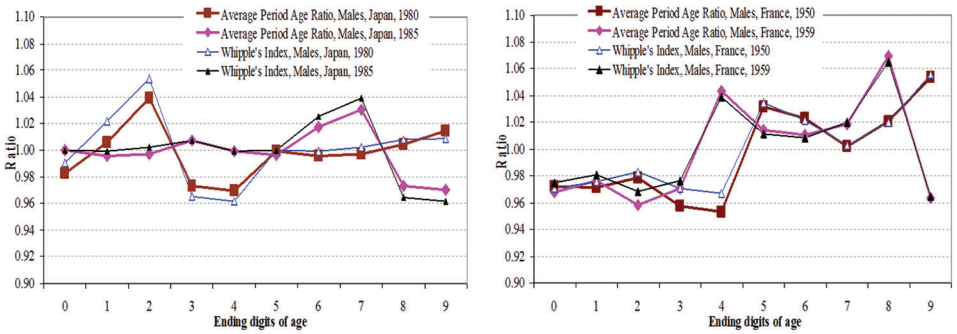

Figure 1. Comparison of the Whipple's index and average period age ratio in the populations of Japan and France
Sources: HMD (https://www.mortality.org/).

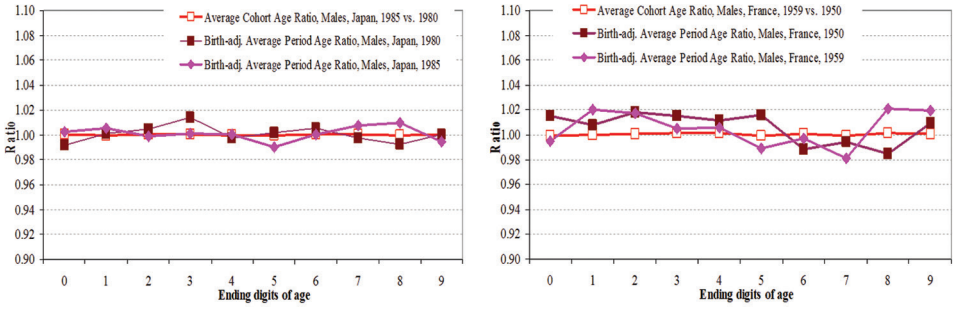

Figure 2. Birth-adjusted average period age ratio in the male populations of Japan and France in selected years
Note: Data for France were from HMD; data for Japan were from HMD and the National Statistics Office.

there was generally no preference on the ending digits of age in the age range of 21-64. No significant age heaping was found in the age ranges 21-64. For earlier censuses, since we do not have the number of births in the 1920s and 1930s in China, we are not able to present birth-adjusted APAR in these censuses.

No preference on an ending digit of age does not mean no preference on some specific ages, which we indeed observed in certain censuses. Figure 7 illustrates age ratios for the age range of 20-80 in multiple censuses, and Figure 8 shows the cohort age ratios at different ages based on a comparison of the same cohorts in these censuses. Altogether, in the 1953 and 1964 censuses, we find out some mild preference on the ages 40, 50, 60, 70, and 80 years old. For example, in Figure 7, the age ratios at ages of 40, 50, 60, 70, and 80 were all above 1.03: These ages hold at least 3% more of population numbers than the adjacent ages. In contrast, age ratios at the adjacent ages were all below 1. Although there were wars and social riots in China from 1870 to 1900, most of them were small-scaled, and thus the cohort born in 1870 to 1900 could be considered as rather stable. At the same time, because the mortality rate was relatively high before 1950 (Lee and Wang, 1999; Seifert, 1935), the difference in the number of births between adjacent cohorts is likely minor and could be ignored after certain ages in adulthood. Therefore, if there was no preference on ages, the age ratios at ages of 50, 60, 70, or 80 are supposed to be very close to one. According to Figure 7, in 1964, the cohort age ratios at 61 and 71 were all <1. This also proves that the first census of China had somewhat age heaping at the ages of 60 and 70.

With social development, the age preference on the ages of 40 and 50 generally disappeared after 1982. In the recent three censuses of 1990, 2000, and 2010, however, the preference on age 60, 70 and particularly 80 was still observable in these ages. For example, in the 2000 census, the age ratios at 70 and 80 were more than 1.05. In the 2010 census,

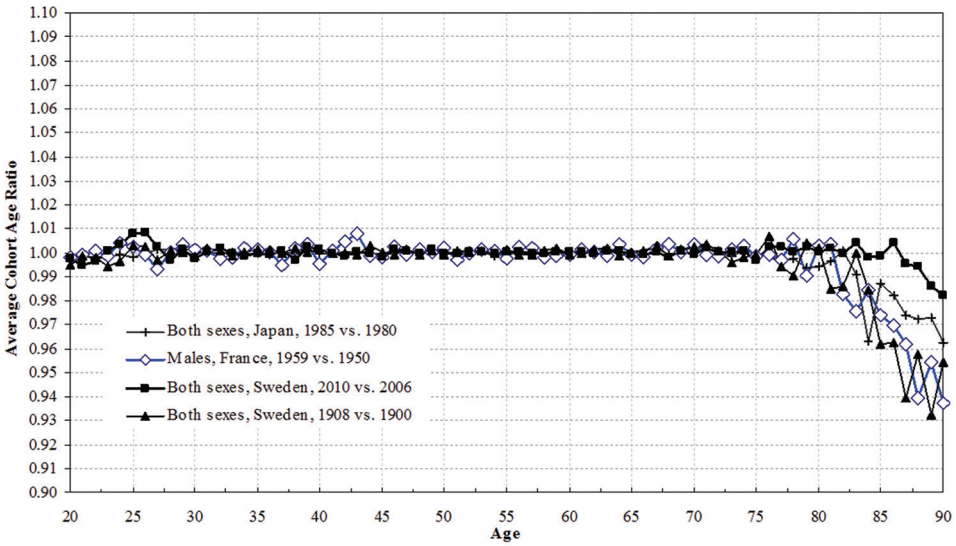

Figure 3. Average cohort age ratio in Sweden, Japan, and France

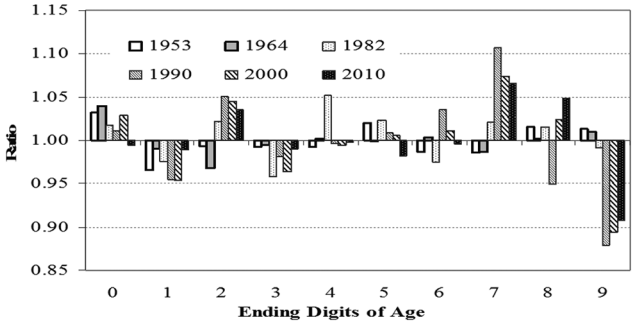

Figure 4. The modified Whipple Index for different ending digits of age in six censuses in China
Note: (1) Data were for ages 21-64 only from National Bureau of Statistics of China.

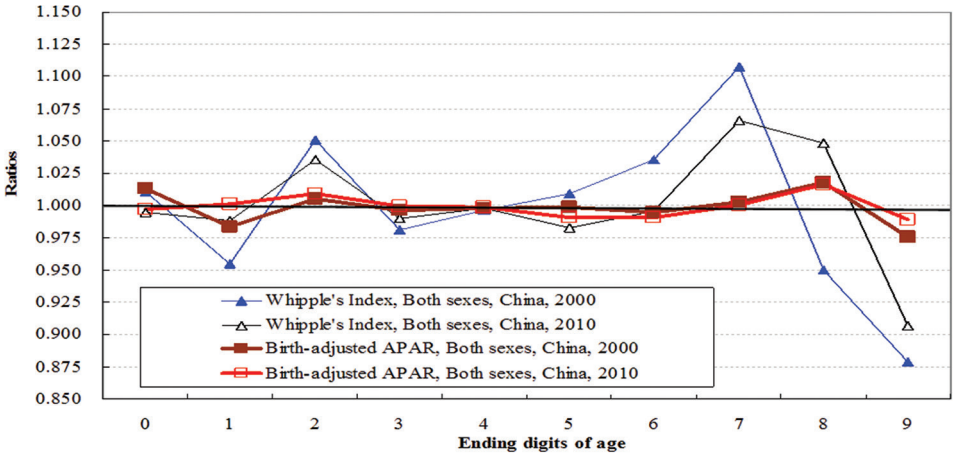

Figure 5. The modified Whipple Index and the birth-adjusted APAR, ages 21-64, China, 2000 and 2010 censuses
Note: Data were from the National Bureau of Statistics of China

Figure 6. ACAR for different ending digits of age based on the multiple censuses in China for ages 21-64
Note: (1) Data were from the National Bureau of Statistics of China. (2) Average cohort age ratio is unadjusted by birth cohort size.

even though the age ratio at 80 was lower than that of 10 years ago when they were 70 years old, but it was still greater than 1.05. These results demonstrate that older adults in China still have some preference for the ending digit of 0 when reporting their ages.

We consider that the preference for some specific ages was policy associated. For example, there was a preference on the age of 18 in the 1953 census, which was consistent by gender (results available on request). This preference is also confirmed by the analysis on the census 11 years later (i.e. 1964), in which the cohort age ratio at the age 29 was <1. It is likely that this age preference is related to the marriage law that sets 18 years old as the minimum marriage age for women, and the regulation that required men enlisted into the army to be at least 18 years old in the 1950s and 1960s. The age ratios in the 1964 and 1982 censuses [Figure 7] as well as the cohort age ratios between both censuses [Figure 8] further demonstrate that there existed age avoidance on ages 20-23 in the 1982 census and the age preference on ages 24 and 25. This could be caused by the fertility decline during the period of natural disasters (1959-1961) and the birth compensation afterward. On the other hand, it may also indicate misreporting to a certain degree in both censuses. This is also revealed by cohort age ratios based on the 1990 and 1982 censuses [Figure 8]. Meanwhile, the underreporting at ages of 21 and 22 in the 1982 census could be affected by the national policy in the early 1980s to promote late marriage and childbirth.

Another observation is that for the 2000 and 2010 censuses, the age ratios had major fluctuations, particularly for the range from 30 to 45 years old [Figures 7 and 8]. Compared with the previous censuses as shown in the two figures, it is highly likely that the data quality of age reporting worsened in the latest two censuses in 2000 and 2010. This may be due to the increasing population mobility, which brings in difficulty for the census enumeration. The worsening data quality in age reporting could lead to the rise of inconsistency across ages between 2000 and 2010, which was particularly significant in the ages below 20 years old [Figure 8].

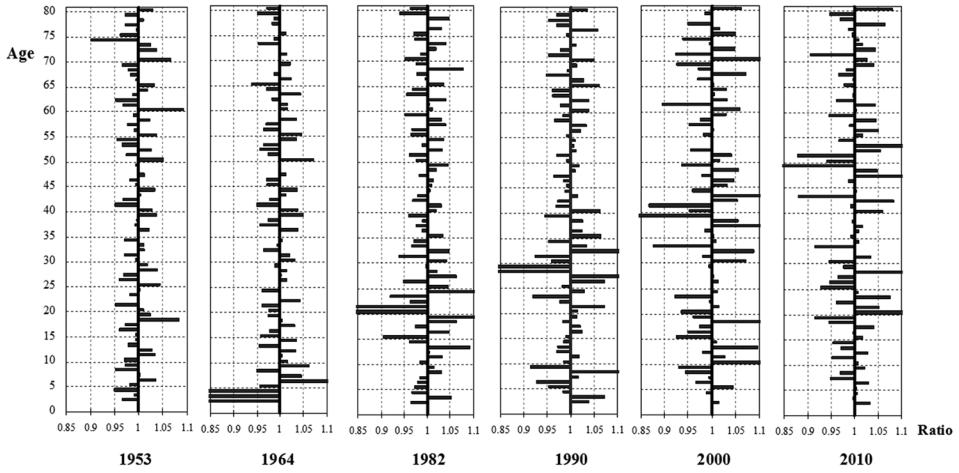

Figure 7. Period age ratios in Chinese censuses

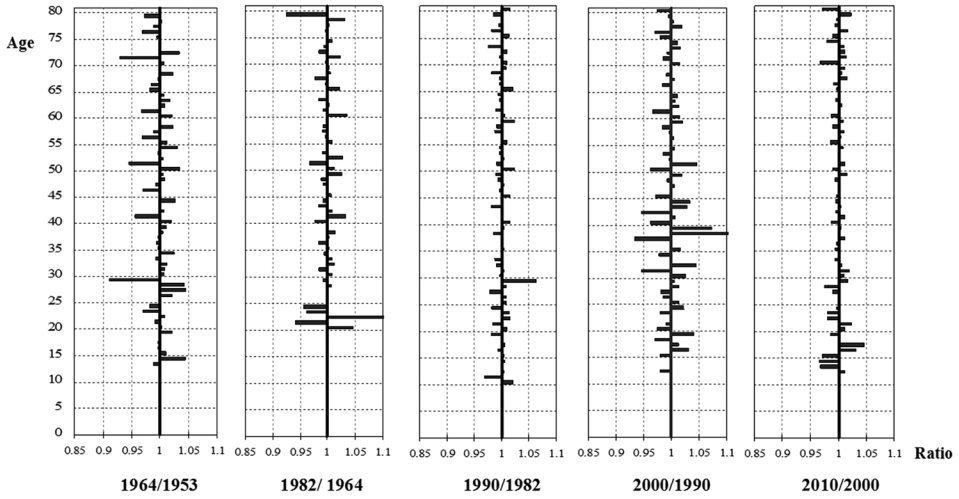

Figure 8. Cohort age ratios at each age between the adjacent censuses of China

5. Concluding Remarks

This paper applied APAR (birth-size adjusted and unadjusted) and ACAR to the six population censuses in China since 1950 to analyzed age heaping in China. We found that the Chinese population generally had a low preference for ending digits of age; however, there existed preferences for specific ages in certain censuses. These preferences had two main patterns: First, in middle and old ages, the Chinese population had a preference on the ending digit of 0, yet this preference diminished after 1990. This trend may be due to the institutional implementation and improvement of the household registration system and personal the identity card system as well as the increasing demands for accurate age reporting in school application, job hunting, housing purchase, and medical insurance**.** The current youth almost cannot over-report their ages, as census enumerators could examine their household registration system and identity cards. However, when census numerators visited a household, they typically asked a person in the household (mostly the household head) to fill the census forms without crosschecking with other available data. Consequently, underreports/undercounts or overreports/overcounts of individuals, out-migrants, and deaths in the household are common in many censuses, despite the well-developed household registration system (Guo and Che, 2008; Li and Ma, 1984; Qiao, 1993; Qiao and Yang, 1993; Wu and Gan, 2013; Yang, 1987; Zha and Qiao, 1993; Zhai, 1987). When people begin to acknowledge the necessity of reporting accurate birth date and age, the cultural tradition preferring or avoiding reporting certain ages will gradually fade away. With the improvement of the vital registration and

household registration systems, the age heaping phenomenon in China will eventually diminish. Second, there existed a preference for specific ages in certain periods of time, which was mainly related to the implementation of some age-related policies such as regulation on the minimal legal ages of marriage, childbearing, and retirement. People likely intentionally misreported, typically over-reported, their ages to meet the age thresholds of these policies. Last, we found that, although the preference for ending digit of age declined after 1990, inconsistencies of age reporting across censuses had indeed increased. This suggests that the overall data quality of age reporting in the 2000 and 2010 censuses likely decreased, which may be due to the increased domestic migrations that made it difficult to enumerate accurately in censuses after 1990. More research is clearly warranted for more insights on this theme.

Using data from Japan and Sweden, two countries with the best quality of demographic data, we show that the APAR method has similar properties as the modified Whipple's Index (Noumbissi, 1992; Spoorenberg, 2007). However, we also acknowledged the limitation of both the Whipple's Index and the APAR method. When population changes are not smooth (due to significant differences in births, deaths, and migration), it may not accurately reflect age heaping if the direct calculation of the ratio or the index is used (Barrett, 2019). That means, when applying these two methods to identify the age preference/avoidance, it is necessary to consider the historical background of the specific birth cohort or time period in the study population, to clarify whether the observed age heaping is due to misreporting or is due to particular historical events such as wars that caused the major cohort differences. As a result, we suggest taking the birth cohort size into the calculation as an adjusting factor if such data are available and relatively reliable.

However, cautions are needed for a few issues on applying the APAR and ACAR methods. First, the calculation of ACAR must be based on two or more censuses, to capture the degree of the age preference/avoidance or age reporting consistency. Since the general preference/avoidance for ending digits of age is mainly driven by the cultural tradition and custom, which are difficult to change, the age preference/avoidance at the same age or same digit is generally comparable between adjacent censuses when the censual interval is relatively short. (e.g., less than 20 years). Second, when the censual interval is exactly 10 years, unless ACAR is adjusted by the size of the birth cohort, the utility of this method could be weakened. However, in this case, the method is yet helpful to examine the consistency of age registration and reporting in multiple censuses. Third, when using the cohort age ratios to identify the preference/avoidance of the ending digits of age, it is ideal to combine with the period age ratios, and if possible, it is also good to adjust the cohort age ratios by the number of births of the cohort if such data are available and relatively reliable (Equation 1a). Otherwise, it may be difficult to clarify whether there really exists digit preferences or digit avoidances in age-reporting. Fourth, the criterion used for assessing the levels of a preference/avoidance in the present study is quite arbitrarily. We suggest using a combination of criteria of different age ratio methods to determine the level of age heaping in the study population(s). A systematic examination using various data sources with the known quality (e.g., data from human mortality database) is also warranted to shed light on this issue. Fifth, the average age ratio is not reliable, especially after age 90, when population numbers vary greatly across ages. Other methods are thus needed for analyzing and detecting age heaping in age-reporting among older and very older people. Sixth, as the preference/avoidance of a certain age may be a response to certain policies and the preference for a certain ending digit of age may mainly come from customs, it is recommended to pay attention to both situations when investigating age heaping. Seventh, the large scale of international migration in some countries may produce a bias in detecting the digit preference in age-reporting in censuses if such migration is not evenly distributed across ages. This makes up a challenge to assess the age heaping in such countries. This is also the case for examining the age heaping in sub-national populations when domestic migration is relatively large.

Our approach presented in this study uses age ratios calculated from five adjacent ages. To test its statistical sensitivity, we also examined the situations of three, seven, and nine adjacent ages. The tests produced similar outcomes and supported the effectiveness and robustness of age ratios based on five adjacent ages. Furthermore, besides the census data as illustrated in the current study, the method can also be applied to data obtained from vital registration or even surveys if its coverage and representativeness are adequate.

In sum, APAR and ACAR are likely good alternative methods for the traditional or the modified Whipple's Index to study the digit preference/avoidance in age reporting. Both the APAR and ACAR methods can be applied to ages beyond adulthood ages used by the Whipple's Index as long as the population changes are smooth. If APAR is adjusted by the size of birth cohorts, it would better reflect ending digit preference in age-reporting. ACAR could also be used to test the consistency of age registration/reporting across multiple censuses if the birth registration data quality is reasonably good. However, the limitations of this method abovementioned still suggest a need for new and better methods for examining the age heaping.

Authors' Contributions

DG designed the study, performed the analysis, drafted, and revised the manuscript. QF revised the manuscript and interpreted the results.

Conflicts of Interest and Funding

None.

Ethics Approval

Not applicable – this study used secondary aggregated data from publicly available census tabulations.

Disclaimer

The views expressed in this paper are solely those of the authors and do not reflect those of the United Nations and the National University of Singapore.

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Appendix

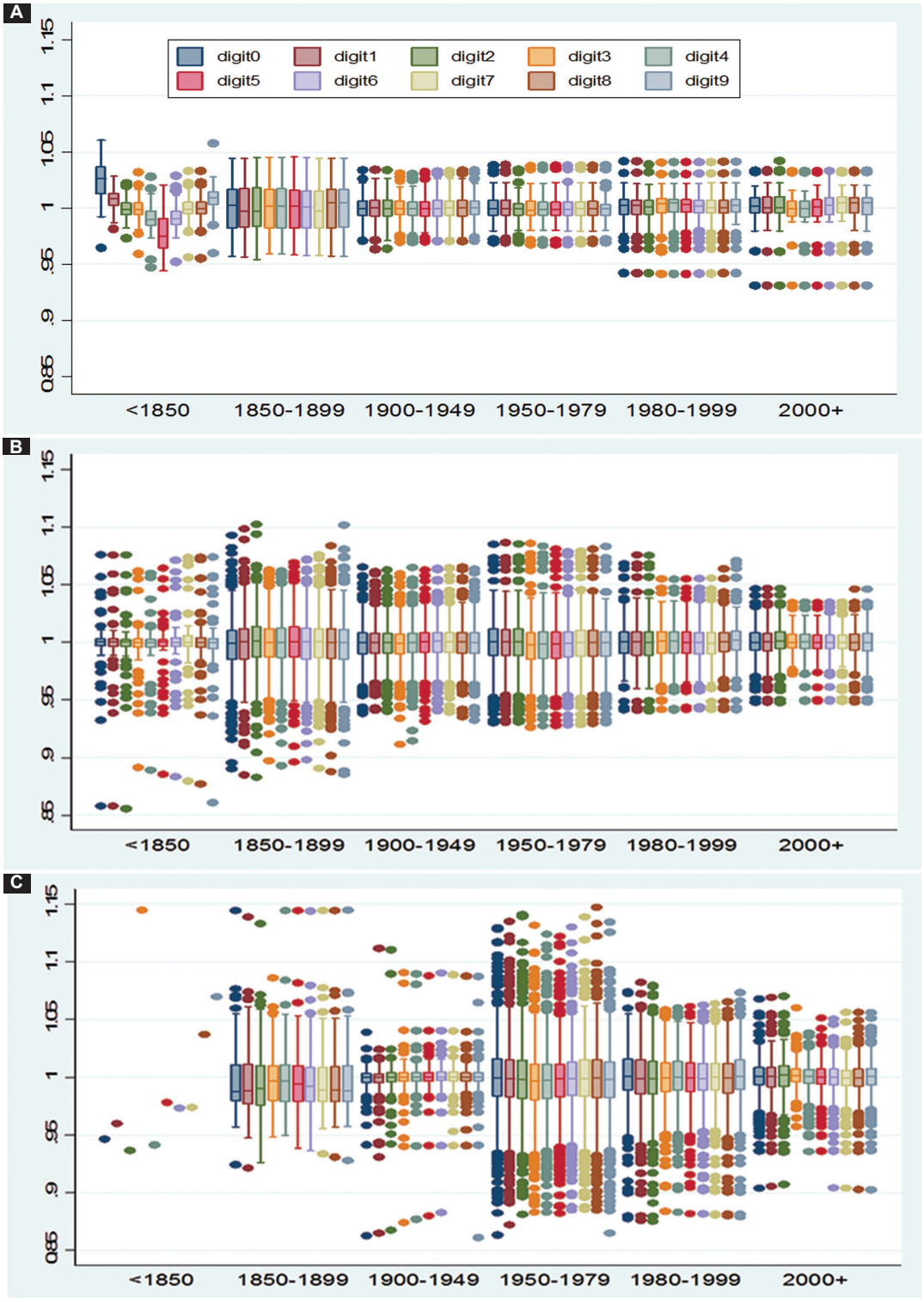

Figure A. Distribution of age period average ratio (APAR) by periods for Human Mortality Countries. (**A**) Two countries with the best demographic data quality (Japan and Sweden), (**B**) Eleven countries with the very good demographic data quality*, (**C**) Remaining HMD countries (twenty 25)

Note: *11 countries with good data (excluding Sweden and Japan, two countries with best quality of demographic data) were from Thatcher, Kannisto and Vaupel (1998).

Table A. Comparison of the average period age ratio (APAR) and the Whipple Index (WI) for ending digits of age among male populations in Sweden and Japan in selected years

	Ending digits of age										100*Total Dev.
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	
Sweden, 1800											
APAR	1.031	1.006	0.990	1.001	0.991	0.974	0.997	0.991	0.997	1.012	11.270
WI	1.034	1.008	0.988	1.003	0.990	0.974	0.998	0.987	0.996	1.014	12.523
APAR-WI	-0.003	-0.002	0.002	-0.002	0.001	0.000	-0.001	0.004	0.001	-0.002	-1.253
Sweden, 1900											
APAR	1.016	0.964	0.977	0.996	1.004	1.032	0.999	0.978	0.992	1.021	16.779
WI	1.017	0.961	0.976	1.001	1.005	1.024	0.999	0.978	0.993	1.018	15.707
APAR-WI	-0.001	0.003	0.001	-0.005	-0.001	0.008	-0.000	-0.000	-0.001	0.003	1.072
Sweden, 2010											
APAR	0.994	0.992	1.005	1.006	1.006	1.007	0.999	0.996	0.990	0.997	5.536
WI	1.017	1.036	1.038	0.965	1.004	1.014	1.007	0.997	0.989	0.996	5.863
APAR-WI	-0.021	-0.044	-0.033	0.041	0.002	-0.007	-0.008	-0.001	0.001	0.001	-0.327
Japan, 1960											
APAR	0.983	1.006	1.039	0.973	0.970	1.000	0.996	0.997	1.004	1.014	14.525
WI	0.991	1.022	1.053	0.965	0.962	1.000	1.000	1.002	1.008	1.008	17.751
APAR-WI	-0.008	-0.016	-0.014	0.008	0.008	0.000	-0.004	-0.005	-0.004	0.006	-3.226
Japan, 2010											
APAR	1.015	1.032	1.034	0.967	1.005	1.014	1.006	0.996	0.988	0.996	15.856
WI	1.017	1.036	1.038	0.965	1.004	1.014	1.007	0.997	0.989	0.996	16.901
APAR-WI	-0.002	-0.004	-0.004	0.002	0.001	0.000	-0.001	-0.001	-0.001	0.000	-1.045

Note: (1) Data were from the Human Mortality Database (https://www.mortality.org/). Only populations aged 21-64 were used in calculating these two indicators. (2) Total Deviation is calculated as sum of the absolute difference between each ratio (Index) and 1 over all ending digits, multiplying by 100. In the case of APAR, the total deviation is also called the Total Period Age Concentration Index (*ToPACI*).

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RESEARCH ARTICLE

Maternal mortality and fertility in Myanmar: State of the art

Myint Myint Wai[1,2]*, Espen Bjertness[2], Thein Thein Htay[1], Tippawan Liabsuetrakul[3], Johanne Sundby[2]

[1]Ministry of Health and Sports, Myanmar
[2]Department of Community Medicine and Global Health, University of Oslo, Norway
[3]Epidemiology Unit, Faculty of Medicine, Prince of Songkla University, Thailand

Abstract: Many women in developing countries are dying from preventable causes related to pregnancy and childbirth. These maternal deaths are attributed to the poor coverage of reproductive health services and high fertility levels. A holistic review of the reproductive health is necessary to reflect the country's situation and progress of reproductive health and provide recommendations for areas that need an improvement. The aim of this paper is to provide an overview of the historic development of maternal mortality and fertility in Myanmar during the past 25 years, focusing on the antenatal care (ANC) coverage, deliveries attended by skilled persons, and contraceptive use. All published nationally representative data were compiled, and trend analysis was performed. The maternal mortality ratio declined significantly by 9.1 (95%CI: 4.0-14.1) maternal deaths per 100,000 live births/year between 1990 and 2015, but it failed to achieve the target of Millennium Development Goals 5. There was no significant improvement in ANC coverage and care during delivery. Contraceptive use increased significantly, leading to a reduction in the total fertility rate. Nevertheless, overall reproductive health failed to reach a satisfactory level. Maternal mortality still remains high. Thus, there is a need to improve service coverage and more so in the regions with poor performance to reduce the high maternal mortality.

Keywords: *Maternal mortality ratio; Total fertility rate; Reproductive health services; Millennium Development Goals; Myanmar; Antenatal care; Skilled birth attendants*

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***CORRESPONDING AUTHOR**

Myint Myint Wai,
Department of Medical Services, Ministry of Health and Sports, NayPyiTaw, Myanmar.
m.m.wai@medisin.uio.no, mmwai2011@gmail.com

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1. Introduction

Maternal mortality is considered as an indicator representing the status of women in society and the overall health of the population and also reflects the functioning of the health system (World Health Organization [WHO], 2006). The most common indicator used to measure maternal mortality is the maternal mortality ratio (MMR); the number of maternal deaths per 100,000 live births (WHO, 2006). Total fertility rate (TFR) is an important demographic indicator closely associated with maternal mortality (WHO, 2006), as high levels of fertility increase the lifetime risk of dying from maternal causes (WHO, 2015a). TFR refers to the average number of births a woman would have if she lives all her reproductive years; age 15-50 (WHO, 2006). TFR is a good summary measure for comparison between countries, population subgroups, or trends over time (WHO, 2006).

Globally, many women die from preventable causes related to pregnancy and childbirth (WHO, 2018a). Majority of these maternal deaths occur in developing countries, and about one-third of global maternal deaths are in the Southern Asia region (WHO, 2018a). Global movements to combat high maternal mortality in developing countries were formally established at the time of launching of the safe motherhood initiatives in the 1980s (AbouZahr, 2003). The program of action adopted at the International Conference on Population and Development (ICPD) in 1994 reinforced safe motherhood activities to promote the women's health (United Nations Population Fund [UNFPA], 2014). Reduction of maternal mortality was also stipulated in the Millennium Development

Goals (MDGs), which later encompassed reproductive health rights by affirming universal access to reproductive health services (WHO, 2015a).

Despite global initiatives and country-led activities to reduce maternal deaths by improving antenatal care (ANC) coverage, deliveries attended by skilled persons and contraceptive use, maternal mortality is still a leading cause of death in women of reproductive age worldwide (WHO, 2015a). Although the global coverage of deliveries by skilled birth attendants (SBA) has increased; more than 40% of deliveries in the WHO African and Southeast Asia regions were not attended by a skilled person (WHO, 2016a). In 2015, only 40% of all pregnant women in low-income countries had the recommended ANC visits (WHO, 2018a). Although the global contraceptive prevalence rate (CPR) increased, 214 million of women of reproductive age in developing countries who want to avoid pregnancy are not using modern contraceptives (WHO, 2018b).

Since the onset of the primary health-care concept, Myanmar has paid attention to maternal and child health as an essential component of the health-care system (Ministry of Health, 2014). The very first objective of the Myanmar National Population Policy, which was drafted in 1992, is to improve the health status of women and children (MCH section, 2014). With the National Population Policy acting as a guiding framework, the Myanmar Reproductive Health Policy was established in 2002. That policy was developed in line with stipulations outlined in the ICPD program of action and targets of the MDGs (MCH section, 2014). These political commitments led to the formulation of Strategic Plans on Reproductive Health (2004-2008, 2009-2013, and 2014-2018) (MCH section, 2014). Myanmar is also one of the family planning (FP) 2020 focused countries, and as such a costed implementation plan to FP 2020 commitments was adopted in 2014 (Department of Public Health, 2015a) and implemented. Nonetheless, Myanmar is one of the countries in the WHO Southeast Asia region, which failed to attain the MDG 5 target.

The implementation status and progress of health services including the aforementioned plans and commitments are routinely assessed by a monitoring system. A Health Management Information System (HMIS) was established since 1995 for routine monitoring, which started with an essential set of indicators and reviewed and revised according to the country's needs (Ministry of Health and Sports, 2017a). Service coverage indicators for reproductive health such as ANC and SBA and contraceptive prevalence are encompassed within this HMIS. While MMR and TFR are routinely stated in the statistical yearbooks of Central Statistical Organization (CSO), some other distinct surveys have also been conducted in the field of reproductive health, which provides estimates that reflect the reproductive health status of women at specific time periods and enabling the policymakers to evaluate the progress.

Although the reproductive health data are available from various sources, a holistic and comparative review of all the available data to reflect the country's overall situation and progress has yet to be done. An analysis of data sources and gaps published in 2010 compiled the data from different surveys (Ministry of National Planning and Economic Development and UNDP, 2010), but did not include the routine administrative data. Thus, this paper aims to provide a comprehensive overview of the historic trends of maternal mortality and fertility in Myanmar from 1990 to 2015/2016, focusing on the coverages of ANC and SBA and CPR. We aim to review the progress made in the past decades by critically exploring and comparing all the available national representative data, which are nationally or internationally published.

2. Method

The variables, MMR, TFR, total marital fertility rate (TMFR), ANC coverage, percentage of deliveries assisted by SBA, and CPR, were selected for presentation in this paper. These maternal and reproductive health (MRH) indicators were accessed through the online sources of MOHS and the Department of Population, and CSO Myanmar. The online sources of the United Nations Organizations: The WHO, UNFPA, United Nations Children Fund (UNICEF), United Nations Population Division (UNPD), and United Nations Development Programme (UNDP) were also reviewed to gather the Myanmar country data. Nationally representative published data of the selected indicators in the past three decades were compiled to present the trends in maternal mortality and fertility through analysis of service coverage indicators in Myanmar.

First, the MMR of Myanmar was assessed from "Health in Myanmar 2014," which was published by the Ministry of Health. Other data sources were followed through the sources and references of Health in Myanmar using a snowball approach. Thus, we visited the websites of the Department of Population and CSO Myanmar to get maternal mortality and fertility data. The online sources of UNFPA, UNICEF, UNPD, and UNDP also provided Myanmar country data from the nationwide surveys which conducted in past decades. United Nations' estimates of maternal mortality for Myanmar were gathered from the Global Health Observatory data: Maternal mortality country profiles on the WHO website.

Second, coverages of ANC and delivery care, prevalence of contraception, and fertility estimates were assessed using data from the 2001 and 2007 reports of Fertility and Reproductive Health Surveys (FRHS) by UNFPA, Integrated

Household Living Condition Assessment (IHLCA) I and II (2005 and 2010) by UNDP and Multiple Indicators Cluster Survey (MICS 2009-2010) by UNICEF. A series of public health statistics reports (2012-2016) of MOHS that provide data from the routine reporting system (HMIS) of the ministry were also used to estimate these indicators.

Finally, the most recent estimates of all these indicators are compiled from the 2014 Myanmar Census (from the Department of Population website) and the Myanmar Demographic and Health Survey 2015-2016 (from the MOHS web page).

To obtain a comprehensive overview of the trend of each indicator, a trend analysis was applied for each indicator, and the statistical significance of the progress was shown with regression analysis (at 95% confidence interval). Correlation between the impact indicators and the service coverage indicators was also tested.

3. Findings

3.1. Maternal Mortality

MMR in Myanmar varied across different data sources. All the MMR data collected were compiled and are presented in Figure 1 with different sub-groupings.

According to the CSO reports, MMR fluctuated from 110 to 165/100,000 live births between 2001 and 2013 (Central Statistical Organization [CSO], 2012; 2016); but it rose to 223 in 2014 (CSO, 2017). As the data are based on the Vital Registration and Statistics (VRS) system, it thus depends on the reporting status. Even though the VRS system covered all the urban and rural areas in 2009, reports were available from only 314 of the 325 urban units and 281 of the 292 rural townships (units) in 2009 (CSO, 2012). The incomplete reporting can be partly attributed to the lower MMR reported in the CSO data.

We found two mortality surveys had been conducted during 1999-2005 indicated a higher MMR. A National Mortality Survey was conducted in 1999 by the CSO and reported an MMR of 255: One hundred and seventy-eight for urban areas and 281 for rural areas (CSO, 2012). The second one, a cause-specific maternal mortality survey, undertaken in 2004-2005 by the Ministry of Health in collaboration with UNICEF reported an even higher MMR of 316/100,000 live births (WHO-Myanmar, 2014). After lacking of nationwide maternal mortality survey data for nearly a decade, the 2014 Myanmar Census tried to provide reliable estimates on MMR (Department of Population, 2016a). According to the Thematic Report on Maternal Mortality (2014 Myanmar Census), MMR was 282 per 100,000 live births, with 95% confidence interval (CI)of 176-387 (Department of Population, 2016a).

Another data source, UN estimates of MMR for Myanmar were also presented as the UN inter-agency group produced estimations and calculations based on similar available country's data. Regarding the UN estimates, Myanmar had made a significant progress in reducing maternal mortality as indicated by the downward trend in MMR with 60.7% change between 1990 and 2015 (WHO-SEARO, 2016), revealing annual rate of reduction by 3.7% (95% CI: 1.6-5.3%) (WHO, 2018c).

In this context, trend analysis for MMR was applied to MMR estimates of UN inter-agency group and the 2014 Myanmar census. The surveys data are not included in this trend analysis, because the UN inter-agency estimation already

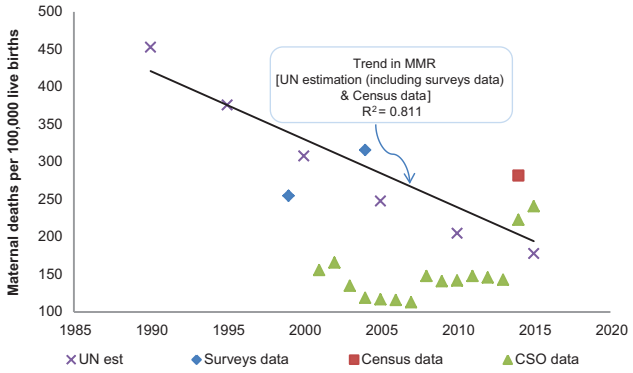

Figure 1. Maternal mortality ratio in Myanmar (1990-2015).

Data Sources: The routine Central Statistical Organization estimates were from the Statistical Yearbook Myanmar 2010, 2016, and 2017; the UN estimates were from the Global Health Observatory data: Maternal mortality country profiles; the survey data were from the Statistical Yearbook Myanmar 2010 and WHO Country Cooperation Strategy (2014-2018); and the census estimate from the Thematic Report on Maternal Mortality of the 2014 Myanmar Census.

incorporated these data in the estimation process (WHO, 2018c). The regression analysis showed that the MMR was significantly reduced by 9.1 maternal deaths/100,000 live births/year (95%CI: 4.0-14.1). Despite a reduction in MMR to reach 178/100,000 live births (uncertainty interval 121-284) in 2015, Myanmar failed to meet the MDG 5 target set at 113/100,000 live births (WHO-SEARO, 2016; WHO, 2015b).

The cause-specific maternal mortality survey conducted in 2005 reported the main causes of maternal deaths in Myanmar as postpartum hemorrhage 31%, hypertensive disorders of pregnancy, including eclampsia 17%, and abortion-related mortality 10% (WHO-Myanmar, 2014). Similarly, a maternal death review in 2013 reported that 38% of maternal deaths were due to postpartum hemorrhage, followed by pregnancy-induced hypertension 21% and abortion 12% (Maternal and Reproductive Health Division, 2014). Majority of these maternal deaths can be prevented by proper care during pregnancy and delivery by a skilled professional, and by timely management and referral.

3.1.1. Care during pregnancy

The ANC coverage data were grouped into two: One from the routine reporting (HMIS data) and the other from various surveys (Figure 2). Country improvements in service coverage, including ANC coverage, have been a success factor for a global reduction in maternal mortality (WHO, 2015a). Similarly, Myanmar shows a negative correlation (r=−0.66) between maternal mortalities (MMR of UN estimates) and ANC coverage (survey data).

Although Figure 2 indicates an upward trend in the ANC coverage, the improvement is not statistically significant with the surveys data. Moreover, the ANC coverage indicated in Figure 2 only represented ANC 1, i.e., receiving ANC with a skilled provider at least once during pregnancy.

The FRHS included the proportion of women having three ANC visits and above; the proportion increased from 62% to 73% between 1997 and 2007 (Department of Population and UNFPA, 2002; 2009). The more recent 2015-2016 Myanmar Demographic and Health Survey (MDHS) reported that the ANC coverage with at least one visit (ANC 1) was 80.7%, but the coverage of four ANC visits or above (ANC 4+) was only 58.6% (Ministry of Health and Sports and Inner City Fund (ICF) International, 2016; Ministry of Health and Sports, 2017b). The difference between ANC 1 and ANC 4+ was more prominent in rural areas (76.5% vs 50.8%) (Ministry of Health and Sports and ICF International, 2016; Ministry of Health and Sports, 2017b).

More importantly, a noticeable number of women did not receive care during pregnancy: About 19% in 1997 and 13% in 2007 (Ministry of National Planning and Economic Development and UNDP, 2010; Department of Population and UNFPA, 2009). According to 2015-2016 MDHS, 12.8% of the pregnant women did not receive ANC by any provider with a marked urban/rural difference: About 4% versus 16% (Ministry of Health and Sports, 2017b).

The HMIS has provided ANC coverage data since 1996. According to data retrieved from the HMIS reports, a significant improvement in ANC 1 coverage has been made from <60% in 1996 to >85% in 2016 (P<0.001). The ANC 4+ coverage is only available from 2012. The ANC 4+ coverage slightly increased from 67% in 2012 to 72.3% in 2016 with no significant improvement (Department of Health Planning, 2014; Department of Public Health, 2015; 2017).

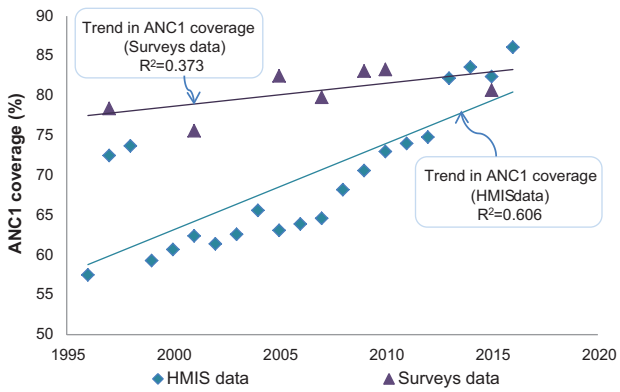

Figure 2. Trends in antenatal care 1 coverage.

Data Sources: Health Management Information System data included estimates from Public Health Statistics reports (2012, 2013, and 2014-2016); surveys data included estimates from Fertility and Reproductive Health Surveys (2001 and 2007), Integrated Household Living Conditions Survey (2009-2010), Multiple Indicator Cluster Survey (2009-2010), and Myanmar Demographic and Health Survey (2015-2016).

3.1.2. Delivery care

During the MDG era, the MMR decline in the Southeast Asia region was occurred in line with improvements in the proportion of deliveries attended by SBA (WHO-SEARO, 2016). The reduction of MMR in Myanmar also found together with increased SBA coverage (correlation coefficient; r=−0.76 between MMR [UN estimates] and SBA coverage [surveys data]).

The percentage of deliveries attended by skilled providers increased in the reviewed period (Figure 3). The SBA coverage as indicated in the routine HMIS revealed significant progress from 52% in 1996 to 78% in 2016 (Department of Health Planning, 2014; Department of Public Health, 2015; 2017). However, the progress measured in the surveys' data was not significant as the estimates are sparse around the (fitted) trend line. The series of FRHS reports show a gradual increase in SBA coverage 48% in 1991 to nearly 64% in 2007 (Department of Population and UNFPA, 2002; 2009). The 2005 and 2010 IHLCA gave higher estimates as 73% and 78%, respectively (Ministry of National Planning and Economic Development and UNDP, 2011). The 2009-2010 MICS data were in-between these estimates at 70.6% (Ministry of National Planning and Economic Development and Ministry of Health, 2011). Despite the high coverage reported in the earlier reports, the most recent 2015-2016 MDHS reveals a much lower coverage: Only 60% of deliveries had been attended by skilled persons, with a noticeably lower rate in the rural areas at 52.3% (Ministry of Health and Sports, 2017b).

On examination of the discrepancies between these estimates, we found that 40 selected clusters were not visited during the fieldwork of MICS because of inaccessibility due to security reasons. These sites were then replaced with other clusters of similar size. However, the situation in these new geographical areas is likely to systematically differ from the inaccessible areas (Ministry of National Planning and Economic Development and Ministry of Health, 2011). Thus, SBA coverage is more likely to be overestimated in the new areas when compared to the inaccessible areas, and as such, the overall average is exaggerated.

The IHLCA reports also show higher estimates of SBA coverage. The coverage could be exaggerated due to differences in the definition of a SBA, which varies nationally. In Myanmar, SBAs are defined to include doctors, nurses, lady health visitors (LHVs, who are experienced midwives [MWs] and supervisor of the MWs) and MWs (Ministry of Health and Sports, 2017b). The auxiliary MWs (AMWs) and traditional birth attendants (TBAs) are not included in SBA

On reviewing the survey reports with regard to their SBA definition; the IHLCA reports mentioned as "skilled personnel (doctor, nurse, or midwife), excluding TBAs" (Ministry of National Planning and Economic Development and UNDP, 2007. p. 28). The IHLCA report did not mention regarding the role of the AMW, and if AMWs were considered as SBA; the estimates for ANC and delivery by SBA tend to show a higher coverage than other reports.

Not only are deliveries supposed to be assisted by skilled persons but also the place of delivery is important to ensure safe delivery. In Myanmar, the percentage of deliveries at a health facility is much lower than that of delivery by SBA: More worsening in rural areas. According to the 2009-2010 MICS, the percentage of delivery in a health facility was 36.2% (65.2% urban vs 24.5% rural areas), while the SBA coverage was 70.6% (Ministry of National Planning and Economic Development and Ministry of Health, 2011). Similarly, when the SBA percentage was 60.2% (urban 87.8% and rural 52.3%), the institutional delivery was 37.1%: About 70.1% in urban versus 27.6% in rural areas (Ministry of Health

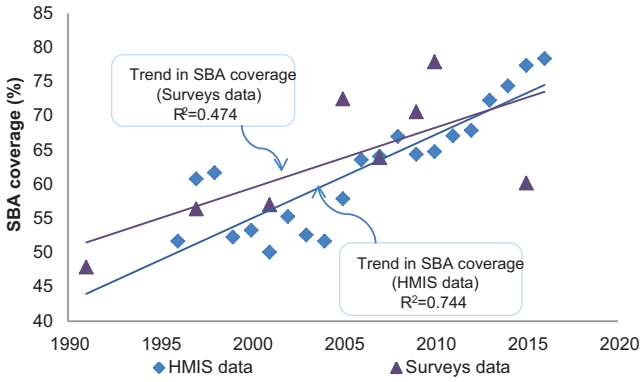

Figure 3. Trends in percentage of deliveries attended by skilled providers.
Data Sources: Health Management Information System data included estimates from Public Health Statistics reports (2012, 2013, and 2014-2016); surveys data included estimates from Fertility and Reproductive Health Surveys (2001 and 2007), Integrated Household Living Conditions Survey (2009-2010), Multiple Indicator Cluster Survey (2009-2010), and Myanmar Demographic and Health Survey (2015-2016).

and Sports, 2017b). Low institutional delivery percentages show that many births took place at home, those delivered by midwifery assistance include. It may be attributed to poor access to health facilities in rural areas due to long distances and a lack of appropriate facilities (Ministry of Health and Sports, 2017b).

3.2. Contraceptive Uptake and Fertility Decline

The inverse trend of CPR and TFR is presented in Figure 4. The contraceptive prevalence was the most promising indicator in Myanmar, showing significant progress both measured as any methods or as modern methods. Very low contraceptive use was observed in 1991 at 16.8% with only 13.6% of the women using modern methods (Department of Population and UNFPA, 2002). Furthermore, CPR continuously increased and did not vary much among different surveys. The trend lines are very steep with significant progress (P<0.01). The latest nationwide survey, MDHS 2015-2016 gave an estimate of CPR (any methods) as 52.2%, and CPR (modern methods) was estimated at 51.3%, showing a very low use of traditional methods (Ministry of Health and Sports, 2017b).

With an increased use of contraceptives, Myanmar has demonstrated a decreasing trend in fertility (correlation coefficient between TFR and CPR of any method=−0.71). The 1983 census revealed a TFR of 4.7 (urban 3.4 and rural 5.2), while the 2014 census reported a TFR of 2.5 (urban 1.9 and rural 2.8) (Department of Population, 2016b). Similarly, the 2015-2016 MDHS exhibited a TFR of 2.3 with 1.9 in urban and 2.4 in rural (Ministry of Health and Sports, 2017b). Despite this progress, it is important to note the TMFR. For a society like Myanmar, childbearing and contraceptive use is generally confined to married couples (Department of Population and UNFPA, 2009). At the time of the census in 2014, TFR was around 2.5, and TMFR stood at a much higher level of 5.0 (Department of Population, 2016b). The TFR and TMFR differed considerably in both urban: 1.9 versus 4.4 and rural areas: 2.8 versus 5.2 (Department of Population, 2016b).

In relation to contraceptive use, the problem of unsafe abortions should be put into consideration. As per the findings from the 2005 maternal mortality survey, approximately 10% of maternal deaths were from abortion-related causes (MCH section, 2014). Likewise, septicemia was the leading cause of maternal mortality in 2008, while septic-induced abortion as a result of unsafe abortions was a contributing factor (MCH section, 2014). In spite of the increased trends in contraceptive use among Myanmar women, a considerable amount of unintended pregnancies end up in unsafe abortions and contributing to maternal mortality.

3.3. Regional Variation in Maternal Mortality and Fertility

Even with the existence of some controversy and discrepancies, nationwide surveys and reports provide sufficient information to present the variation in MRH indicators with temporal trends. Moreover, the 2014 Myanmar Census and the very first Myanmar Demographic and Health survey 2015-2016 provided stronger evidence to reflect the reproductive health situation up to the sub-national level. The MRH indicators with variations among different States and Regions are summarized in Table 1.

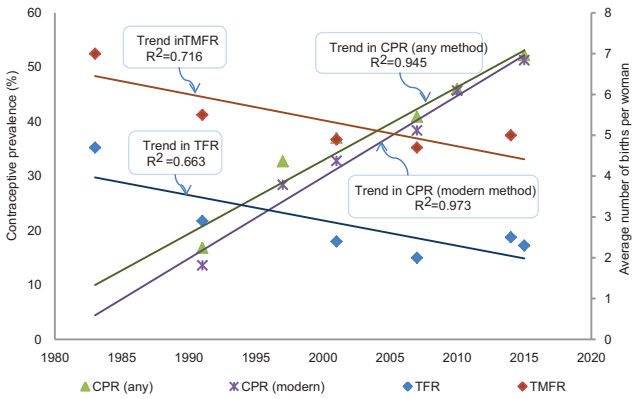

Figure 4. Trends in total fertility rate and total marital fertility rate and contraceptive prevalence of modern and any methods.
Data Sources: Contraceptive prevalence rate (CPR) (any) and CPR (modern) included estimates presented in Fertility and Reproductive Health Survey reports (2001 and 2007), Multiple Indicator Cluster Survey (2009-2010) and Myanmar Demographic and Health Survey (2015-2016). TFR and TMFR included estimates presented in FRHS reports (2001 and 2007) and Thematic Report on Fertility and Nuptiality of the 2014 Myanmar Census.

Table 1. Regional variation in major indicators of reproductive health in Myanmar.

Residence/ State/Region	MMR	TFR	CPR	ANC with SBA (ANC 1)	ANC with SBA (ANC 4+)	% of Delivery by SBA
UNION	281.6	2.51	51.3	80.7	58.6	60.2
Urban	192.5	1.91	57.3	94.9	84.2	87.8
Rural	309.7	2.78	49.1	76.5	50.8	52.3
Kachin	269.7	3.04	41.6	80	58.3	63.7
Kayah	276.1	3.51	50.6	93.3	68.8	53.2
Kayin		3.37	39.5	71.7	52.7	49.6
Chin	356.7	5	25.2	73.5	39.9	35.6
Sagaing	271	2.45	51.1	84.8	54.4	65.3
Tanintharyi	157.1	3.31	43.3	80.6	60.3	65.3
Bago	315.6	2.36	60.1	79.5	58.1	62.9
Magway	343.6	2.29	45.4	82.5	57.1	68.4
Mandalay	279.7	2.12	55.3	85.4	67	78.7
Mon	216.9	2.52	44.6	93.2	63.4	66.8
Rakhine	314.3	2.76	36.9	71.1	40.3	29.7
Yangon	213.3	1.85	60.2	94.6	84.6	82.5
Shan	278.3	3.07	46.1	68.1	46.9	46.7
Ayeyawady	353.7	2.81	55.4	78.3	57.2	50
Nay Pyi Taw	198.1	2.42	54.7	78.9	56.1	66.5
	<270%	<2.5%	>50%	>80%	>60%	>65%
	270-300%	2.5-3.0%	40-50%	75-80%	50-60%	50-65%
	>300%	>3.0%	<40%	<75%	<50%	<50%

Data Sources: Maternal mortality ratio and total fertility rate from the 2014 Myanmar Census; contraceptive prevalence rate, antenatal care and skilled birth attendants from Myanmar Demographic and Health Survey (2015-2016).

In general, the regions with low coverages of ANC and delivery by SBA tend to have a high MMR. More importantly, the above-presented data indicate the country situation at the end of the MDG era, forming the reference for monitoring the progress of Sustainable Development Goals (SDGs).

4. Discussion

Although Myanmar could not meet the MDG 5 target, the maternal mortally ratio was significantly reduced during the MDG era with regard to improvement of ANC coverage, CPR, and deliveries by SBA.

Myanmar country data on MMR were diverged across the data sources. The country civil registration and vital statistics (CRVS) system reported a lower MMR. The low MMR can be attributed to underreporting, as the reporting status was incomplete. And on reviewing the mortality surveys' data, the MMR was increased between the two surveys. These national mortality surveys attempted to provide MMR estimates on different periods and conducted by different agencies, but the comparability is uncertain as we could not obtain full information on the methods used for model estimation in each survey. However, the MMR estimates from these two national mortality surveys are included in the analysis for estimation of MMR by UN inter-agency group (WHO, 2018c). Regarding the census data, the Thematic Report on Maternal mortality (2014 Census) has provided some explanation for discrepancies between data sources. The estimation of the maternal mortality data presented in the World Health Statistics was undertaken by UN inter-agency group: WHO, UNICEF, UNFPA, the World Bank, and UNPD (WHO, 2015b). The estimations were carried out based on a classification of countries into having complete and reliable data, having incomplete or deficient data, and countries with no data (Department of Population, 2016a). As Myanmar belongs to the latter, the estimation had to be done using a set of covariates: Gross domestic product per capita, general fertility rate (live births per woman aged 15-49), and skilled attendants at birth as a proportion of live births (Department of Population, 2016a). The national mortality surveys data are also encompassed in the analysis (WHO,

2018c) and the random intercepts effects for countries, and regions are incorporated in the model estimates (Department of Population, 2016a). On comparing MMR, the UN estimation for 2013 was 200 per100,000 live births with a range of uncertainty from 120 to 350, and MMR of the 2014 Myanmar Census was 282/100,000 live births (95% CI: 176-387). Each estimate was found to be within the range of the other, and the difference between these two estimates was considered as not being statistically significant (Department of Population, 2016a). Thus, a trend analysis was applied to the UN estimates and the 2014 census data, which reveals a significant reduction of MMR in Myanmar.

This significant decline in maternal mortality is believed to be as a result of improvements in the coverage of reproductive health services: Care during pregnancy and delivery care by skilled health providers. Receiving ANC with a skilled person helps the women to seek services for and understand the warning signs during pregnancy and childbirth (UNICEF, 2018). Although ANC 1 coverage did not show a significant improvement, it reached the commitment expressed in the Five-year Strategic Plan of Reproductive Health (2014-2018) to attain 80% ANC coverage (MCH section, 2014). However, the ANC coverage of four visits and above (ANC 4+) was still very low, more pronounced in the rural areas as only half of the pregnant women had ANC 4+. There is a need for improvement. The WHO recommends a minimum of four ANC visits; and the recommended visits are now moving to eight contact points (WHO, 2016b). In addition to the number of visits, the correct timing of ANC attendance and the quality ANC is equally important.

Another indicator closely related to MMR that is also included in SDG targets (target 3.1.2) is the proportion of births attended by skilled health personnel. The SBA coverage in Myanmar increased to a certain extent, but did not show any significant progress and is yet to reach a satisfactory level. The Five-year Strategic Plan of Reproductive Health (2014-2018) had a target of ensuring the SBA assisted 80% of deliveries. However, the 2015-2016 MDHS reported only 60% coverage (MCH section, 2014; Ministry of Health and Sports, 2017b), and many of these deliveries did not take place in health facilities. Among the women delivered by SBA, 70% of urban women gave birth at health facilities, whereas 70% of rural women delivered at home (Ministry of Health and Sports, 2017b). The role of the enabling environment for institutional delivery has come into attention, especially in rural areas. Along with increasing institutional deliveries, some health facilities are poorly staffed and not well equipped. These conditions encourage home deliveries by skilled providers in non-conducive environments; in case of pregnancy complications, there is a high likelihood of losing both the baby and the mother. An inequitable distribution of the health workforce is often seen, even in countries with high national health worker densities (WHO, 2017). Rural and hard-to-reach areas tend to be understaffed when compared to urban areas, thereby contributing a negative effect on the accessibility to the service (WHO, 2017). This is the reality also in Myanmar.

The contraceptive prevalence in Myanmar significantly increased, both for modern and any methods. Myanmar was able to reach the target set for FP 2020 commitments, i.e., to increase the CPR of modern methods to 50% by 2015, but still need to increase more to meet the target of CPR 60% and above by 2020 (Ministry of Health and Sports, 2017b). Even though all the reproductive health services are provided in an integrated manner to ensure the continuum of care; FP services are easier to provide into the community as women are at liberty to choose suitable contraceptive methods. Being a FP 2020 focused country also reinforces Myanmar toward universal access to FP and contraceptive services.

The improvement in contraceptive coverage also affects fertility level. Although the TFR of Myanmar did not significantly reduce on a yearly basis, it did show a decreasing trend and stood nearly at the same level as the global and regional averages (2.65 and 2.35) in 2015 (Department of Population, 2016b). However, TFR is not sufficient enough in reflecting the country's fertility situation; the TMFR which is twice that of TFR needs to be factored in as well. Increased age of first marriage and the relatively high proportion of young, unmarried women in Myanmar have also contributed to lower the average number of children per woman in the reproductive age (Department of Population, 2015).

In Myanmar, non-marriage generally results in a non-participation in reproduction; thus, the relatively high proportion of women who never married plays a significant role in the determination of fertility (Department of Population and UNFPA, 2009). According to the 2014 census, 12% of women in the age group of 50-54 were never married (Department of Population, 2016b). Furthermore, in the 2015-2016 MDHS, only 60% of women in the reproductive age group (15-49 years) were currently married; 14% of women in the age group of 45-49 were never married (Ministry of Health and Sports, 2017b). For the above-stated reasons, it is advisable to include the estimates on TMFR in future demographic and health surveys, as it was not reported in the recent MDHS.

Moreover, assessments of the fertility level in Myanmar have generally only included married women in the samples; with a consideration of the socio-cultural aspect. The same reasoning is applied to surveys on contraceptive use. On the other hand, even though contraceptive use increased among Myanmar women, many unintended pregnancies end up in unsafe abortions, which also is an important factor linked to maternal mortality. In Myanmar, abortion is legally restricted and only permitted to save the life of the woman (United Nations, 2014). This is not only the case from a legal point of view but also a cultural and religious perspective that constraints access to induced abortion.

The main challenge in analyzing and comparing reproductive health indicators from various reports is the inconsistency of the data. For example, ANC and SBA coverage data from the MICS report, as explained in the findings, and the definition of SBA in IHLCA reports are two recognizable examples which can produce different estimates. Fortunately, we get more reliable estimates at the end of MDG era, from the 2014 Myanmar Census and the 2015-2016 MDHS. Thus, all the indicators we presented were summarized in a table as the reliable estimates are available up to the sub-national level, and these can help to set priorities (WHO, 2006) by the program planners and implementers. For example, the regions having MMR of 50-250/100,000 live births indicates that problems may exist in the quality of care for labor/ delivery, while the region having MMR higher than 250/100,000 live births may also have problems in access to services (WHO, 2006).

These discrepancies among the data sources also demonstrate the need for a stronger health information system for the country. The current HMIS collects data starting from the most basic unit (township) up to the national level. This routine reporting also provides an input to the country's CRVS, which is being established to be a stronger monitoring system that strengthens the existing one. As of now, the Ministry is trying to strengthen the routine HMIS using an electronic reporting system, replacing the current routine reporting, which uses paper sheets. It started in 2014 as a pilot and was expanded yearly, covering two-thirds of the nation as at the end of 2016 (Department of Public Health, 2017). It would be better to cover the whole country, to reduce contradictions between the data of different reports and to obtain reliable estimates for monitoring of SDGs.

5. Conclusion

Although the MMR in Myanmar significantly declined in 1990-2015, it failed to reach a targeted low level. Myanmar still needs to improve reproductive health services to increase ANC coverage, deliveries by skilled persons, and institutional delivery. Although the contraceptive prevalence increased significantly in Myanmar giving a reduction in TFR; there is a need to factor in the total marital fertility, which has not decreased much. Moreover, the issue of unsafe abortions is another parameter highlighting the need for contraceptive services to improve more. Paying attention to in-country differences and focusing more on the geographical and service areas with poor MRH status is a challenge that should be taken head on to reduce maternal mortality**.**

Author's Contributions

Myint Myint Wai conceptualized the study framework, compiled the published data from different reports, performed analysis, and drafted the manuscript. Johanne Sundby conceptualized the study framework and gave intellectual inputs to find relevant information, interpret the data, and draft the manuscript. Thein Thein Htay and Espen Bjertness contributed to finding relevant information and interpretation of the data and information. Tippawan Liabsuetrakul contributed to interpretation of the data and information. All the authors have read and approved the final manuscript.

Ethics

The data were compiled from publicly available data sources.

Availability of Supporting Data

All data are secondary data from publicly available data sources.

Conflicts of Interest

No conflicts of interest to disclose.

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RESEARCH ARTICLE

Internal youth migration in Uganda: Analyzing associates and employment outcomes

Sandra Mirembe[1,2]*, Abel Nzabona[2], John A. Mushomi[2]

[1]Center for Population and Applied Statistics, Makerere University, Uganda,
[2]Department of Population Studies, Makerere University, Uganda

Abstract: Youth internal migration is seen as a solution to youth unemployment, and this has resulted in over urbanization and its associated negative effects such as congestion, pollution, unemployment, underemployment, and increased crime rates. The study aimed at examining the employment status of youth migrants, assessing the relationship between demographic factors and youth internal migration, investigating the association between socio-economic factors and youth internal migration, and evaluating the association between reasons for migration and migrant employment status. The study used secondary data collected in the youth employment and migration in Eastern and Southern Africa project. In Uganda, the project was carried out in nine districts. The study focused on both men and women aged 18-35 years and a total number of 1524 respondents were interviewed. Results of the study revealed that age, residence, and region had a significant association with migration status ($p \leq 0.05$). Age, sex, number of children, region, and reasons for migration had a significant association with self-employment status of the migrant ($p < 0.05$). Marital status, sex, and reasons for migration had an association with the possibility of a migrant youth being employed ($p \leq 0.05$). The study recommends that local governments should provide the required infrastructures, social services, and amenities to encourage youths to carry out economic activities so as to develop their places of origin.

***Keywords*:** Employment status; Migration associates; Social networks; Uganda; Youth internal migration

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***CORRESPONDING AUTHOR**

Sandra Mirembe,
Master of Arts in Demography, Researcher, Centre for population and applied Statistics (CPAS), Makerere University, Uganda.
mirembesannie@gmail.com

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1. Introduction

Youth is all young person's female and male aged between 18 and 35 years (The Government of Uganda, 1995). The study used Uganda's definition of youth. Youth is a stage of human development during which young people make the transition from childhood to adulthood and from dependence to independence and interdependence. This transition (social, economic, and biological) is fundamental to safeguarding, shaping, further developing, and deploying their human and social capital. It is during this period that youth make important decisions about their lives particularly their ethical, social, economic, cultural, political, and civic positioning and role – setting the stage for adulthood (United Nations, 2014).

On the other hand, migration is the movement of a person or group of persons from one geographical unit to another across an administrative or political border wishing to settle definitely or temporarily in a place other than their place of origin (United Nations, 2003). Migration comprises internal and international migration. Internal migration is movement within the same country, from one administrative unit, such as a region, province or municipality to another. Internal migration is usually in the form of Rural Urban Migration (RUM) or Urban to Urban migration. In contrast, international migration involves the crossing of one or several international borders resulting in a change in the legal status

of the individual concerned. International migration also covers movements of refugees, displaced persons, and other persons forced to leave their country (United Nations, 2003).

Today, the world has the largest youth generation in human history. There are 1.8 billion young people living on the planet with approximately 85% of them living in developing states (United Nations, 2019). The number of youth migrants has continued to grow rapidly over the past 15 years because migration has become one of the mechanisms through which most youths try to escape the vicious cycle of poverty as a result of the high unemployment rates in the area/country of origin. Youth migrants constitute a relatively large proportion of international migrants, and their movement has a significant impact on origin, transit, and destination countries or communities (United Nations, 2013). In addition to that, 30% of all migrants are between ages of 20 and 29 and female youth migrants account for approximately 50% of international migrant population (United Nations, 2013). Africa is the world's youngest continent, as the proportion of youth among the region's total population is higher than in any other continent. In 2010, 70% of the region's population was under the age of 30 (United Nations, 2011) and in 2015, 52% of the migrants were youth migrants (United Nations, 2016).

Uganda being a politically stable country has over the years been a host country for majority of the refugees especially those from neighboring war-torn areas. The country has the youngest population with 78% below 30 years (Uganda Bureau of Statistics, 2014). Ugandan young labor force is rapidly growing, and it almost doubled in the past decade from 4.2 million in 2005-2006 to an estimated 9.5 million in 2015 (Goldin, Hobson, Glick *et al*., 2015). In 2017, 16% of the population had lived in another place before their current residence. Of these, 18% were females and 14% were males. This means that more migrants are leaving their places of origin to new destination areas (Uganda Bureau of Statistics, 2017). On the other hand, unemployment and underemployment are big issues that youth in the country face. The overall unemployment rate stands at 9.4% and is particularly high among youth (60% of the unemployed) and those with higher levels of education. According to the Uganda National Planning Authority (NPA), the youth unemployment rate reaches up to 37.8% when including volunteers and unpaid family workers (National Planning Authority, 2015).

1.1. Rationale

Youth decisions have a significant impact not only on their own lives and opportunities for human development but also on the lives of their societies and communities, both in the short and long term. Youth migrants always find themselves in irregular situations and face situations of exploitation, trafficking, exclusion, and detention. Many youth migrants always find themselves in the so-called 3-D jobs (dirty, dangerous, and degrading) despite these youths being educated and having the required skills (United Nations, 2014). Youth migrants are more vulnerable to migration experiences that result in isolation, exclusion, and insecurity. They are in most cases affected by xenophobia, discrimination and suffer marginalization due to lack of fluency in the local language, new and different cultural norms, and insufficient information about laws and regulations in their new destination areas (United Nations, 2014).

Most studies on migration in Uganda have focused on the determinants of RUM and its consequences (Mutandwa, Taremwa and Uwimana *et al*., 2011; Stark and Bloom, 1985) while other studies (Thorat and Jones, 2011; Taylor, 1999; Ackah and Medvedev, 2012) have gone ahead to look at the benefits of remittances in socio-economic development of the countries of origin. A rich analysis of population migration in Uganda has focused on population redistribution with respect to Kigezi and Bugishu (Kabera, 1983), but the study did not isolate internal youth migrations, and a few studies have examined the associates of youth internal migration (Deotti and Estruch, 2016; Herrera and Sahn, 2013). Investigations about internal migration flow especially among the youth have been limited because of reliable data challenges and the fact that it has a less political connotation. Examination of internal mobility patterns including associates and employment outcomes is, however, essential as it provides information to policymakers in a bid to benefit from youth migration flows, as well as managing mobility costs and risks.

The main purpose of this study is to examine the associates of youth internal migration and how migration affected youth employment status in Uganda.

1.2. Theoretical Framework

The theoretical framework explaining individual-level factors of youth migration was based on propositions made by the pull and push theory of migration. According to the theory, globalization has changed the way people see the world. As people become more aware of living standards and lifestyles in other parts of the world, for example, through television or the stories (and sometimes wealth) of returning expatriates, their understanding of their "relative" poverty has increased, and their expectations have changed. This motivates people to migrate to secure greater income. There is also evidence

that young people, in particular, consider migration because they want to escape the drudgery of subsistence living and see "the bright lights of the big city." The theory considers pull and push factors to appear in both areas of origin and areas of destination. In the areas of origin the factors are called push factors, and in the areas of destination pull factors. In both types of areas, we speak for the same factors, but the social conditions in one area are favorable, and in the other area are not. They are connected through the economic, political, and war relations of the areas of origin and destination. At the same time, the root causes of migration – both licit and illicit – lay in the unstable political, social, and economic conditions in areas of origin. Other causes include rapid growth of the population, high unemployment, abject poverty, internal conflicts resulting in civil disorder and widespread violence, unstable or oppressive political regimes, and grave violations of human rights (Stanojoska and Petrevski, 2012).

The conceptual framework in Figure 1 shows that migration can lead to employment (in situations where a youth leaves the place of origin to a new destination area to look for work), or employment can lead to migration (in situations where a youth employee is being given work transfer to operate organization activities in another area) (Estruch, 2016). Individual demographic factors such as age, sex, and residence are hypothesized to affect migration and employment in such a way that females are in most cases constrained by social-cultural values to migrate and look for work because they are expected to stay at home to look after family members (Lakuma, Marty, and Kuteesa, 2016); youths aged above 30 years are more likely to migrate to look for work because they have family responsibilities to fulfill (Konseiga, 2005). On the other hand, urban youths tend to have contacts of their friends within the urban centers and other areas which help them to get information about the existing opportunities in other areas (Lakuma, Marty, and Kuteesa, 2016).

Socioeconomic factors such as marital status, highest education level, and reasons for migration are hypothesized to affect migration and employment (Lakuma, Marty, and Kuteesa, 2016). For example, the never-married youths are more likely to migrate to look for work because they are not constrained by their spouses in the places of origin (Gubhaju and Gordon, 2009). Economic reasons of a youth are more likely to drive a youth to migrant to look for work/set up small businesses in the new destination area while highly educated youths are likely to migrant to look for greener pastures in new destination areas because they have the contacts of the youths they have studied with and as well can access information through the media about the existing opportunities in other areas (Lakuma, Marty, and Kuteesa, 2016).

2. Data and Methods

2.1. Data Source

The study used secondary data collected in a survey of Youth Employment and Migration in Eastern and Southern Africa (YEMESA) coordinated by African Migration and Development Policy Centre (AMADPOC) in December 2017. The main objective of the survey was to enhance the understanding of how migration influences youth employment, self-employment, and entrepreneurship in Eastern and Southern Africa. In Uganda, the YEMESA project was carried out in

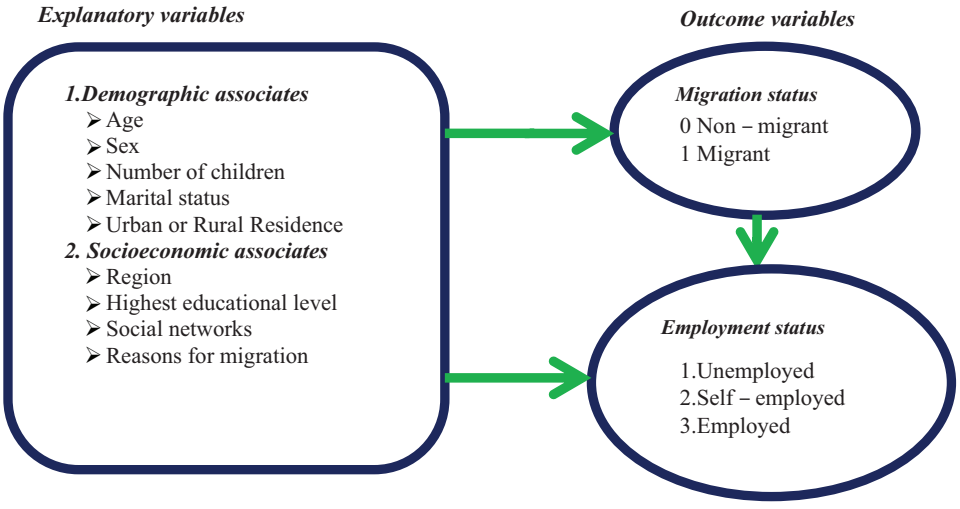

Figure 1. Conceptual framework for associates of youth migration and employment status.
Source: Adapted from Deotti and Estruch (2016) with permission.

nine districts. The study was conducted through face to face interviews. Age was the key inclusion/exclusion criterion whereby persons aged 18-35 were eligible for inclusion in the study. The study administered an individual questionnaire, which meant that members of the household who were present at the time of the interviews and were in the age range of 18-35 years would be considered in the study. A total number of 1148 migrants and 376 nonmigrants were considered in the study.

2.2. Study Design

The study considered four broad national regions (Central, East, North, and West) plus the capital city Kampala. From each region, two districts were selected at random. These were Masaka and Mubende (Central region), Busia and Mbale (Eastern region), Arua and Gulu (Northern region), and Mbarara and Hoima (Western region). Kampala the capital city was purposely selected as the ninth district due to its primate city status, destination of 4612 large in-migrants and prevalence of complex employment dynamics. Respondents were proportionally allocated to the nine districts factoring in the proportion of youths in each district as informed by the National Population and Housing Census. Simple random sampling was used to select the youths from each district for the interview. The study operationally considered youths to be persons aged 18-35 years and this population subgroup constitutes about 33% of the population in the selected districts. In addition, a total of 48 shortlisted enumerators and nine supervisors were ultimately recruited, trained, and deployed to collect the data. A pre-test was carried out in November 2017 followed by the main data collection exercise in the subsequent month. Both the pre-test and the main data collection exercises used computer-assisted personal interviewing method. Uploads of data were effected onto the server for survey chief technology officer – a digital platform used for data collection where information could be accessed in real time.

2.3. Outcome Variables

There are two dependent/outcome variables. The first (migration status) was a binary outcome (migrant vs. nonmigrant). In the YEMESA project, internal migration was captured by asking for the district in which the respondent was born. With such a question data pertaining to whether a person migrated or not was obtained. The second dependent variable was the current employment status of the migrants at the time of the interview with three outcomes: Employed, self-employed, and unemployed.

2.4. Explanatory Variables

The explanatory or independent variables were the individual-level factors which influenced migration status. These factors were divided into demographic and socioeconomic factors. The demographic factors included age, sex, marital status, and number of children. The socioeconomic factors considered were urban or rural residence, region, educational level, reasons for migration, and social networks. In the study, social network was defined as a network of social interactions and personal relationships with friends, relatives or coworkers. Reasons for migration included economic reasons for a better job, new business or higher income in destination; social reasons for better or new relations with relatives, friends or partner in the destination; and forced reasons where an individual unwillingly left the place of origin due to factors such as wars, insecurity, disease outbreak, hunger, and other environmental disasters.

2.5. Analytical Strategies

The univariate analysis involved the use of frequency distributions for the explanatory variables both demographic and socioeconomic factors as well as the outcome variables. Multivariable binary logit model was done to test which explanatory variables affected migration status among all the respondents. The multinomial logit model was adopted to assess whether migration status affected employment in the presence of other covariates and what factors associated with employment. The model used relative risk ratios (RRR), which mean that for a unit change in the predictor variable, the logit of an outcome relative to the reference group is expected to change by its respective parameter estimate given that the variables in the model are held constant. For this case, all variables included at bivariate analysis were included in the multinomial logit model. In the model, un-employed response was chosen as the comparison category.

3. Results

Results in Table 1 show that 75.3% of the sample were migrants, 46.0% were self-employed and 40.9% were employed. A majority (40.2%) of the sample were aged 23-27, 55.6% were males and 76.1% were coming from rural areas. Almost

Table 1. Background characteristics of the respondents (*n*=1524).

Variable	Number	Percentage
Migration status		
Nonmigrant	376	24.7
Migrant	1148	75.3
Current employment status		
Unemployed	200	13.1
Self-employed	701	46.0
Employed	623	40.9
Age		
18-22	462	30.3
23-27	612	40.2
28-32	323	21.2
33-35	127	8.3
Sex		
Male	848	55.6
Female	676	44.4
Residence		
Rural	1159	76.0
Urban	365	24.0
Number of children		
None	749	49.1
Have a child and more	775	50.9
Region		
North	326	21.4
East	250	16.4
West	269	17.7
Central	301	19.8
Kampala	378	24.8
Highest education level		
Primary education or lower	438	28.7
Secondary education or more	1,086	71.3
Marital status		
Currently married	411	27.0
Widowed/divorced	278	18.2
Never married	835	54.8
Social networks		
None	889	77.4
Social group	259	22.6
*Missing data	376	0.0
Reasons for migration		
Economic reasons	913	79.5
Social reasons	145	12.6
Forced reasons	90	7.8
*Missing data	376	0.0

Note: *Missing data on nonmigrants and the differences in totals are due missing data for nonmigrants.

half (50.9%) of the sample had a child, 71.3% had secondary or more education while 28.7% had primary or low-level educational attainment. More than half (54.8%) of the sample had never been married while only 27.0% were married. A majority (77.4%) of the sample did not belong to any social network, 79.5% of the migrants had left their places of origin due to economic reasons, and 24.8% of the migrants were residing in Kampala region.

3.1. Associates of Migration Status

The binary logistic regression model was run to assess the association between both demographic and socioeconomic individual-level variables with migration status, as shown in Table 2. Results in Table 2 showed that age, residence, and region had a significant association with migration status ($p<0.05$). With age, youths aged 23-27 had increased odds to be migrants as compared to those aged 18-22 (Odds Ratio [OR] = 1.4; 95% confidence interval [CI]: 1.0-1.8) and youths aged 33-35 had almost three more odds to be migrants compared to those aged 18-22 years (OR = 2.5; 95% CI: 1.3-4.5). In other words, the likelihood of youth being a migrant increased with the increase in a youth's age. Youths from urban areas had less odds to be migrants as compared to those from rural areas (OR = 0.4, 95% CI: 0.3-0.6) and youths from central region had more odds be migrants as compared to those from Northern region (OR = 1.0; 95% CI: 0.5-1.0). On the other hand, sex, number of children, marital status, and highest education level had no association with the likelihood of a youth being a migrant ($p>0.05$).

3.2. Association between Migration Status and Employment Status

The multinomial logistic regression model was run to assess the association between migration status and employment status. This association could not be tested with other individual level factors because of collinearity (Table 3). Results showed that migrant status had a significant association with self-employment because the risk of a youth being self-employed over being unemployed was higher for a migrant youth than a non - migrant youth (RRR = 1.4, 95% CI: 1.0-2.0). On the other hand, migrant status did not have any association with employed status of the migrant ($p>0.05$).

Table 2. Factors predicting migration status.

Migration status	Odds ratio
Age	
23-27 (18-22)	1.4 (1.0-1.8)*
28-32 (18-22)	1.5 (1.0-2.2)
33-35 (18-22)	2.5 (1.4-4.5)**
Sex	
Female (Male)	1.1 (0.9-1.5)
Residence	
Urban (Rural)	0.4 (0.3-0.6)**
Number of children	
Have a child and more (None)	0.9 (0.6-1.2)
Region	
East (North)	0.7 (0.5-1.1)
West (North)	0.7 (0.5-1.0)
Central (North)	1.0 (0.5-1.0)*
Kampala (North)	1.0 (0.7-1.4)
Marital status	
Widowed/Separated (Currently married)	1.2 (0.8-1.8)
Never married (Currently married)	0.9 (0.6-1.3)
Highest education level	
Secondary education or more (Primary education or lower)	0.6 (0.4-0.8)

(1) There were 1524 observations. (2) The category of a variable in the parentheses is the reference group of the variable. (3) ORs (odds ratios) in the parentheses are the 95% confidence intervals. All ORs were adjusted for covariates in Table 1. (4) *$p<0.05$, **$p=0.01$.

3.3. Associates of Employment Status

The multinomial logistic regression model was run to assess the association between both demographic and socioeconomic individual – level factors with employment status as shown in Table 4.

Results showed that age, sex, number of children, region and reasons for migration had a significant association with self-employment status of the migrant (p<0.05). Whereby, the risk of a youth being self-employed over being unemployed was 2 times higher for a youth aged 23-27 years than a youth aged 18-22 years (RRR = 2.0, 95% CI: 1.3-3.3), the risk of a youth being self-employed over being unemployed was 2 times higher for a youth aged 28-32 years than a youth aged 18-22 years (RRR = 2.3, 95% CI 1.2-4.4) and the risk of a youth being self-employment over being unemployed was almost four times higher for a youth aged 33-35 years compared to a youth aged 18-22 years (RRR= 3.5, 95% CI: 1.4-9.1). In addition, the risk of a youth being self-employment over being unemployed was lower for a female youth compared to a male youth (RRR=0.6, 95% CI: 0.4-1.0) and the risk of a youth being self-employed over being unemployed was almost two times higher for a youth who had a child and more compared to a youth who had no children (RRR= 1.8, 95% CI: 1.0-3.0). With region, the risk of a youth being self-employed over being unemployed was lower for a youth from Eastern region compared to a youth from Northern region (RRR= 0.5, 95% CI: 0.3-0.9). Lastly the risk of a youth being self-employment over being unemployed was lower for a youth who migrated due to social reasons compared to a youth who migrated due to economic reasons (RRR=0.4, 95% CI:0.2-0.7). On the other hand, residence, marital status, highest education level, and social networks did not have any association with self-employment status of the migrant youth (p>0.05).

Table 3. Association between migration status and employment status.

Migration status	RRR
Self-employed versus unemployment	
Migrant versus Non – migrant	1.4 (1.0-2.0)*
Employed versus unemployment	
Migrant versus Non – migrant	1.3 (0.9-1.8)

(1) There were 1,524 observations. (2) The category of a variable in the parentheses is the reference group of the variable. (3) RRRs (relative risk ratios) in the parentheses are the 95% confidence intervals. All RRRs were adjusted for covariates in Table 1. (4) *p<0.05.

Table 4. Factors predicting employment status.

Employment status	RRR
Self-employed versus unemployment	
Age	
23-27 (18-22)	2.0 (1.3-3.3)**
28-32 (18-22)	2.3 (1.2-4.2)*
33-35 (18-22)	3.5 (1.4-9.1)*
Sex	
Female (Male)	0.6 (0.4-1.0)*
Residence	
Urban (Rural)	0.8 (0.5-1.4)
Number of children	
Have a child and more (None)	1.8 (1.1-3.1)*
Region	
East (North)	0.5 (0.3-1.0)*
West (North)	0.7 (0.4-1.3)
Central (North)	0.8 (0.4-1.6)
Kampala (North)	0.9 (0.5-1.8)

(Contd...)

Table 4. (*Continued*)

Employed versus unemployed	
Marital status	
Widowed/Separated (Currently married)	1.5 (0.8-2.9)
Never married (Currently married)	0.7 (0.4-1.2)
Highest educational level	
Secondary education or more (Primary education or lower)	1.2 (0.8-1.8)
Reasons for migration	
Social reasons (Economic reasons)	0.4 (0.2-0.7)**
Forced reasons (Economic reasons)	1.0 (0.5-2.0)
Social networks	
Social group (None)	1.6 (1.0-2.7)
Employed versus unemployed	
Age	
23-27 (18-22)	1.4 (0.9-2.3)
28-32 (18-22)	1.1 (0.6-2.0)
33-35 (18-22)	1.2 (0.4-3.3)
Sex	
Female (Male)	0.6 (0.4-0.9)*
Residence	
Urban (Rural)	0.9 (0.5-1.4)
Number of children	
Have a child and more (None)	1.3 (0.8-2.2)
Region	
East (North)	0.7 (0.4-1.2)
West (North)	0.8 (0.4-1.5)
Central (North)	1.5 (0.8-2.7)
Kampala (North)	1.7 (0.9-3.1)
Marital status	
Widowed/Separated (Currently married)	2.2 (1.1-4.5)*
Never married (Currently married)	1.8 (0.9-3.3)
Highest educational level	
Secondary education or more (Primary education or lower)	1.6 (1.1-2.5)*
Reasons for migration	
Social reasons (Economic reasons)	0.5 (0.3-0.7)**
Forced reasons (Economic reasons)	0.8 (0.4-1.6)
Social networks	
Social group (None)	1.3 (0.8-2.3)

(1) There were 1,524 observations. (2) The category of a variable in the parentheses is the reference group of the variable. (3) RRRs (relative risk ratios) in the parentheses are the 95% confidence intervals. All RRR were adjusted for covariates in Table 1. (4) *p<0.05, **p<0.01.

In addition, sex, marital status, highest educational level and reasons for migration had an association with the possibility of a migrant youth being employed (p<0.05) whereby, the risk of a youth being employed over being unemployed was lower for a female youth compared to a male youth (RRR = 0.6, 95% CI:0.4-1.0), the risk of a youth being employed over being unemployed was two times higher for a youth who was widowed/separated compared to a youth who was currently

married (RRR=2.3, 95% CI:1.2-4.5). In addition, the risk of a youth being employed over being unemployed was higher for a youth who had acquired secondary education or more than a youth who had acquired primary education or lower and the risk of a youth being employed over being unemployed was lower for a youth who had migrated due to social reasons compared to a youth who had migrated due to economic reasons (RRR = 0.5, 95% CI: 0.3-0.7). On the other hand, age, residence, number of children, region and social networks did not have any association with the possibility of a migrant youth being employed (p>0.05).

4. Discussion

Results of the study showed that age is the only demographic factor that had a significant association with migration status. Whereby the likelihood of a youth being a migrant increased with the increase in a youth's age because youths aged 23-27 were 1.4 times more likely to be migrants as compared to youths aged 18-22 and youths aged 33-35 were almost 3 times more likely to be migrants as compared to youths aged 18-22 years. The study results are in support of the studies conducted by Bell and Muhidin (2009); Ackah and Medvedev (2012); Lakuma, Marty, and Kuteesa (2016) which found a positive association between age and migration status. This is true because usually young adults aged between 23 and 36 years, have completed tertiary education, are flexible, open minded, in good health and in most cases want to stabilize financially (for example, having their own house and a personal business which can raise daily income to take care of the day to day expenses of the household) (United Nations Department of Economic and Social Affairs, 2016). This makes it easier for them to look for opportunities elsewhere other than their original places of origin.

On the other hand, youths from urban areas were more likely to be migrants as compared to youths from rural areas. The results are in support of the study conducted by Ackah and Medvedev (2012); Lakuma, Marty, and Kuteesa (2016) which also revealed that there existed a significant association between place of residence and the possibility of someone being a migrant. The association exists because in most cases, youths residing in urban areas can easily have access to the social media and phone contacts which helps to maintain contacts of their friends with whom they had either worked or studied with. With such contacts, a youth migrant is able to get all the necessary information about the available opportunities, existing cultures and the language spoken in the proposed new destination area hence making movement easier (United Nations, 2013).

Youths from urban areas had fewer odds to be migrants as compared to those from rural areas and youths from central region had more odds to be migrants as compared to those from Northern region. On the other hand, sex, number of children, marital status, and highest education level had no association with the likelihood of youth being a migrant.

However, the results of the study revealed that there was no relationship between sex and number of children with migration status. The results are in contradiction with several (Awumbila, Teye, Litchfield *et al*., 2015; Herrera and Sahn 2013; Nzabona and Maniragaba, 2016) which reported an association between sex and migration as well as studies (Dobson, 2009; Dustmann, 2003; Mushomi, 2016) which suggested that number of children had an association with migration. In the study, sex and number of children were not statistically significant probably because youths are ambitious to explore and will certainly move to new destination areas regardless of their gender or parenthood background (United Nations, 2016).

Results of the study also showed that region is the only socioeconomic factor that had an association with migration status. With, youths from central region were more likely to be migrants as compared to youths from the Northern region. Results of the study are in agreement with the results of the study conducted by Osawe (2013) in Nigeria and Mushomi (2016) in Uganda which showed that region was significantly associated with migration. The region stands out to be significantly associated with migration status because youths formerly residing in the central region are nearer to Kampala which is the country's capital city, therefore, these youths move to provide labor to the economic activities taking place in the city (Magelah and Ntambirweki-Karugonjo, 2014).

On the other hand, the study results revealed that marital status and highest education level did not have any association with migration status. The results are in contradiction to studies by Ackah and Medvedev (2012); Boutin (2016) and Lakuma, Marty, and Kuteesa (2016) which found an association between highest education level and migration as well as studies conducted by Gubhaju and Gordon (2009); Herrin, Knight, and Balihuta (2008) which also found an association between marital status and migration. Education level did not have an association with migration status probably because most of the jobs in the cities or urban areas in the country are mainly in the informal sector which requires limited trained skills but rather who connects the youth to the job (Pletscher, 2015).

The self-employed youths are employers not only to themselves but also to others. The study results revealed that residence, marital status, highest education level, fuel used for cooking, and social networks did not have any association with self-employment status of the migrant youth while age, sex, number of children, region, and reasons for migration

had a significant association with employment status of the migrant. As regard to self-employed youths in the country, self-employed youths spend most of their time working in their own small scale business and they are largely engaged in petty businesses such as operating chapatti stalls, retail shops, restaurants, mobile money outlets, saloons, bars, boutiques, artisanry, motorcycle cyclists, selling narcotic drugs, market stalls, petty trade, bricklaying, building and construction, mechanical repair, maintenance and food processing, and operating taxi vehicles (Magelah and Ntambirweki-Karugonjo, 2014). Given the fact that there are limited jobs in the country, self-employment is actually the dream of each and every youth in the country. The various advantages attached to it, that is, independence, control, and freedom from routine make it the most preferable employment status among the youths. In other words, the youth is able to decide when, where and how to work (Goldin, Hobson, Glick *et al*., 2015)).

Employed status is a situation in which a youth is engaged or hired into a service with an intention of being paid at the end of either a day, a week, or a month (Shamchiyeva, 2017). The study results revealed that age, residence, number of children, region, fuel used for cooking, and social networks did not have any association with employed status while sex, marital status, highest education level, and reasons for migration had an association with the possibility of a migrant youth being employed. In Uganda, most of the male youths are employed in activities such as mechanics, welding, mobile money, and carpentry and most female youths are employed in activities such as hair dressing, shop attendants, and mobile money businesses. However, most of the youths take on employed status as a means of surviving and as well be able to raise capital to start up their own businesses (Shamchiyeva, 2017).

In the study, reasons for migration were subdivided into social, economic, and forced reasons. Results of the study revealed that reasons for migration have a significant association with self-employment status and employed status. With self-employment status, the relative risk of a youth being self-employed over one who was unemployed was lower for a youth who migrated due to social reasons relative to a youth who migrated due to economic reasons. On the other hand, the relative risk of a youth being employed over a youth who was unemployed was also lower for a youth who had migrated due to social reasons relative to a youth who had migrated due to economic reasons. Results of the study are in agreement with a study conducted by United Nations (2011) in developing countries which also suggested that there was a significant association between reasons for migration and employment status because youths usually leave their places of origin to new destination areas where they believe they can easily access employment to stabilize their income as well as have a stronger and greater engagement in the society (United Nations, 2011).

5. Policy Implications

Our findings have important policy implications. Local governments should include the needs of the youths, especially those aged 33-35 years because they have almost three more odds to be migrants as compared to youths aged 18-22 years. This could be done through infrastructural development and provision of social services and amenities (such as electricity, improvement and construction of new education facilities, improve health-care delivery, safe water, tightening of security, and upgrading of local markets) to their local communities so as to encourage the youths to stay and carry out economic activities in their places of origin other than moving away to the nearby urban areas which are already worsened with effects of unplanned urbanization.

With the region having a strong association with migration status, informal settlement evictions should be ended. Many rural to urban migrants live in informal settlements and face intense disruptions to both their home life and livelihoods through the threat of eviction. There should be increase in the capacity of state and nonstate stakeholders to upgrade informal settlements and orientate urban planning that supports access to basic services and affordable housing.

There is also a need to overcome the problem of regional imbalance which is one of the causes of migration. To do this, governments should work in hand with the private sector to improve service delivery, create more employment opportunities and redistribute tax revenues so that poorer localities can have the capacity to provide adequate local public services hence leading to equitable growth in the country.

While we stressed the strengths of our study, the study has some limitations. For example, some information about nonmigrants was not available, such as socioeconomic status of the migrant's place of origin/sending household, living conditions, wages, which made the dataset rather lacking on some variables which would otherwise have enriched the study. Age was also a limitation because it is usually affected by social desirability bias, cultural, and other issues in the country.

6. Conclusions

The study has provided insights about associates of migration status and migrant employment status. Further research is needed to assess reasons for migration with other individual or household level factors.

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Authors' Contribution

SM conceived, designed, and implemented the study inclusive of data analysis and presentation, interpretation and discussion of results. AN provided guidance on study conceptualization, data analysis and interpretation of results. JM guided on study conceptualization and advised on data analysis. All authors participated in drafting the manuscript, read and approved the final version.

Conflicts of Interest

The authors declare that they have no conflicts of interests.

Ethical Approval

Permission and access to use the dataset were granted by AMADPOC, the institution that coordinated the migration survey on behalf of IDRC.

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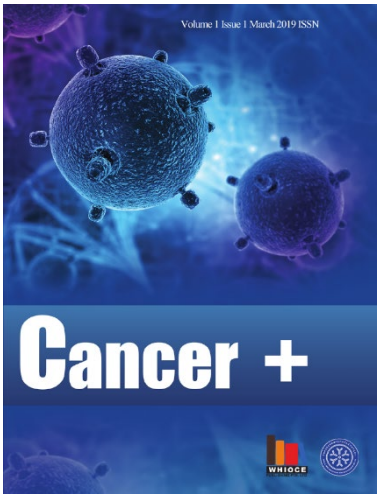

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