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Bayesian Analysis of Breast Cancer Mortality to Reduce the Effects of Misclassification

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Background: Breast cancer (BC) is the most common cancer in Iranian women. Studying the mortality statistics is important to monitor the effects of screening programs or the influence of earlier diagnosis on the burden of this chronic disease. Misclassification is still a problem in the Iranian death registry data and about 20% of death statistics are recorded in misclassified categories.
Objectives: The aim of this study is to re-estimate the mortality rate of Breast cancer in the Iran by a Bayesian model in order to exclude the bias due to misclassification.
Materials and Methods: The mortality data were extracted from national death Statistic, which reported or published by the Ministry of Health and Medical Education, from 1995 to 2004. The rate of mortality due to BC [ICD-10; C50] were expressed as the annual rates per/100,000 population in age group (< 15, 15 - 49 and ≥ 50 years of age) and also, age standardized rate (ASR) calculated in this study. To correct the misclassification effect, a Bayesian approach was used with Poisson count regression and beta prior.
Results: The results of the Bayesian analysis indicated that there were between 20 to 30 percent misclassified deaths statistic in mortality records which did not reported and re-estimated by this model for BC. Also the rate of BC mortality has increased in recent years; however it seems that the rate would be leveled off from 2002 to 2004.
Conclusions: The findings revealed a substantial misclassified mortality statistics of BC in the Iranian women. Therefore policy makers in health scope should notice to this unreported data.

Keywords: Breast Cancer; Mortality; Bayes Theorem

1. Background

Breast cancer (BC) is the most common cancer among women worldwide (1). Cancer is an important health problem in Iran. According to recent reports, published by the Ministry of Health and Medical Education; cancer is the third cause of death in Iran (after coronary heart disease and accidents) (2). In Iran, breast cancer ranks first among cancers diagnosed in women (3). Breast cancer is the most frequent cancer in population of women in Tehran too (4) and the fifth most common cause of death for Iranian women (5).

Mortality is a familiar projection in the assessment of the burden of cancers. Studying the mortality statistics is important to monitor the effects of screening programs or the influence of earlier diagnosis on the burden of this chronic disease (6). Data on cancer mortality can be used to guide policy makers in order to setup cancer prevention programs. But this aim needs reliable death registry systems which report death statistics annually and accurately. On the other hand, when death statistics are subjected to misclassification, it leads to biased estimation in epidemiological analysis, and can therefore makes to underestimate health risks for causes of death like cancers (7). Based on the Iranian death statistics, between 15% to 20% of mortality data are registered in misclassified categories; including Senility without mention of psychosis Symptoms, septicemia, etc. (8).

There are two approaches for reducing the effects of misclassification when misclassification occurs; The first using a small validation sample (9) and the second being a Bayesian analysis which provided subjective prior information for the subset of the parameters for re-estimate and correct the death statistic (10, 11).

2. Objectives

The aim of this study was to correct the mortality rate of BC for the Iranian women, using a Bayesian model.

Implication for health policy/practice/research/medical education:
This study helps the policy makers to correct the national statistics of mortality.

3. Materials and Methods

The mortality data were extracted from national death Statistic, which reported or published by the Ministry of Health and Medical Education (MOH&ME), from 1995 to 2004. These death statistics were registered for Iranian population by the Information Technology and Statistic Management Center from 1995 to 2000 and for other years (2001 to 2004) published by the Ministry of Health and Medical Education (8). The data were stratified in age group and cause of death. The coding was according to the 9th revision of the International Classification of Diseases [ICD-10].

The annual breast cancer death rate [ICD-10; C50] were expressed per 100000 population in age groups (<15, 15-49 and ≥ 50 years of age). Also, age standardized rate (ASR) calculated in this study (12). To correct the misclassification effect, a Bayesian approach was used with Poisson count regression and beta prior. The Iranian population sizes, between years of 1995-2004, were extracted from the national census from 1996 (conducted by Statistics Centre of Iran) and also the estimations according to population growth rate (which estimated by the Statistics Center for the years before and after national census) (13).

The Bayesian model which considered here was derived from an approach proposed by Stamey et al. to re-estimate and correct the misclassification effects in a Poisson regression model (7). This technique was extended to overcome the problem of misclassification in cancer mortality data (10, 11) Also Pourhoseingholi et al. developed this technique to estimate mortality rate of colorectal cancer (14) liver cancer (15) and pancreatic cancer (16). In this study, to correct the misclassification effect, the Bayesian approach proposed by Stamey et al. and developed by Pourhoseingholi et al. was used with Poisson count regression and a beta prior (7, 14). In this Poisson regression the dependent variable was the number of death due to BC and the independent variables were Sex and Age. The Bayesian correction was taken into account and all analysis carried out, using a macro, written is S-Plus.

4. Results

All mortality records for women due to Breast Cancer (from 1995 to 2004) were included in this analysis. Mortality rate due to BC (classified in age groups) which generated from the original database (called Frequentist Rate) and their corresponding projections which produced by Bayesian model (called Bayesian Rate) appeared in Table 1 and Table 2. Based on the results of Bayesian model, the Bayesian rates were between 20 to 30 percent higher than corresponding Frequentist rates (Table 1). It means that there are 20 - 30 percent underreported deaths in mortality records due to BC (Figure 1 and Figure 2). The age standardized mortality rate due to BC also increased dramatically during these years, though it seems that the rate would be leveled off from 2002 to 2004. Moreover the mortality increased as age increased (Table 2).

Table 1. Age Standardized Rate and Age Specific Rate (Per 100,000) for Breast Cancer Mortality After Adjusting for Misclassification by Bayesian Model

Year	Crud Rate		ASR	
	FR[a]	BR[a]	FR	BR
1995	0.96	1.18	1.40	1.72
1996	1.36	1.65	1.93	2.34
1997	1.54	1.85	2.23	2.45
1998	1.41	1.69	1.99	2.39
1999	1.91	2.26	2.74	3.24
2000	2.12	2.48	3.18	3.78
2001	2.38	2.90	3.11	3.79
2002	2.75	3.30	3.69	4.87
2003	2.72	3.18	3.69	4.32
2004	2.58	3.07	3.52	4.26

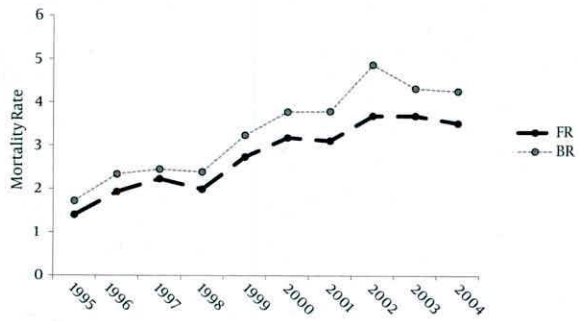
[a] Abbreviations: BR, bayesian rate; FR, frequentist rate.

Table 2. Mortality Rate in Different Age Groups (Per 100,000) for Brest Cancer After Adjusting for Misclassification by Bayesian Model

Year	Age Group, y					
	<15		15 - 49		≥ 50	
	FR[a]	BR[a]	FR	BR	FR	BR
1995	0.00	0.00	0.74	0.91	4.63	5.67
1996	0.03	0.04	1.08	1.32	6.24	7.80
1997	0.02	0.02	1.14	1.25	7.47	8.81
1998	0.02	0.02	1.20	1.56	6.24	8.11
1999	0.05	0.06	1.49	2.01	8.93	11.61
2000	0.06	0.07	1.65	1.96	10.58	12.91
2001	0.01	0.01	1.82	2.22	9.88	12.04
2002	0.00	0.00	2.14	2.82	11.80	14.99
2003	0.00	0.00	2.10	2.67	11.90	15.11
2004	0.00	0.00	2.08	2.62	11.16	14.84

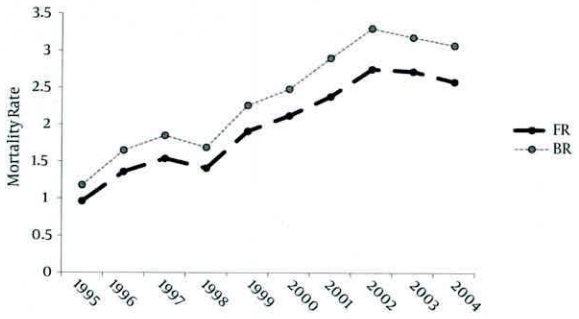
[a] Abbreviations: BR, bayesian rate; FR, frequentist rate.

Figure 1. Trends of Breast Cancer Mortality During the Period 1995 - 2004



Age standardized rate per 100,000; FR, frequentist rate; BR, bayesian rate.

Figure 2. Trends of Breast Cancer Mortality During the Period 1995 - 2004



Crude rate per 100,000; FR, frequentist rate; BR, bayesian rate

5. Discussion

The results of this study indicated that between 20% - 30% of mortality due to BC was underestimated. So there is a substantial under reported mortality due to BC in the population of Iranian women. Also there is an increasing trend for BC mortality in Iran in recent decade, although its mortality is still relatively low compared with Western industrialized countries. Iran is located in the western part of Asia which in this region, breast cancer in women is number one (17). In a vulnerable household women's health assessment study which covered 11 provincial centers in Iran, 6.6% of participants reported the family history of breast cancer (18).

According to WHO mortality database, the ASRs for Breast cancer in three Asian countries (including Hong Kong, Korea and Japan) were lower, compared to the ASRs in Western countries with increasing trend (except for Hong Kong), between 1990 and 2006 (19). Iranian data suggested a similar decreasing trend, compare to other Asian countries. Although mortality data is a well index for measuring burden of diseases, the misclassification of registered data for mortality records is still a problem in developing counties. In Iran, mortality data for different causes of death are collected from various sources and have been assessed to be about 80% complete (20). In spite of this, there are still about 20% undefined mortality records that are categorized in wrong categories of causes of death as the misclassification.

Recently, the Bayesian approach was more employed for resolve the problem of misclassification. Whittemore and Gong used this model to estimate mortality rate of cervical cancer which subjected to misclassification (10). Stamey et al. employed this technique in data consisting the number of deaths due to cancer and non-cancer which happened in residents of Hiroshima and Nagasaki, who experienced or be affected the atomic bombings in August of 1945 (7) and Pourhoseingholi et al. studied this technique to estimate mortality rate in colorectal cancer (14), liver cancer (15) and pancreatic cancer (16) according to Iranian death statistics.

In conclusion, this study provides a Bayesian comprehensive projection of death due to BC, based on the national Iranian death registry, indicating that the trend of BC mortality has dramatically increased in the recent decade. In addition, there is still a substantial undercount of BC mortality according to the Bayesian model. Therefore, policy makers in health scope should notice to this unreported data to make a reliable estimation for the indicators of the burden of disease.

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Authors' Contribution

Pourhoseingholi M. A. developed the original idea, Vahedi M. and Pourhoseingholi A. participated in Data analysis, Pourhoseingholi M. A., Vahedi M., Pourhoseingholi A. and Ashtari S. participated in manuscript writing.

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Nothing to declare.

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