Sri Lanka Journal of Social Sciences 2024 ***47*** *(2):233-244*
DOI:https://doi.org/10.4038/sljss.v47i02.8854

RESEARCH ARTICLE

Proposed variant of Myers' Index

Jamal Abdul Nasir, Maira Imtiaz* and Maliha Javaid
Department of Statistics, Government College University, Lahore, Pakistan.

Abstract: This paper extends the Alternative Myers' index Pal *et al*. (2014) as a common measure of the quality of age reporting in addition to Pal *et al*. (2014) past development using the data of selected Asian countries. The most recent wave of country-specific demographic and health survey data is used for the present study. Three different versions of the Myers' index are proposed. The proposed versions are calculated by replacing the original population with a person-year approach. When proposed variants are compared with the alternative version, the proposed modified variants seem to be appropriate as they fall closer to the original Myer index values. In contrast, alternative index values are distant from the standard Myers' index values. Moreover, the results of the analysis extended to compare the proposed variants and alternative index across the place of residence and the education status of the respondents. Finally, in all these comparisons the results revealed to be in the same direction that the modified variants are better in terms of distance than an alternative index with the standard Myers' index values.

Keywords*:* Age heaping, Myers' index, person years, demographic and health survey, asian countries.

INTRODUCTION

For many researchers such as demographers, statisticians, humanists, economists and so forth, age reporting errors have been a persistent reason for worry, particularly in progressive nations. To evaluate the extent of digit preference and aversion to the age statistics several measures were used for instance, Myers' index (Myers, 1940), Whipple's index (Whipple, 1919), Bachi index (Bachi, 1951), Ramachandran measure (Ramachandran, 1967) and Carrier index (Carrier, 1959) for single-year age distributions. Among these mentioned age misreporting measures, Myers (Myers, 1940) and Whipple index (Whipple ,1919) are enormously used empirically in literature since 1950s (Ramachandran, 1967; Yusuf, 1967; Shryock & Siegel, 1980; Srinivasan, 1998; Spoorenberg & Dutreuilh, 2007; Francis *et al*., 2019; Singh *et al*., 2022). Very often, Myer's index is calculated for censuses data (Bailey & Makannah, 1993; Bekele, 2006; Susuman *et al*., 2015; Dahiru & Dikko, 2013). Among these measures, the focus of this present study is on Myers' index. Myers' index (1940) summarizes the absolute deviations in the population to give an index of preference as a measure of age misreporting in a particular census or survey. In terms of numerical structure, one of the key assumptions of linearity is assumed in the estimation of Myers' blended index. In literature, different extensions have been proposed for the Whipple index such as Whipple types, modified Whipple index and further modified Whipple (Noumbissi, 1992; Spoorenberg & Dutreuilh, 2007; Nasir & Hinde, 2014). Whipple modifications are accessible, however, Myers' index is standing alone where no extension is available for that method except an alternative approach (Pal *et*

* Corresponding author (mairaimtiaz12345@gmail.com; https://orcid.org/0009-0009-4595-1444))

al., 2014). Hence, the broad objective of the paper is that this study concentrates only on Myers' blended method and proposes some new extensions by comparing it with the existing Myers' alternative index. The fundamental goal of this study is to get the method in the statistics and to discover the case, if there is any improved method to measure erroneous age reporting in different Asian countries. Errors in specifying age in demographic health surveys can be observed for ever-married women during the age group between 15 and 49. Age distortions have been identified in research literature since the 1950s (Bachi, 1951; Kpedekpo, 1982; Bailey & Makannah, 1993; Bekele, 2006; Susuman *et al*., 2015; Dahiru & Dikko, 2013; Francis *et al*., 2019; Fayehun *et al*., 2020; Singh *et al*., 2022). In this study, the motivation for considering Myers' variants resembled Whipple's variants. Whipple and its variants give the same level of age misreporting, but the variants are easy to compute. To the best of our knowledge, the study signifies the development of variants of Myers' index. Age distortions

Table 1: Total sample sizes of ever-married women in different Asian countries Demographic and Health Survey.

Name of the country	Total DHS*waves	Most recent DHS	Total number of ever-married women	Compiling Agencies of DHS***
Armenia	4	2015-16	6,116	National Statistical Service, Armenia
Azerbaijan	1	2006	8,444	State Statistical Committee (SSC)
Bangladesh	12	2017-18	20,127	National Institute of Population Research and Training (NIPORT)
India	5	2019-21	724,115	International Institute for Population Sciences (IIPS)
Indonesia	12	2017	49,627	National Population and Family Planning Board (BKKBN)
Jordan	7	2017-18	14,689	Department of Statistics (DOS) and Inner City Fund (ICF)
Maldives	2	2016-17	7,699	Ministry of Health (MOH)
Afghanistan	3	2018-19**	29,461	Central Statistics Organization (CSO)
Pakistan	5	2017-18	15,068	National Institute of Population Studies (NIPS)
Nepal	8	2021**	12,862	Ministry of Health, Nepal
Myanmar	1	2015-16	12,885	Ministry of Health and Sports (MoHS), Nay Pyi Taw, Myanmar
Philippine	7	2017	25,074	Philippine Statistics Authority (PSA)
Sri Lanka	3	2016**	5,865	Department of Census and Statistics, Ministry of Plan Implementation, Colombo, Sri Lanka
Thailand	1	1987	6,775	Institute of Population Studies Chulalongkorn University, Bangkok, Thailand
Turkey	6	2018**	9,746	Hacettepe University Institute of Population Studies
Vietnam	3	2005	13,996	General Statistical Office (GSO), Vietnam
Yemen	3	2013	25,434	Ministry of Public Health and Population (MOPHP)
Cambodia	5	2014	17,578	National Institute of Statistics

*Demographic and Health Survey

**Data not available

***Compiled by the author using data from: CSO, MoPH & ICF (2017); DCS & Institute for Resource Development (1988); DOS & ICF (2019); GSO, NIHE & ORC Macro (2006); Hacettepe University Institute of Population Studies (2014); Institute of Population Studies, Chulalongkorn University & Institute for Resource Development/Westinghouse (1988); IIPS & ICF (2017); MOH & ICF (2018); MoHS & ICF (2017); Ministry of Health, New ERA & ICF (2017); MOPHP, CSO, PAPFAM & ICF International (2015); (NIPORT), Mitra and Associates & ICF International (2016); NIPS & ICF (2019); National Institute of Statistics, Directorate General for Health & ICF International (2015); BKKBN, BPS, Kemenkes & ICF (2018); National Statistical Service, Ministry of Health & ICF (2017); PSA & ICF (2018); SSC & Macro International Inc. (2008)

remained a key challenge in most Asian and African countries. This is the reason for the inclusion of Asian countries for application purposes in the present article.

DATA AND METHODS

Demographic and health survey data of selected Asian countries

To test the proposed indices presented in the introduction section, the main variable of interest is the age of the respondents collected through census or surveys. Under the assumption that age heaping is pronounced in developing countries, about 18 different countries were taken in the study. Single-year age returns were selected for the most recent round of the country-specific Demographic and Health Survey (DHS). Table 1 presents the list of selected Asian countries including the most recent DHS. Table 1 entries are arranged in descending order of the survey year. Among 18 countries, DHS in India was observed to be the most recent survey held in 2019-20. Data from Sri Lanka and Thailand's 1987 DHS waves had to be used in the present study. Even if, about three rounds of DHS (1987, 2006-07 and 2016) were conducted in Sri Lanka but only the data from 1987 DHS is available. Thailand completed only one wave of DHS in 1987. The maximum number (12) of DHS were held in Bangladesh (Table 1). The key respondent of the DHS has been ever-married women aged (15-49) years.

METHODS

Myers' Index

Myers' index is mentioned as a "blended index" since it originated by Myer (1940) to escape bias in the computed index. Robert J. Myers (1940) developed the method for measuring age heaping. It gives the extent of digit preference for all terminal digits 0 to 9. It can be used to report errors for all ages 10 – 89 years (Kpedekpo, 1982). This technique has been made on the assumption that in the absence of systematic irregularities in the reporting of age, the population is equally distributed and the collective population of each age ending in terminal digits from 0 to 9 should be displayed as 10 % of the population (Myers, 1954; Bello, 2012; Fayehun *et al*., 2020). If the sum at any given digit exceeds 10% of the total blended population, it indicates the selection of ages that represent digit preference. While the sum at any given digit is less than 10% of the total population it indicates under selection as digit avoidance (Bello, 2012; Susuman *et al*., 2015). A blended strategy to avoid bias and the limitation of indices is calculated in a way that defines the point in which numbers finishing at '0' would ordinarily be higher than those ending in 1 to 9 due to the impact of mortality. This technique is extremely valuable in computing the degree of digit preference error in single-year age information. The range of the Myers' index is from 0 to 180, where 0 shows no digit presence and 180 demonstrates the extreme situation. It is calculated as.

$$\text{Myers' blended index} = \sum_{i=0}^{9} \left| \left[\frac{p_i}{\sum_{i=0}^{9} p_i} \times 100 \right] - 10\% \right| \quad (1)$$

P_i Represent blended population and $_i$ range from 0 to 9.

Myers' Alternative Index

Traditionally, Myers' index was used to assess the level of age misreporting which is accessible for single-year age distributions. A few modifications and corrections have been made to this specific index. The first modification in the Myers' index was proposed by (Pal *et al*., 2014) with the key assumption of linearity. An alternative approach based on the same essential principles of the original Myers' index wherever the blended sum at each terminal digit should be approximately equal to 10% of the total blended population. In an alternative approach, all age preference and avoidance effects can be constructed by taking original population data replaced with person-years. However, the remaining steps of the calculation of the alternative approach are the same as the original method.

Modified Myers' Index: proposed versions

By following Myers (1940) and Pal *et al*. (2014) work, in this study, the extensions of Myers' index (Linear, Exponential, Alternative-type) have been developed based on the similar principles of Myers' blended method, the sum of every terminal digit that is equivalent to 10% of the complete population. Compelling single-year age data of all women replaced with the person-years and computed the original and proposed versions of the Myers' index. Applying person-years to the selected age data could be better in the sense that it would diminish the amount of margin of error. The proposed versions are compared with the alternative approach as well as the original Myers' index. The following three versions are proposed:

Version 1

Under the condition of linearity, we have

$$_nL_x = \frac{n}{2}(l_x + l_{x+n}) \quad (2)$$

In equation (2) $_nl_x$ is linear person-year; l_x and l_{x+n} is the linear population age interval$(x, x+1)$; n specified as the number of years.

$$P_k^* = \mathrm{n}L_x w_i + \mathrm{n}L_x w_j \tag{3}$$

Where w_i and w_j are weights of two-terminal digit (0 to 9) groups; i values refer to as first group terminal digits ranging from (10-39); whereas j values represent the second group terminal digits from (20-49); k specifies as total values vary from 0 to 9.

The generic expression for the Myers' linear index would be:

$$\text{Myers}' \text{ linear blended index} = \sum_{k=0}^{9} \left| \left[\frac{P_k^*}{\sum_{k=0}^{9} P_k^*} \times 100 \right] - 10\% \right| \tag{4}$$

In equation (4) P_k^* Specifies as a linear blended population while; $\sum_{k=0}^{9} P_k^*$ is the total sum of the liner blended population; k specifies as total values vary from 0 to 9.

Version 2

In the case of exponential, we have

$$\mathrm{n}L_x = \frac{5n}{12} l_{x+n} - \frac{n}{12} l_{x-n} + \frac{2n}{3} l_x \tag{5}$$

Where in equation (5) l_x is exponential person-year; l_x, l_{x+n} and l_{x-n} is the exponential population age interval$(x, x+1, x-1)$; n specifies as the number of years.

$$P_k^{**} = \mathrm{n}L_x w_i + \mathrm{n}L_x w_j \tag{6}$$

Where w_i and w_j are weights of two-terminal digits (0 to 9) groups; i values refer to as group one terminal digits from (10-39); j values refer to as group two-terminal digits ranging (20-49); k specifies as total values vary from 0 to 9.

The generic expression for Myers' exponential index would be:

$$\text{Myers}' \text{ exponential blended index} = \sum_{k=0}^{9} \left| \left[\frac{P_k^{**}}{\sum_{k=0}^{9} P_k^{**}} \times 100 \right] - 10\% \right| \tag{7}$$

Where in equation (7), P_k^{**} specify as an exponential blended population; $\sum_{k=0}^{9} P_k^{**}$ is the total sum of the exponential blended population; k values range from 0 to 9.

Version 3

In the case of Alternative-type, we have

$$Px_i = A_i * N_i \tag{8}$$

In equation (8), A_i is current age; N_i is the number of persons; Px_i is the number of persons reporting their age in completed years.

$$P_k^{1*} = Px_i w_i + Px_i w_j \tag{9}$$

Where w_i and w_j are weights of two-terminal digits (0 to 9) groups; i values refer to as group one terminal digits that range from (10-39); j values refer to as group two-terminal digits that range from (20-49); k specifies as total values vary from 0 to 9.

$$MI_0^{10} = P_{10}^{1*} + P_{20}^{1*} + P_{30}^{1*} + P_{40}^{1*} \tag{10}$$

$$MI_1^{10} = P_{11}^{1*} + P_{21}^{1*} + P_{31}^{1*} + P_{41}^{1*} \tag{11}$$

$$\begin{array}{ccccc} . & . & . & . & . \\ . & . & . & . & . \\ . & . & . & . & . \end{array}$$

$$MI_9^{10} = P_{19}^{1*} + P_{29}^{1*} + P_{39}^{1*} + P_{49}^{1*} \tag{12}$$

In equations (10, 11 and 12) $Px^{1*}$is the number of persons reporting their age in completed years.

$$\text{Myers}' \text{ Alternative} - \text{type index} = \sum_{k=0}^{9} \left| \left[\frac{MI_k}{\sum_{k=0}^{9} MI_k} \times 100 \right] - 10\% \right| \tag{13}$$

In equation (13) MI_k specify as Myers' Alternative-type index population; $\sum_{k=0}^{9} MI_k$ refer to as a total sum of Myers' Alternative-type index population; k values ranging from 0 to 9.

Application of proposed indices

Table 2 represents the calculated values of the Myers' index, the alternative version (Pal version) and proposed versions of the index. We show measured figures from Linear (version-I) Myers' index, which is built by the person-year-based linear approach. First, calculate the linear equation no (2) on the original population data and replace it with the person-years while the remaining steps are the same as the original Myers' Index method. For instance, using the 2017-18 Pakistan DHS, there are 214 ever-married women at age 24 years and 198 women at age 23 years, there will be 206 women at age 23 years using a linear approach (equation no 2), there will be 201 ever married women using an exponential approach (equation no 5). After obtaining linear and exponential age-specific counts, the blended sums are calculated in a similar way to the original Myers' blended population. Linear and exponential blended sums are multiplied with weights as in the original Myers' approach. Finally, deviations from 10% of the linear and exponential blended population are calculated to estimate the modified versions of Myers' index. Finally, we illustrate the structure of the Alternative-type Myers' index (version 3). To some extent, the calculation of version 3 differs from other variants, which is the base point of the alternative index. Firstly, equation (8) is calculated on the original population and then weights are assigned to columns according to the given age group. Then multiply the calculated column with the weighting columns (Group-i; 10-39) and (Group-ii; 20-49) and add these two columns together. Finally, construct 10 terminal digits. To calculate the blended population all 0-digit numbers are added from the previous column using equation (10). The next stage is revised for the next digit-1 and so on for all terminal digits and the remaining stages are identical to the original method.

RESULTS

Index-wise comparisons

The results of the Myers' index and its extension values from a single-year women's age are presented below in Table 2. The table shows the comparison of standard Myers' and Alternative with the proposed indices. There is a discrepancy in the results concerning the alternative index, where values are away from the original Myers' value. All findings in the proposed versions are close to and lower than the original index values. Following the values of the linear and exponential index from a table, it is a slightly different discussion that values are decreasing relative to the original values. The exponential method could be the deletion of the erroneous age statement so the values of these variants are lower. Through the

Table 2 : Results of Myers' Blended Index and its proposed indices, for ever-married women, age 15 - 49, in selected Asian countries

Name of the country	Myers' Index (Original)	Pal *et al*. (2014) Index	Myers' Index proposed versions		
			Person year approach		
		Alternative	Linear	Exponential	Alternative-type
Armenia	6.13	16.6	2.88	2.76	8.06
Azerbaijan	6.94	16.29	2.27	2.59	9.79
Bangladesh	6.42	16.66	3.14	3.60	6.30
India	16.14	20.55	7.94	8.40	18.13
Indonesia	7.34	16.55	2.87	3.14	6.59
Jordan	2.77	17.07	1.49	1.72	4.23
Maldives	5.69	16. 51	2.74	3.32	5.41
Afghanistan	38.07	39.67	19.63	22.67	40.46
Pakistan	15.39	19.77	7.37	8.61	15.71
Nepal	11.28	16.52	5.79	6.78	8.77
Myanmar	6.59	16.80	2.86	3.82	6.69
Philippine	11.48	16.69	6.32	6.60	6.35
Sri Lanka	4.73	16.85	3.29	3.99	5.62
Thailand	2.54	16.85	2.25	2.47	5.80
Turkey	6.84	16.67	2.95	3.49	7.29
Vietnam	8.20	16.57	3.23	3.85	10.10
Yemen	27.87	30.81	16.24	18.63	31.03
Cambodia	4.06	16.63	5.0	6.78	16.43

Table 3 : Results of Myers' Blended Index and its proposed indices, for the ever-married women, age 15 - 49, in selected Asian countries

Name of the country	Myers' Index (Original)		Pal *et al*. (2014) Index Alternative		Myers' Index proposed versions Person year approach Linear		Exponential		Alternative-type	
	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural
Armenia	9.13	5.90	16.62	16.58	5.81	2.39	5.96	3.05	8.83	9.22
Azerbaijan	7.43	7.98	16.42	16.15	2.83	4.32	3.58	4.55	9.17	11.92
Bangladesh	6.21	7.00	16.69	16.65	3.31	3.09	4.01	3.71	7.03	7.42
India	13.53	17.0	18.72	21.16	6.77	8.33	7.81	9.65	14.89	19.24
Indonesia	7.56	7.09	16.51	16.59	3.32	2.38	3.51	2.80	6.59	6.58
Jordan	4.16	4.43	17.09	17.0	1.78	1.84	1.96	2.18	5.61	4.05
Maldives	11.88	6.00	17.20	16.53	8.85	2.93	8.85	3.43	15.87	4.79
Afghanistan	39.28	37.6	40.12	39.52	19.81	19.8	22.34	22.78	42.25	39.88
Pakistan	14.71	16.4	22.68	18.91	8.01	7.10	9.51	8.00	15.01	17.27
Nepal	10.58	13.4	16.54	16.48	5.37	6.67	6.75	7.12	8.65	10.39
Myanmar	8.06	5.98	16.73	16.82	4.37	2.49	4.38	3.79	5.73	7.35
Philippine	9.27	12.7	16.72	16.67	5.10	7.14	5.04	7.52	6.57	6.48
Sri Lanka	5.60	5.21	16.73	16.88	4.81	3.85	5.10	4.64	6.13	6.15
Thailand	5.09	4.00	16.73	16.91	4.07	2.07	4.43	2.42	6.48	5.51
Turkey	7.22	5.70	16.62	16.83	3.14	3.16	3.40	4.25	6.58	9.40
Vietnam	6.33	9.73	16.76	16.48	2.82	4.52	2.77	5.13	11.34	9.47
Yemen	19.27	32.0	23.49	34.43	10.10	18.4	12.0	21.81	23.35	35.09
Cambodia	5.33	3.57	16.55	16.67	6.45	4.35	8.22	6.09	18.43	15.47

Table 4: Results of Myers' Blended Index and its proposed indices, for the selected ever-married women, age 15 - 49, in Asian countries

Name of the country	Myers' Index (Original)		Pal *et al*. (2014) Index		Myers' Index proposed versions Person year approach					
			Alternative		Linear		Exponential		Alternative-type	
	NE	ED	NE	ED	NE	ED	NE	ED	NE	ED
Armenia	120	6.12	105.7	16.61	90.45	2.81	101.49	2.72	120	7.98
Azerbaijan	27.51	6.99	25.95	16.29	24.46	2.19	25.25	2.60	42.45	9.50
Bangladesh	5.40	7.36	17.85	16.44	4.22	3.88	4.93	4.45	6.95	7.15
India	27.46	14.43	29.91	17.54	13.58	7.17	15.55	8.05	28.51	15.14
Indonesia	12	7.37	20.76	16.50	11.34	2.83	11.15	3.24	13.82	6.61
Jordan	14.01	2.68	21.43	17.0	5.67	1.46	7.62	1.73	14.27	4.04
Maldives	17.09	5.67	21.07	16.35	12.54	2.94	13.03	3.69	17.16	5.64
Afghanistan	39.72	31.27	41.45	28.81	21.02	12	23..97	16.40	41.98	34.16
Pakistan	19.32	11.64	22.59	17.84	10.10	5.18	11.66	6.47	19.67	11.82
Nepal	9.15	13.34	17.32	16.04	4.34	7.18	5.25	9.55	8.76	13.81
Myanmar	13.79	6.06	20.19	16.70	8.47	2.64	9.61	4.17	13.28	7.00
Philippine	19.59	11.61	21.96	16.68	9.26	6.37	11.61	6.68	17.42	6.34
Sri Lanka	10.59	4.33	18.30	16.78	4.86	3.29	5.23	3.89	13.22	4.83
Thailand	9.47	2.81	19.16	16.71	5.91	2.78	6.92	2.91	10.29	6.34
Turkey	11.04	8.21	19.38	16.56	6.96	3.49	7.65	3.83	12.17	6.80
Vietnam	14.12	8.64	17.18	16.57	7.79	3.46	8.03	4.37	14.11	10.06
Cambodia	5.97	4.34	17.48	15.50	6.14	5.00	5.56	7.00	9.06	17.86

NE: no education

ED: At least primary education

exponential index reducing a digit preference by a general pattern additionally, a linear method diminishes digit preference more than the exponential method. Nevertheless, the values of the linear index are lower than the values of the exponential index.

Comparison of an alternative-type index with other indices

The alternative-type method (version 3) works closely with and below the original index. These methods show the original factor of age heaping that reduces the index values which minimizes the problem in datasheets**.** The first row of Table 2 shows an alternative type from Armenia is 8.06 and is close to Myers' 6.13 while the linear and exponential indices are 2.88 and 2.76. Thus, these are somewhat close to the original value, however, the alternative index is 16.6 which indicates a huge difference from the original value. If we take the index values of Bangladesh the original value is 6.42 and the alternative type is 6.30 while the linear and exponential are 3.14 and 3.60. The alternative-type value is almost equal to original value and its alternative value is 16.66 which shows an enormous difference from the original. Like Armenia and Bangladesh, the remaining countries, approximately compute the equivalent results (Azerbaijan, Indonesia, Pakistan, Jordan, Maldives, Myanmar, Sri Lanka and Turkey). All alternative-type version values are very close to the classical Myers' index so far, while a huge difference is noted in the alternative index.

Country-wise comparison

We compare the results of two standards (alternative and original indices) with three proposed extensions (linear, exponential and alternative type) in different Asian countries. A noticeable pattern occurs in Tables 2, 3 and 4 by analyzing the level of education and the urban-rural categories in various Asian countries. A notable fact, in Table 2 is that there is only one shift in the case of Cambodia, where our findings are larger than the original values. However, in Cambodia, there are some exceptions in terms of having more index values compared with the other countries. Except for Cambodia, the Myers' indices for all Asian countries are higher than the linear and exponential indices**.** In Table 2 among the analyzed countries, only Jordan (2.77), Thailand (2.54), Sri Lanka (4.73) and Cambodia (4.06) are considered to have relatively accurate data. This implies that the reported ages in these countries, across different demographic factors, are less disposed to age misreporting. India (16.14) and Pakistan (15.39) are noted to have fewer rough data compared to Yemen (27.87) and Afghanistan (38.07). The calculation highlights the varying degrees of data reliability across countries, emphasizing the importance of examining data quality. The minor difference in calculating age misreporting index values is observed between urban and rural study samples (Table 3). From Table 3, urban populations in Azerbaijan (7.43), Bangladesh (6.21), India (13.53), Jordan (4.16), Pakistan (14.71), Nepal (10.58), the Philippines (9.27), Vietnam (6.33) and Yemen (19.27) exhibit less age heaping compared to their rural areas. Indonesia, Sri Lanka and Thailand represent almost equal data reporting, that both urban and rural areas indicate better data quality in both sectors. This indicates that urban areas tend to have better-quality data with fewer instances of age misreporting. The observation highlights the significance of considering the urban-rural divide in assessing data quality, with urban areas generally providing more accurate age-related information. However, a considerable difference is observed between the non-educated women's age misreporting compared with at least primary educated, ever-married women in the study sample (Table 4). Age misreporting was revealed to be the highest (120) among non-educated survey respondents in Armenia. From Table 4, uneducated respondents from Armenia (120), Azerbaijan (27.51), India (27.46) and Afghanistan (39.72) exhibit a significant degree of age misreporting, indicating that the reported ages may not accurately reflect the actual ages of individuals in these populations. In contrast, uneducated respondents from Bangladesh (5.40), Cambodia (5.97), Nepal (9.15), Sri Lanka (10.59) and Thailand (9.47) show lower levels of age misreporting. This shows a relatively more accurate reporting of ages among uneducated populations compared to previously mentioned countries. The observation highlights the impact of education on data quality, with uneducated populations in some countries providing data of rough quality. Education plays an essential role in determining data quality with the literate population providing approximately accurate data in selected Asian countries except Afghanistan (31.27). Note that the values for Myers' original values for educated and uneducated in Bangladesh and Nepal is having a different pattern. Surprisingly, no information on the educational status of women is available in the latest wave of Yemen DHS. Figure 2 shows that the variation of index values that takes the alternative method is distant from the original line in the graph, while the remaining versions are closer to Myers' line. Figure 1 shows age distribution in some Asian countries, where there are reported age anomalies even if the population is grouped in one year. These figures represent the distortion in age distribution.

FINAL REMARKS

The present study used standard and modified versions of Myers' index to explore the degree and pattern of age

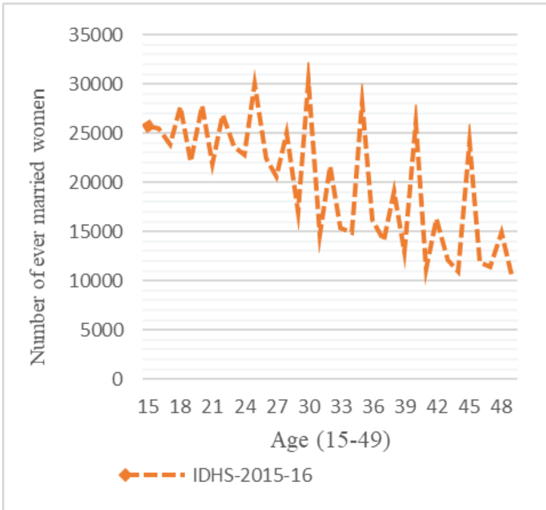

Figure 1.a : A single-year age distribution for total ever-married women in India based on sample of the DHS

Source: India Demographic and Health Survey 2015-16

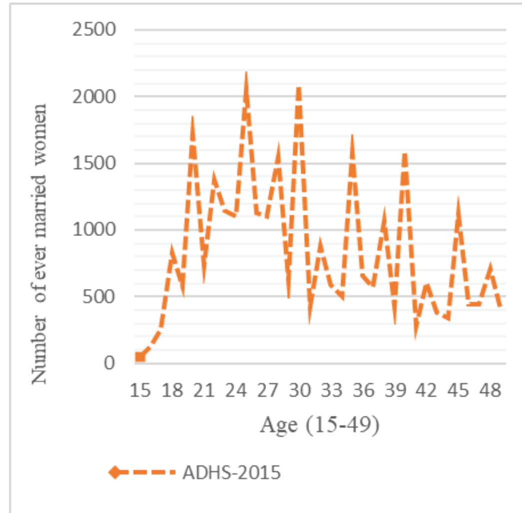

Figure 1.b : A single-year age distribution for total ever-married women in Afghanistan based on sample of the DHS

Source: Afghanistan Demographic and Health Survey 2015

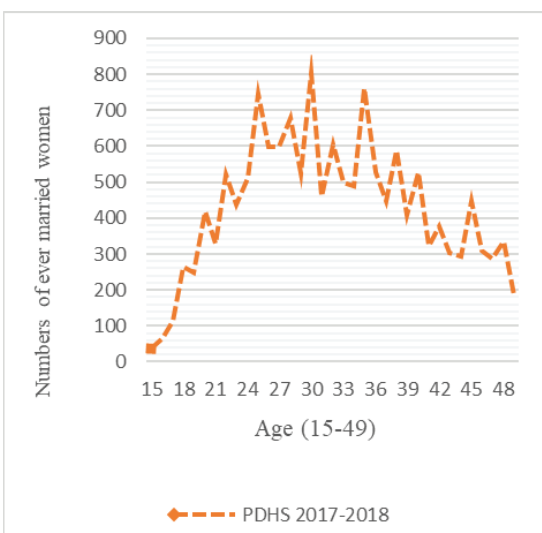

Figure 1.c : A single-year age distribution for total ever-married women in Pakistan based on sample of the DHS

Source: PDHS: Pakistan Demographic and Health Survey 2017-18

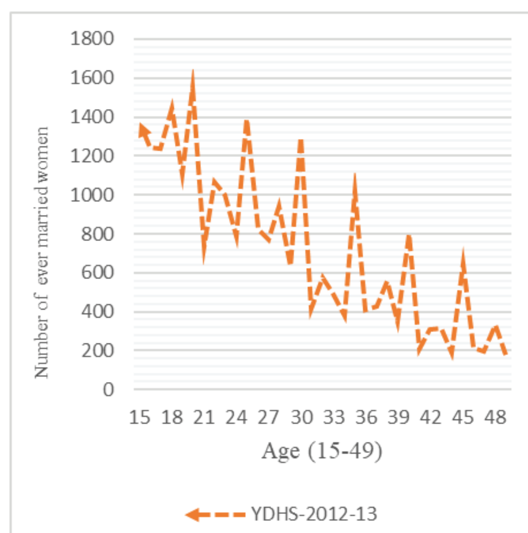

Figure 1.d : A single-year age distribution for total ever-married women in Yamen based on sample of the DHS

Source: YDHS: Yamen Demographic and Health Survey 2012-13

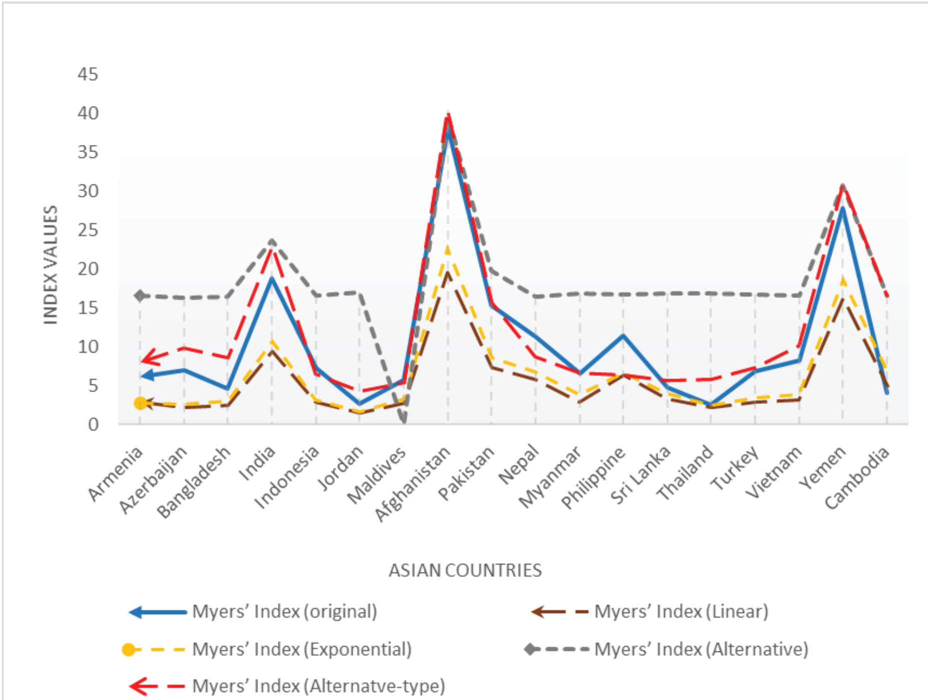

Figure 2: A single-year age distribution of Myers' index values for different Asian countries

heaping in different Asian countries using the most recent round of Demographic and Health Surveys conducted in different periods. This investigation was restricted to reproductive age limit of women and the degree to which Asian women preferred or stayed away from their survey replies for the age finishing off with specific digits. The analysis was conducted at three levels of 18 different countries: national or overall data, place of residence (urban versus rural) and education status (no education versus at least primary education). As expected, index results show a greater age misreporting among women with no education compared with those having at least a primary education. To check the applicability and legitimacy, the extended versions of Myers' index are used to measure the degree of age misreporting. Results are compared with the original Myers' blended index and the extensions of the Myers' index with similar material.

The concluded results are based on the new strategy that represents the accuracy of the index values, as there is the least distance between the values of the original and proposed versions of the Myers' index. However, the alternative Myers' index seems overestimated and distant away from the original values. Modified versions are valuable for the minimization of age heaping. Its startling advantage lies in the use of the person-year approach, because the assumption for an even distribution of persons of the terminal digits seems unrealistic. The person-year formula is used to overcome the assumptions of the rectangular distribution that is used to calculate the blended index. Further details of the advantages of person-year approach can be seen in the literature (Hinde, 2014; Shryock & Siegel, 1980). In addition, the proposed methods are also based on one of the key assumptions of linearity which is used in the estimation of the Myers' index in terms of numerical structure. Notably, our suggested index gives the findings and error directions that are nearly identical to the original Myers' index.

These findings are understandable, while extensions of Myers' index are more likely to be better than the alternative index. The extensions of Myers' index offer a basic proposed method that completely represents the changes in all age digits. The proposed indices are close to Myers' blended method. The survey, conducted on the age parameter of married women to elaborate on comparative patterns of age misreporting. In Afghanistan, India and Yemen show higher preference by age 15-49 when compared to other Asian countries. Significant evidence arises that there exist huge distinctions in the age reporting quality among Asian countries. However, by following the figures, the majority of irregularities are observed in the graph of India, Afghanistan and Yemen. The graph of Pakistan also shows how anomalies that represent the quality of data reporting in these countries are not reasonable. In age reporting data for women, high anomalies might be the result of proxy reporting of age information. This implies that age awareness in these nations is very low and many have just an unclear thought regarding their age. The impact of such misrepresentation can lead to misclassification and miscalculation of population rates. Through this study, it is suggested to select a specialized enumerator for capturing age-related data from women.

REFERENCES

Bachi, R. (1951) The Tendency to Round Off Age Returns: Measurement and Correction, *Bulletin of the International Statistical Institute,* 33(4), pp:195-222.

Bailey, M. & Makannah, T. J. (1993) Patterns of Digit Preference and Avoidance in the Age Statistics of Some Recent African Censuses: 1970-1986, *Journal of Official Statistics*, 9(3), pp: 705-715.

Bekele, S. (2006) Analysis on the Quality of Age and Sex Data Collected in the Two Population and Housing Censuses of Ethiopia, *SINET: Ethiopian Journal of Science*, 29(2), pp: 123-132.

Bello, Y. (2012) Error Detection in Outpatients' Age Data Using Demographic Techniques, *International Journal of Pure and Applied Sciences and Technology,* 10(1), pp: 27-36.

Carrier, N. H. (1959) A Note on the Measurement of Digital Preference in Age Recordings, *Journal of the Institute of Actuaries,* 85(1), pp: 71-85.

Central Statistics Organization (CSO), Ministry of Public Health (MoPH) & ICF (2017) *Afghanistan Demographic and Health Survey 2015*, Kabul: Central Statistics Organization. [Online] Available from: Https://www.rhsupplies.org/uploads/tx_rhscpublications/Afghanistan_-_2017.pdf [Accessed : 15th August 2023]

Dahiru, T. & Dikko, H. G. (2013) Digit Preference in Nigerian Censuses Data of 1991 and 2006, *Epidemiology, Biostatistics and Public Health,* 10(2).

Department of Census and Statistics (DCS) & Institute for Resource Development (1988) *Sri Lanka Demographic and Health Survey 1987*, Colombo: Department of Census and Statistics. [Online] Available from: Https://dhsprogram.com/pubs/pdf/FR35/FR35.pdf [Accessed :15th August 2023]

Department of Statistics (DOS) & The DHS Program, ICF (2019) *Jordan Population and Family Health Survey 2017-18*. Amman, Jordan and Rockville, Maryland, USA: DOS & ICF. [Online] Available from: Https://dhsprogram.com/pubs/pdf/FR346/FR346.pdf [Accessed : 15th August 2023]

Fayehun, O., Ajayi, A. I., Onuegbu, C. & Egerson, D. (2020) Age Heaping among Adults in Nigeria: Evidence from the Nigeria Demographic and Health Surveys 2003-2013, *Journal of Biosocial Science*, 52(1), pp: 132–139.

Francis, E., Senyefia, B. & Sena, B. B. (2019) Statistical Analysis of Age Reporting Errors by Insured and Uninsured Patients in Cape Coast Teaching Hospital of Ghana. *Biomedical Statistics and Informatics*, 4(2), pp: 15-21.

General Statistical Office (GSO), National Institute of Hygiene and Epidemiology (NIHE) & ORC Macro (2006) *Vietnam Population and AIDS Indicator Survey 2005*. Calverton, Maryland, USA: GSO, NIHE & ORC Macro. [Online] Available from: Https://dhsprogram.com/pubs/pdf/AIS3/AIS3.pdf [Accessed: 15 August 2023]

Hacettepe University Institute of Population Studies (2014) 2013 *Turkey Demographic and Health Survey*. Ankara, Turkey: Hacettepe University Institute of Population Studies, T.R. Ministry of Development & TÜBİTAK. [Online] Available from: Https://dhsprogram.com/pubs/pdf/FR352/FR352.pdf [Accessed: 15th August 2023]

Hinde, A. (2014) *Demographic Methods*. Oxford: Routledge.

Institute of Population Studies, Chulalongkorn University & Institute for Resource Development/Westinghouse (1988) *Thailand Demographic and Health Survey 1987.* Bangkok, Thailand and Columbia, Maryland, USA: Institute of Population Studies, Chulalongkorn University & Institute for Resource Development/Westinghouse. [Online] Available from: Https://dhsprogram.com/pubs/pdf/FR37/FR37.pdf [Accessed: 15th August 2023]

International Institute for Population Sciences (IIPS) & ICF (2017) *National Family Health Survey (NFHS-4), 2015-16: India*. Mumbai: IIPS. [Online] Available from: Https://dhsprogram.com/pubs/pdf/FR339/FR339.pdf [Accessed: 15th August 2023]

Kpedekpo, G. M. K. (1982) *Essentials of Demographic Analysis for Africa*. London: Heinemann.

Ministry of Health (MOH) & ICF (2018) *Maldives Demographic and Health Survey 2016-17*. Malé, Maldives & Rockville, Maryland, USA: MOH & ICF. [Online] Available from: https://dhsprogram.com/pubs/pdf/FR349/FR349.pdf [Accessed: 15th August 2023]

Ministry of Health and Sports (MoHS) & ICF (2017) *Myanmar Demographic and Health Survey 2015-16*. Nay Pyi Taw, Myanmar & Rockville, Maryland, USA: MoHS & ICF. [Online] Available from: https://dhsprogram.com/pubs/pdf/FR324/FR324.pdf [Accessed: 15th August 2023]

Ministry of Health, New ERA & ICF (2017) *Nepal Demographic and Health Survey 2016*. Kathmandu, Nepal: Ministry of Health, Nepal. [Online] Available from: https://dhsprogram.com/pubs/pdf/FR336/FR336.pdf[Accessed: 15th August 2023]

Ministry of Public Health and Population (MOPHP), Central Statistical Organization (CSO), Pan Arab Program for Family Health (PAPFAM) & ICF International (2015) *Yemen National Health and Demographic Survey 2013*. Rockville, Maryland, USA: MOPHP, CSO, PAPFAM & ICF International. [Online] Available from: https://dhsprogram.com/pubs/pdf/FR296/FR296.pdf [Accessed: 15th August 2023]

Mwambene, E., Appunni, S. S., Hamisi, H. F., Lougue, S., Regassa, N., & Ogujiuba, K. (2012). An assessment of the age reporting in Tanzania population census.

Myers, R. J. (1940) Errors and Bias in the Reporting of Ages in Census Data, *Transactions of the Actuarial Society of America,* 41(2), pp: 395-415.

Myers, R. J. (1954) The Effect of Age of Mother and Birth Order on Sex Ratio at Birth, *The Milbank Memorial Fund Quarterly,* 32(3), pp: 275-281.

Nasir, J. A. & Hinde, A. (2014) An Extension of Modified Whipple Index-Further Modified Whipple Index, *Pakistan Journal of Statistics,* 30(2), pp: 265-272.

National Institute of Population Research and Training (NIPORT), Mitra and Associates & ICF International (2016) *Bangladesh Demographic and Health Survey 2014*. Dhaka, Bangladesh & Rockville, Maryland, USA: NIPORT, Mitra and Associates & ICF International. [Online] Available from: https://dhsprogram.com/pubs/pdf/FR311/FR311.pdf [Accessed: 15th August 2023]

National Institute of Population Studies (NIPS) & ICF (2019) *Pakistan Demographic and Health Survey 2017-18*. Islamabad, Pakistan & Rockville, Maryland, USA: NIPS & ICF. [Online] Available from: https://dhsprogram.com/pubs/pdf/FR354/FR354.pdf [Accessed: 15th August 2023]

National Institute of Statistics, Directorate General for Health & ICF International (2015) *Cambodia Demographic and Health Survey 2014*. Phnom Penh, Cambodia & Rockville, Maryland, USA: National Institute of Statistics, Directorate General for Health & ICF International. [Online] Available from:https://dhsprogram.com/pubs/pdf/FR312/FR312.pdf [Accessed: 15th August 2023]

National Population and Family Planning Board (BKKBN), Statistics Indonesia (BPS), Ministry of Health (Kemenkes) & ICF (2018) *Indonesia Demographic and Health Survey 2017*. Jakarta, Indonesia: BKKBN, BPS, Kemenkes & ICF. [Online] Available from: https://dhsprogram.com/pubs/pdf/FR342/FR342.pdf [Accessed: 15th August 2023]

National Statistical Service, Ministry of Health & ICF (2017) *Armenia Demographic and Health Survey 2015-16*. Rockville, Maryland, USA: National Statistical Service, Ministry of Health & ICF. [Online] Available from: https://dhsprogram.com/pubs/pdf/FR325/FR325.pdf [Accessed: 15 August 2023]

Noumbissi, A. (1992) L'indice de Whipple Modifié: Une Application Aux Données Du Cameroun, de La Suède et de La Belgique [The modified Whipple index: an application to data from Cameroon, Sweden and Belgium], *Population (french edition),* 47(4), pp: 1038-1041.

Pal, J. K., Mukhopadhyay, B. K. & Gupta, S. K. (2014) Myers' Blended Method: An Alternative Approach, *Journal of Scientific Research and Reports,* 3(18), pp: 2459-2465.

Philippine Statistics Authority (PSA) & ICF (2018) *Philippines National Demographic and Health Survey 2017*. Quezon City, Philippines & Rockville, Maryland, USA: PSA & ICF. [Online] Available from: https://dhsprogram.com/pubs/pdf/FR347/FR347.pdf [Accessed: 15th August 2023]

Ramachandran, K. V. (1967) An Index to Measure Digit Preference Error in Age Data. *World Population Conference, Belgrade*, *1965, Vol. III,* pp: 202–203, New York: United Nations.

Shryock, H. S. & Siegel, J. S. (1980) *The Methods and Materials of Demography.* Volume 2, Washington, DC: Department of Commerce, Bureau of the Census.

Singh, M., Kashyap, G. C. & Bango, M. (2022) Age Heaping among Individuals in Selected South Asian Countries: Evidence from Demographic and Health Surveys, *Journal of Biosocial Science,* 54(4), pp: 725–734.

Srinivasan, K. (1998) *Basic demographic techniques and applications*. London: SAGE.

Spoorenberg, T. & Dutreuilh, C. (2007) Quality of Age Reporting: Extension and Application of the Modified Whipple's Index, *Population,* 62(4), pp: 729-741.

State Statistical Committee (SSC) & Macro International Inc. (2008) *Azerbaijan Demographic and Health Survey 2006*. Calverton, Maryland, USA: SSC & Macro International Inc. [Online] Available from: https://dhsprogram.com/pubs/pdf/FR195/FR195.pdf [Accessed: 15th August 2023]

Whipple, G. C. (1919) *Vital Statistics; an Introduction to the Science of Demography*. New York: Wiley.

Susuman, A. S., Hamisi, H. F., Lougue, S., Regassa, N. A., Ogujiuba, K. & Mwambene, E. (2015) An Assessment of the Age Reporting in Tanzania Population Census 2012, *The Journal of Social Sciences Research,* 8(1), pp: 1553–1563.

Yusuf, F. (1967) On the Extent of Digital Preference in Reporting of Ages in Pakistan, *The Pakistan Development Review,* 7(4), pp: 519-532.