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Abstract

Background: Vital information is recorded in only 25% of middle-income countries.

Aims: This study was carried out to estimate the number and causes of deaths expected in the population, using hospital death data and comparing it with the Ministry of Health and the Civil Registration Office, Tehran, Islamic Republic of Iran.

Methods: Death data of hospitals were extracted from 2011 to 2015 and were corrected qualitatively through reference to medical records. Using Murray’s proposed method, an estimate of the expected death was obtained by separating the cause.

Results: During 5 years of study, 12,704 deaths were recorded in the hospital and Murray’s Method estimates 28,768 deaths for the entire population. The cause with the highest percentage of death was ischemic heart disease. The results were compared with the data of the Ministry of Health and the Civil Registration Office, which had a relative error of 6.9% and −13.5% respectively. This study showed fewer records in Ministry of Health and lower estimate than Civil Registration data.

Conclusions: Considering the importance of registering deaths, alternative methods are needed
to estimate the number and causes of death in a population with low cost and efficiently.

Keywords: Death estimated; Murray Method; hospital mortality; cause-specific mortality rate, Iran


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Introduction

Statistics and causes of mortality in each community form a number of significant components in the health planning of a particular community (1). Since death event occurs once, its timely registration is significant and its correct statistical record is the basis of demographic analysis (2). In order to monitor epidemiological changes of illnesses, the health sector relies heavily on the proper functioning of such vital records and statistics (3). Moreover, the trend of changes in the causes of mortality over time determines the orientation of the country’s health policies. Based on different age and sex groups, death indicates the status of health services and the health status of different groups of society (4). Despite the vital significance of information on the causes of mortality, data availability and accuracy are limited in many countries (5). Vital information is recorded in only 25% of middle-income countries and 5–10% of low-income countries (6,7).

In the Islamic Republic of Iran, various institutions are responsible for registering vital events such as the Civil Registration Office and the Ministry of Health. In addition to these two institutions, regarding death registration, the forensic organization has taken certain measures in some cases and collected useful information on specific death cases (8). The Civil Registration Office and the Ministry of Health have always had a percentage of errors in collecting deaths data due to a number of frequent reasons. The vast majority of information
collected by demographic experts in the country, in relation to mortality rates and disagreements in this regard, confirm the failure in accurately registering mortalities (9).

Studies of the extent and causes of mortality in the Islamic Republic of Iran, and many other countries, indicate its direct relation with the level of a society’s health and development. Therefore, such research has a major effect on programmes aimed at promoting the health and livelihood of the community (10).

A similar study by Murray et al. was conducted based on data available in Mexico, in which hospital deaths registered were used to estimate the cause-specific mortality rate in the whole population with the minimum rate of error (11). This highlighted certain novel approaches to estimating cause-specific mortality fractions with data on cause of death collected from different institutions. The Islamic Republic of Iran is also one of the countries that Murray et al. mentioned as potential for applying the method. In addition, the results of studies by Khosravi (12) and Komijani (13) point out the low registration of death events in the country using various statistical methods.

Using the Murray Method, and considering that data available in hospitals are the most suitable and most accessible source for determining the cause of death, the distribution of the expected mortality was determined based on the international coding of diseases in the whole population of Ardebil (northwest of the Islamic Republic of Iran) by sex, age, and causes of death. Ardebil province covers 17,953 square kilometres and its population is 1,270,420 based on 2016 census (https://www.amar.org.ir).

In the review of the human development index (HDI), Ardebil province scored 0.692 (middle ranking); for the whole country the RDI is 0.742. The effective factors in this index include life expectancy, literacy rate, and per capita income. This data, including distribution of mortality in Ardebil province by age, sex, and causes of mortality, can be used in regional health decision-making as well as for intervention measures and improvements in registration and reporting systems for death in the province.

**Methods**

This study is a descriptive–analytic study. Data were extracted from civil registration offices, the death registration system of the Ministry of Health, and from hospitals in Ardebil province.
Death information was extracted from Ardebil University of Medical Sciences, and the mortality data collected from the hospitals was done in accordance with the regulatory checklist. Data were subsequently investigated quantitatively and qualitatively and in terms of the mortality cause. In cases where the required information was not correctly registered, the information was extracted to improve the quality of the data by using the medical records of the deceased. In the case of indecipherable international coding of diseases, medical records were extracted from the underlying cause of death and registered in the forms. The mortality rate was calculated based on the proposed Murray Method. We compared this information with the data registered in the Ardebil province Civil Registration Office and Ministry of Health and obtained the percentage of relative error by year, which was compared with the actual information recorded.

**Information analysis method**

The results of this study were calculated using Excel software and the proposed Murray Method using the formula (11):

\[ D_{asj} = \frac{H_{asj}}{P_{asj}} \]

\( D_{asj} \) is the total death rate for the age group \( a \), sex \( s \), and the cause of death \( j \). \( H_{asj} \) is the mortality rate in the hospital for the age group \( a \), sex \( s \), and the cause of death \( j \). \( P_{asj} \) is the ratio of death in the hospital for age group \( a \), sex \( s \), and cause of death \( j \). The relative error percentage is calculated based on the following formula:

\[ \text{Relative error percentage} = \frac{\text{The actual amount - Test result}}{\text{The actual amount}} \times 100 \]

It should be noted that due to the lack of any similar study in the Islamic Republic of Iran and the lack of access to mortality ratios in hospitals, Murray's study ratios were used in this research.

**Ethical considerations**

Ethical clearance for this study was received from the School of Public Health, Shahid Beheshti University of Medical Sciences, Tehran, Islamic Republic of Iran, ref. IR.SBMU.PHNS.REC.2016.141.
Results

A total of 12,704 deaths occurred in the hospitals in Ardebil province from 2011 to 2015, covering all age groups, of which 7,341 cases were males (57.8%) and 5,363 cases were females (42.2), and the male to female ratio was 1.36. The mean (SD) age of death in males was 55.19 (28.72) and in females 57.29 (29.42) years. The mean age of death in the groups 1–28 days, 15–64 years, and all ages in females was higher than that of males and the observed differences were statistically significant ($P < 0.05$). The observed differences between the age of death in males and females for other age groups were not statistically significant ($P > 0.05$) (Table 1).

Table 2 shows the specific estimates of the cause of death obtained using the proposed Murray Method. From 2011 to 2015, the rate of expected deaths for the population was 5,747.2, 5,861.8, 5,739.2, 5,574.1 and 5,845.7. Meanwhile, the leading cause of mortality in all years of the study was ischemic heart disease. Other causes of death according to Murray’s estimation include: other cardiovascular diseases, hypertension, cerebrovascular disease, other unintentional events, stomach cancer, other malignant neoplasms, other respiratory diseases, lung cancer, low birth weight, birth asphyxia, and birth trauma.

Table 3 shows the relative error percent of the data registered in the Ardebil province Civil Registration Office in relation to the information based on the proposed Murray Method by sex and age. This table states that the relative error percent for 2011–2015 was 7.9, 4.7, 8.6, 9.6 and 3.6, respectively. In addition, among males the smallest difference was observed in 2012 with $–0.1\%$, and the largest difference was in 2013 with 7.2\%. Among females, the smallest difference was in 2015 with 4.2\%, and the largest difference was in 2014 with 15.2\%. The data in Table 3 shows that in all study years, the mortality rates registered by the Civil Registration Office is higher than the estimated results of the present study.

Table 4 shows the difference between the data registered in Ardebil University of Medical Sciences and the information based on the proposed Murray Method categorized by sex and age. Table 4 states that the smallest difference was in 2015 with $–4.9\%$ and the highest difference was in 2012 with $–21.4\%$. Among males, the smallest difference was observed in 2015 with $–5.4\%$, and the largest difference was in 2011 with $–23\%$. Among females, the smallest difference was observed in 2015 with $–4.2\%$ and the largest difference was in 2012 with $–20\%$. The data in Table 4 shows that in all years of study, the rate of mortality registered by Ardebil University of Medical Sciences is less than the results of this study.
Figure 1 shows the obtained relative error percentage from a comparison of the Murray Method results with the information from the civil registration office and ministry of health over 5 years, which itself indicates the improvement in information registration. During this period the number of registered death events in the Civil Registration Office was 6.9% higher compared to the Murray Method estimation, while Ardebil University of Medical Sciences has –13.5% fewer registrations.

Discussion and conclusion

Registering vital events, especially mortality, is essential in order to research the causes of premature deaths and plan effectively for health promotion programmes. The mortality rate in hospitals in Ardebil from 2011 to 2015 showed a male to female ratio of 1.36%. For the total of deaths in hospitals, 57.8% was related to males and 42.2% to females. Studies by Foruzanfar (14), Tariq (15) and Pattaraarchachai (16) provided similar results in terms of the sex ratio of the deceased. Khosravi et al. (2015) (17) also reported a male/female sex ratio of 1.37% among the deceased and a total of 57.9% was related to males and 42.1% to females. Studies by Moore and Wilson (18) suggest that males are more likely to die from parasitic and infectious diseases than females, which may be due to differences in male and female immunity to these infections.

In the United States of America, United Kingdom and Japan, males are twice as likely to die from parasitic diseases than females (19). Males also demonstrate more high-risk behaviours such as violence, accidents and suicide (20). Studies by Akbari (21), Pope (22) and Kubeta (23) also state that the average age of death due to accidents, events and cardiovascular disease in males is lower than in females, helping to explain the difference in age between the sexes, which is consistent with the results of this study.

In the present study, we obtained the rate of estimated deaths in all study years, which were more than the rate of deaths registered by the Ministry of Health; this is consistent with the results of Khosravi et al. (24), Murray et al. (11), Komijani et al. (13), Jebarian (9) and Zanjani (25). However, the estimated mortality rate in our study is lower than that registered by the Civil Registration Office. Given that the causes of mortality in a significant ratio of hospital deaths, especially in the early years, were unclear, these cases were placed in the other group of causes and were probably related to the most common causes of death (such as cardiovascular diseases). Clearly, by improving the hospital registration system, it can be expected that the ratio of "other causes" will be reduced and added to the main groups. Therefore, this study demonstrated that the population mortality estimation becomes more accurate from the hospital data and the relative error rate relative to mortality compiled by the Civil Registration Office decreases.
One of the major obstacles to effective death registration system in the Islamic Republic of Iran is that the responsible authorities act individually and in isolation. Based on the experiences of the electronic registration system of mortality in high-income countries, which have a central database, it is recommended to create a centralized meta-electronic registration system in the country.

Given the low registration over the consecutive years indicated in this study, and given the significance of information registration in health decision-making and policy-making, the current registration system seems unable to provide adequate information for the development of health programmes in the Islamic Republic of Iran. Therefore, alternative methods are needed in order to have a descriptive epidemiological estimation of population with low cost and short time. The method used in this study has the advantage of comparing the expected rate of mortality in the form of cause-specific mortality groups, which play a significant role in decision-making and formulating health policies.

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