



## The Quality of Age Reporting in the 2014 Morocco Census

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### Abstract

Aiming to update the economic, demographic, and social characteristics and housing conditions of the population, Morocco has conducted its last General Population and Housing Census (GPHC) in 2014. Accurate data on age is a key element for decision making, and necessary to build policies and improve health indicators. The main objective of this paper is to assess the quality of age reporting in the 2014 Morocco census. Based on the 2014 Morocco census data, we calculated the Myers' index to evaluate whether there is age heaping on any digit between 0 and 9. We used the United Nations Age-Sex Accuracy index (UNACI) to examine the five-year age-sex data. In 2014, the overall Myers' index, for the total Moroccan population, was 1.35 (1.39 for men, 1.32 for women, 1.50 in urban, and 1.41 in rural). The digit scores were approximatively equal and close to zero. The UNACI score was 20.62 (23.63 in urban and 20.45 in rural). According to our study, the age reporting data in the studied census was of good quality. In addition, remarkable progress in data quality was detected compared to the previous censuses. Consequently, information from this census can be used in the country's development. However, we found that grouped age data was of poor quality in two regions. Thus, more attention should be paid to improving data quality in those regions in the coming census, especially among men. We provided clear and reliable information on age reporting in the 2014 Morocco census. That helps to improve the quality of age reporting in the 2024 census.



**Keywords:** Accuracy, Myers' index, Digit preference/avoidance, Age reporting, 2014 Morocco census.

## Introduction

Since 1960, the Morocco GPHC has been carried out periodically. The sixth GPHC was carried out in 2014 to 1) determine the legal population nationally and by territorial units of the Kingdom; 2) extract the economic, demographic, and social characteristics and housing conditions of the population; and 3) create a sampling frame to carry intercensal surveys planned, usually, between two successive censuses.

It is well known that the analysis of socio-economic factors is based mostly on age and sex distributions. The data on age and sex is extremely important in estimating the demographic characteristics of any country. A great number of demographic indicators such as fertility, migration, morbidity, mortality rates are estimated using age and sex data. These variables are also useful to make population projections and analyse socioeconomic and health problems based on age and gender (United Nations Economic and Social Commission for Western Asia (ESCWA), 2013). However, statistics on age and sex frequently suffer from reporting inaccuracies and anomalies, which can have a significant influence on the data's usefulness (Bello, 2012). Age misreporting, often known as a content (or response) error, is one of the most prevalent problems, especially in developing countries (Fajardo-González, Attanasio, and Ha, 2014). Age misreporting can occur for a variety of reasons (Obonyo, 2012; Unisa et al., 2009), but the most prevalent explanation is that the responder does not know his/her precise age or the age of the household members for whom he/she is reporting (ESCWA, 2013).

The quality of age reporting in Morocco's previous censuses was assessed in many studies. Indeed, in 2014, Fajardo-González and collaborators evaluate the quality of age reporting in the census of several countries including Morocco (Fajardo-González, Attanasio, and Ha, 2014). They conclude that data on age and sex was of relatively good quality in the 2004 Morocco census.



In addition, the United Nations Economic and Social Commission for Western Asia (ESCWA) included Morocco in a study of age reporting in selected Arab censuses of population in 2013 (ESCWA, 2013). This study had the same finding as to the first. Likewise, data from 1971, 1982, and 1994 Morocco censuses was introduced in T. Spoorenberg's work in 2007 (Spoorenberg and Dutreuilh, 2007). Furthermore, in 1973, Nagi and his collaborators assess the quality of age reporting of the first Morocco census of 1960 (Nagi, Stockwell, and Snavley, 1973). Accordingly, data on age was of very poor quality in 1960. Regarding the 2014 Morocco census, the ESCWA polished, in 2019, a paper aiming to assess the quality of age and sex data gathered in recent censuses in the UNESCWA region including Morocco. They employed three well-known demographic analysis techniques to summarise the disparities in census age and sex data quality between selected countries, as well as to show trends within countries over time (ESCWA, 2019). This study gave a general idea about the quality of age and sex data collected in the 2014 Morocco census, but it does not allow making a comparison between the 12 regions of Morocco. Furthermore, we applied some different indices to assess the quality of age reporting and measure the regularity of distributions by sex and age.

Thus, the main objective of this research is to examine the quality of age reporting in the 2014 Moroccan census using graphical and statistical demographic methods. In addition, we plan to provide clear and trustworthy information to decision-makers at Morocco's High Commission for Planning (HCP) to assist them in developing instruments to enhance the accuracy of age reporting in future censuses. The purpose is also to give the 2014 Moroccan census findings greater credibility. Furthermore, it appears that the data from this vital source of economic, demographic, and social data, on which strategies, policies, plans, and programs are based, must be assessed for its accuracy.



## Data and Methods

### The quality of age reporting

To assess the quality of age reporting in the 2014 Morocco census, we used some graphical and statistical demographic methods. Thus, we applied Myers' index (Myers, 1954) to measure preference for (avoidance of) specific digits (0-9). To assess the accuracy of the statistics by age group and the regularity of the age structure, we applied the United Nations Age-Sex Accuracy Index (UNACI) (Gendreau et al. 1985; Roger, Waltisperger, and Corbille-Guitton, 1981). We chose those methods because Myers' index gives information about preference for (avoidance of) all digits from 0 to 9, while Whipple's index measures preference for (avoidance of) only for two digits 0 and 5. In addition, the UNACI better reflects the overall accuracy of the statistics by age and sex and evaluates the regularity of the five-year age-sex structure. We also analysed the population pyramid and the pattern of sex ratios by five-year age groups. The quality of age reporting data was compared according to the 12 Moroccan regions involved in the census.

#### *Myers' Index (M)*

The Myers' index measures the preference or avoidance of ages ending in each of the digits between 0 and 9. Myers proposed to calculate for each of these digits a "blended sum" which, if there were no preference or avoidance, would be approximately equal to 10% of the total blended population.  $M$  is the sum of the absolute differences in the percentages of each blended sum with the theoretical 10. If age heaping is non-existent, all blended sums are approximately equal. Consequently,  $M$  would be approximately 0 (Kpedekpo, 1982). The higher the value, the greater the preferences or avoidances for ages ending in a specific digit. Its maximum value (90) (Hobbs, 2004) is reached when there is a preference for all ages ending in the same digit.  $M$  is calculated by following the steps below:



Step 1: We calculate the sums  $S_u$  of the population aged 10 and over whose ages end with each of the figures 0 to 9 respectively.

Let  $P(10d+u)$ : the population whose age is in the tens  $d$  and in the units  $u$ .

Note  $S_u$ : the population aged 10 and over whose age as a number of units  $u$ :

$$S_u = \sum_{d=1}^{d_{max}} P(10d + u) \quad (1)$$

Step 2: Note  $S'u$ : the population aged 20 years and over whose age as a number of units  $u$ .

$$S'u = \sum_{d=2}^{d_{max}} P(10d + u) \quad (2)$$

Step 3: Myers' blended population is defined as:

$$T_u = (u+1) S_u + (9-u) S'u \quad (3)$$

Step 4: We calculate the total blended population  $T$ :

$$T = \sum_0^9 T_u \quad (4)$$

Step 5: Myers' index is :

$$M = \sum_{u=0}^9 \left| 100 * \frac{T_u}{T} - 10 \right| \quad (5)$$

### *United Nations Age-Sex Accuracy Index (UNACI)*

The UNACI is different from the Myers' index. It is calculated based on distributions by age groups rather than by years of age and attempts to measure the regularity of the distributions by sex and age. Compared to Myers' method, it has the advantage that the calculated index reflects changes in the number of omissions in the count by age group, intentionally inaccurate age declarations and preferences for ages ending in a given number of units; therefore, this index better reflects the overall accuracy of the statistics by age (Gendreau et al., 1985). To calculate the UNACI, we need the distribution of the population by sex and by five-year (or ten-year) age groups.



We note by  $Pm(i)$  and  $Pf(i)$ , the population of the different five-year age groups for male and female, from  $i = 0$  (0-4 years) to  $i = 14$  (70-74 years). We note also  $m(i)$  and  $f(i)$ , age group ratios for each sex from  $i = 1$  to 13. These ratios are calculated by relating the population in each age group to the arithmetic mean of the population in the following age groups:

$$m(i) = 100 * \frac{Pm(i)}{1/2[Pm(i-1)+Pm(i+1)]} \quad (6)$$

$$f(i) = 100 * \frac{Pf(i)}{1/2[Pf(i-1)+Pf(i+1)]} \quad (7)$$

The deviations from 100 in each of the previous reports are then calculated, followed by the age group ratio indices:

$$Jm = \frac{1}{13} \sum_{i=1}^{13} |m(i) - 100| \quad (8)$$

$$Jf = \frac{1}{13} \sum_{i=1}^{13} |f(i) - 100| \quad (9)$$

We note also  $r(i)$ , the sex-ratios:

$$r(i) = 100 * \frac{Pm(i)}{Pf(i)} \quad (10)$$

We calculate the differences between successive sex- ratios, the average of absolute values of these differences is:

$$k = \frac{1}{13} \sum_{i=0}^{12} |r(i) - r(i + 1)| \quad (11)$$

United Nations Age Sex-Accuracy Index is then:

$$UNACI = Jm + Jf + 3k \quad (12)$$

If  $UNACI < 20$ , the data is of good quality;

If  $20 \leq UNACI < 40$ , the data is of relatively good quality and can be adjusted;

If  $40 \leq UNACI$ , the data is of very poor quality.



### **Data source**

We used data from the 2014 Morocco census published by the HCP of Morocco (HCP of Morocco 2021).

### **Data analysis**

We analysed data using SPSS 26.0 (Chicago, IL, USA) and Microsoft Excel 2016.

## **Results**

### **Population pyramid**

The five-year age groups population pyramid for Morocco, in 2014, is shown in **Figure 1**. It showed a symmetry between males and females. In addition, it reflects, clearly, the Moroccan population structure's overall tendencies (including fertility, mortality, and aging). Furthermore, it remains true that Morocco is in the third stage of the demographic transition. Indeed, the proportion of young people under 15 is decreasing; the working-age population (15-59 years) remains large; and the proportion of people aged 60 and over increasing.

### **The pattern of sex ratio by five-year age groups**

The analysis of sex ratios by five-year age groups, presented in **Figure 2**, revealed that the overall sex ratio in Morocco was about 99 (98 in urban and 102 in rural) men per 100 women in 2014. At the age group [0-4], the sex ratio was 105 boys per 100 girls. In addition, a slight normal decline in older ages (65 and above) was detected.

### **Myers' index**

In **Table 1**, we presented the Myers' index, by sex, area of residency, and region, according to the 2014 Morocco census. Accordingly, the overall Myers' index was 1.35 (1.39 for men and 1.32 for women). By area of residency, it was 1.50 in urban (1.71 among men and 1.30 among women), and 1.41 in rural (1.43 for men and 1.41 for women). Concerning regions, the lowest value of Myers' index was 1.20, found in Tanger-Tétouan-Al



Hoceïma and Drâa-Tafilalet. On the other hand, the highest value was 3.24, recorded in Dakhla-Oued Ed Dahab.

The analysis of digit preference and avoidance in age reporting by sex (**Figure 3**) revealed that all digit scores were approximatively equal and close to zero. Consequently, age heaping appears to be not present in 2014 Morocco census demographic data.

### **United Nations Age-Sex Accuracy index (UNACI)**

The overall UNACI score for the total Moroccan population in 2014 was 20.62 (23.63 in urban and 20.45 in rural) (**Table 2**). By region, the UNACI was lower than (or very close to) 20 for Rabat-Salé-Kénitra (19.85) and Casablanca-Settat (20.74). For Marrakech-Safî, Souss-Massa, Fès-Meknès, Drâa-Tafilalet, Tanger-Tétouan-Al Hoceïma, Oriental, Béni Mellal-Khénifra and Laâyoune-Sakia El Hamra, the UNACI had a relatively good value. However, in Guelmim-Oued Noun and Dakhla-Oued Ed Dahab, the UNACI score was higher than (or very close to) 40.

### **Discussion**

In this paper, we used some graphical and statistical demographic methods to assess the data quality related to age reporting in the 2014 Morocco census. Analysis of the age pyramid revealed that age misreporting appears to be minor in the 2014 Morocco census. It represents the main patterns of the Moroccan population structure (including fertility, mortality, and aging). In addition, Morocco is still in the third stage of its demographic transition. Furthermore, the fertility rate was 2.21 (2.55 in rural and 2.01 in urban) children per woman in 2014 (HCP of Morocco, 2018). Thereby, the fertility drops below the generation replacement threshold in urban. Our analysis showed, also, that there were no major anomalies in sex ratios, except a normal decline in older ages (65 and above) which could be attributed to the increase of life expectancy at birth among women (Seifarth, McGowan, and Milne, 2012).

We found that the total Myers' index was 1.35 (1.39 for men and 1.32 for women). It was 1.50 in urban areas (1.71 among men and 1.30 among





women) and 1.41 in rural areas (1.43 for men and 1.41 for women). It remained that all of those values of Myers' index were very low. Accordingly, we concluded that there was no age heaping in demographic data from the 2014 Morocco census. Differences between men and women appeared to be not significant. However, Fajardo-González and collaborators (Fajardo-González, Attanasio, and Ha, 2014) proved that the preference for terminal digits 0 and 5 was higher among females than among males.

In addition, our study showed an important improvement in the quality of age reporting in Morocco censuses. Indeed, the overall Myers' index improved by 87% compared to the 2004 Morocco census (10.0) (ESCWA, 2013) and by 92% compared to the 1882 Morocco census (17.7) (Spoorenberg and Dutreuilh, 2007). Compared to other countries, Myers' index for the total Moroccan population was slightly better than that calculated for the Iranian population in 2016 (1.6) (Sadoghi, Teimouri, and Pezhhan, 2020). Concerning regions, the value of Myers' index was very low and remains well within the range of good quality of age reporting in 11 regions. On the other hand, Dakhla-Oued Ed Dahab recorded a slightly high value compared to the other regions (3.24, were 4.66 for men and 1.30 for women). Nevertheless, a value of 3.24 remains very small compared to 90, but, compared to the other regions, data on age, in this region, could be improved in the coming census, especially among men.

The overall *UNACI* score for the total Moroccan population in 2014 was 20.62. This value suggests that grouped data was of good quality. Furthermore, the *UNACI* improved by 39% compared to 2004. It was about 33.6 in the 2004 Morocco census (ESCWA, 2013). In addition, we found that the *UNACI* score was slightly higher in urban compared to rural (23.63 against 20.45 respectively). This finding suggests that data from rural areas was more accurate compared to that from urban areas in the 2014 Morocco census. Similarly, Nagi and collaborators previously proved that “the urbanization variable does not appear to be strongly associated with the accuracy of age reporting” (Nagi, Stockwell, and Snavley, 1973). Besides, the *UNACI* score was lower than (or very close to) 20 for Rabat-Salé-Kénitra and Casablanca-Settat, suggesting that grouped age data was of good quality in those regions. In Marrakech-Safi, Souss-Massa, Fès-Meknès, Drâa-



Tafilalet, Tanger-Tétouan-Al Hoceïma, Oriental, Béni Mellal-Khénifra and Laâyoune-Sakia El Hamra, the value of the UNACI score was within the range of relatively good quality. On the other hand, grouped age data from Guelmim-Oued Noun and Dakhla-Oued Ed Dahab appears to be of poor quality, with a *UNACI* score higher than (or very close to) 40.

In this study, we used the Myers' and the United Nations Age-Sex Accuracy indices. One of the disadvantages of the Myers' index is that it is not possible to define precisely the theoretical conditions in which they take values 1 and 0 respectively. On the other hand, the advantage of the *UNAI* is that it is possible to assess the accuracy of the data in the form in which they are used, that is, by age group as defined above. The United Nations index is a raw index because it does not take into account the size of the population. However, when this size is small, the age distribution of the population is largely random and the value of the index is affected (Moultrie et al., 2017).

## **Conclusion**

In this paper, we assessed, applying graphical and statistical demographic methods, the quality of age reporting in the 2014 Morocco census. According to our study, the age reporting data in the studied census was of good quality. Consequently, information from this census can be used to improve the country's development. However, we found that data on age, especially grouped age, in Guelmim-Oued Noun and Dakhla-Oued Ed Dahab was of poor quality. Thus, more attention should be paid to improving the quality of age reporting in the coming census in those regions, especially among men. This study provided decision-makers, in the HCP of Morocco, with clear and reliable information, to help them in developing tools to improve the quality of age reporting in the 2024 census.

## **Statement of ethical approval**

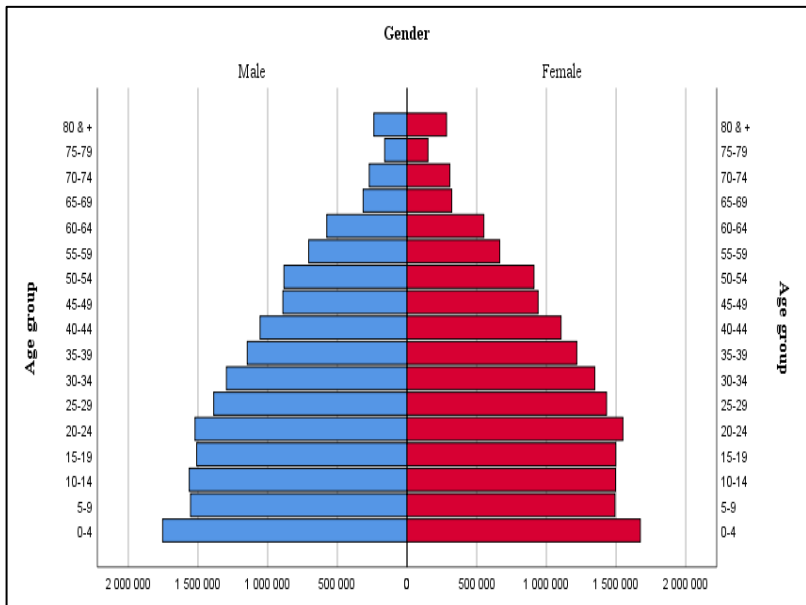
No ethical approval required for this research, which used publicly available datasets. Authors declare that there are no conflicts of interest.

## **Appendices: Figures 1, 2, 3 & Tables 1, 2**



**Figures:**

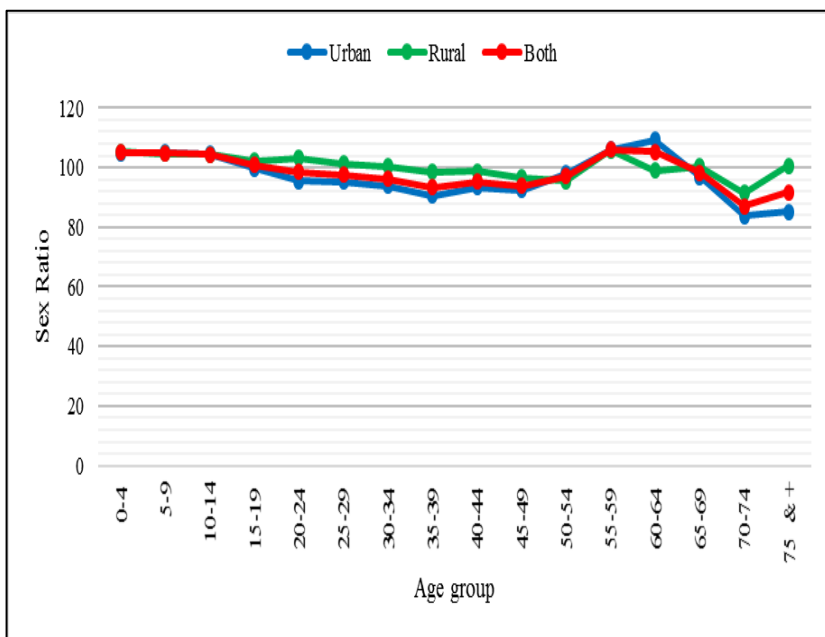
Figure 1: Population pyramid, the 2014 Morocco census



Source: Authors' work on the 2014 Morocco census data



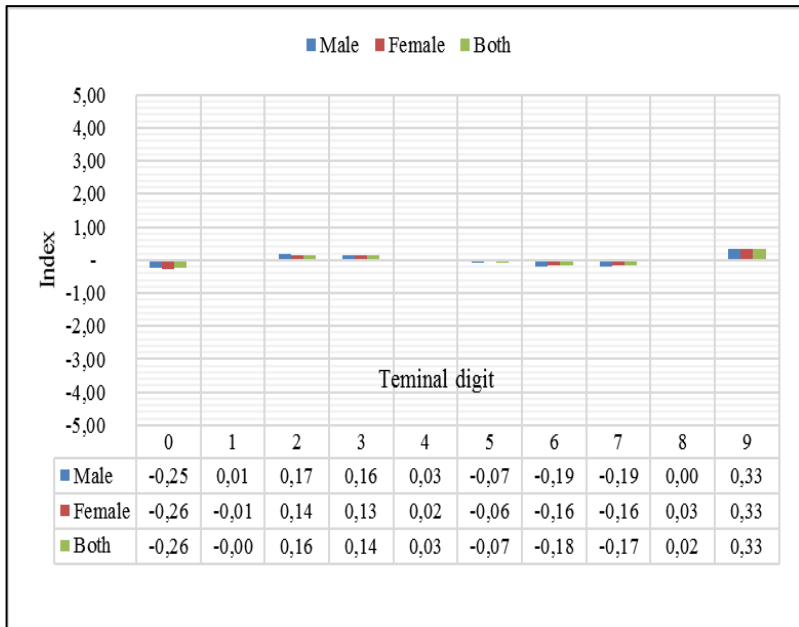
Figure 2. Sex ratio by five – year age groups and area of residency, the 2014 Morocco census



Source: Authors' work on the 2014 Morocco census data



Figure 3. Digit preference and avoidance in age reporting, the 2014 Morocco census



Source: Authors' work on the 2014 Morocco census data



**Tables:**

Table 1: Myers' index by sex, area of residency, and region, the 2014 Morocco census

	Male	Female	Both
<b>Area of residency</b>			
Urban	1.71	1.30	1.50
Rural	1.43	1.41	1.41
<b>Region</b>			
Tanger-Tétouan-Al Hoceïma	1.35	1.07	1.20
Oriental	1.55	1.61	1.58
Fès-Meknès	1.77	1.70	1.74
Rabat-Salé-Kénitra	1.36	1.47	1.42
Béni Mellal-Khénifra	1.36	1.42	1.39
Casablanca-Settat	1.68	1.34	1.46
Marrakech-Safi	1.39	1.24	1.31
Drâa-Tafilalet	1.32	1.09	1.20
Souss-Massa	1.47	1.54	1.49
Guelmim-Oued Noun	1.86	1.86	1.70
Laâyoune-Sakia El Hamra	1.69	0.96	1.33
Dakhla-Oued Ed Dahab	4.66	1.30	3.24
<b>Total</b>	<b>1.39</b>	<b>1.32</b>	<b>1.35</b>

Source: Authors' work on the 2014 Morocco census data



Table 2: United Nation Age Sex Accuracy Index (UNACI) by Area of residency and Region, the 2014 Morocco census

	Index	Component		
		Age ratio score male	Age ratio score female (%)	Sex ratio score x3
<b>Area of residency</b>				
Urban	23.63	7.14	5.32	3.73
Rural	20.45	6.25	7.09	2.37
<b>Region</b>				
Tanger-Tétouan-Al Hoceïma	27.03	7.98	7.84	3.74
Oriental	27.19	6.87	6.30	4.67
Fès-Meknès	23.59	8.22	6.38	3.00
Rabat-Salé-Kénitra	19.85	6.35	6.18	2.44
Béni Mellal-Khénifra	29.46	6.77	7.66	5.01
Casablanca-Settat	20.74	7.05	5.18	2.84
Marrakech-Safi	21.38	6.74	5.86	2.93
Drâa-Tafilalet	25.30	6.24	7.35	3.90
Souss-Massa	22.72	6.02	7.06	3.21
Guelmim-Oued Noun	39.45	7.05	8.38	8.01
Laâyoune-Sakia El Hamra	31.38	7.03	4.99	6.46
Dakhla-Oued Ed Dahab	90.96	12.80	9.07	23.03
<b>Total</b>	<b>20.62</b>	<b>6.79</b>	<b>5.80</b>	<b>2.68</b>

Source: Authors' work on the 2014 Morocco census data



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