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Population Attributable Fraction for Cardiovascular Diseases Risk Factors in Selected Countries: A comparative study

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ABSTRACT

Background: Cardiovascular diseases are the most common cause of death. The prevalence of cardiovascular diseases was reported to be 3,500 per 100,000. And it is predicted that these numbers will increase in the near future. By removing the main factors responsible for non-communicable diseases, cardiovascular disease can be prevented by 80%. **Aim:** The aim of this study was to compare the population attributable fraction for cardiovascular diseases' risk factors in Iran, USA and Spain. **Methods:** This study was a comparative study and the population consisted of Iran, USA and Spain. The required information was collected from printed and electronic documentations and articles published in reliable databases, in the period 2007-2015. **Results:** The cardiovascular diseases' Population Attributable Risk or Fraction for blood pressure was calculated to be 11.37%, 54% and 60%, diabetes 7.32%, 13% and 18%, and high cholesterol 6.85% , 13% and 20%, for Iran, USA and Spain respectively. Among risk factors, blood pressure was the most relevant factor to cardiovascular disease. **Conclusions:** The risk factor for high blood pressure had a more population attributable fraction than other physiological factors in the development of cardiovascular disease. Hence, by implementing comprehensive health policies, educating healthy lifestyle, screening and finding related cases as well as conducting health promotion programs, these diseases can be prevented.

Keywords: Population Attributable fraction, risk factors, cardiovascular diseases.

1. INTRODUCTION

With the development of human societies and controlling of communicable diseases and thus extension of the people's lives, chronic diseases, especially cardiovascular diseases (CVD) have become more common (1). Cardiovascular diseases are often defined as heart's inability to adequately pump blood to meet the requirements of tissues for oxygen and nutrients (2). Cardiovascular diseases may be considered as the major cause of worldwide disability and premature death and as the essential contributing factor in the rise of health care costs; in 2030, based on the estimations of the World Health Organization (WHO), these diseases will cause 23.6 million deaths (3).

Currently, about 80% of deaths and 87% of disabilities which are happening in the lower middle-income countries are originating from cardiovascular diseases (4). Existing studies suggest that in Mediterranean and Middle East countries, including Iran, cardiovascular disease stands a major health and social problem, which is rapidly increasing in all dimensions (5). Heart failure is a major cause of disability and death in the population in Iran and with the changing age pyramid and aging population, in the near future, the current outbreak of 3,500 patients per 100,000 people will grow (6). In addition, Myocardial infarction age in Iran is declining so that a large percentage of patients with these diseases are at ages less than 60 years (4).

The rapid economic and social changes in recent decades in many countries in this region have caused the prevalence of risk factors for cardiovascular diseases to increase considerably (1). Cardiovascular disease can cause increased mortality, disability, poor quality of life, high costs and many social problems (7). On the other hand cardiovascular diseases affect the health of workers and would cause working constraints (8). Economically, the costs associated with this disease are estimated to be at about four billion dollars (9). It is estimated that for every 10% increase in deaths from non-communicable diseases, annual

economic growth is reduced by 5% (10).

International evidences and recommendations from reference organizations show that the removal of the main factors responsible for non-communicable diseases, 80% of cardiovascular diseases and type II diabetes and 40 Per cent of cancers can be prevented.

The cost for the prevention of these diseases is far less than the cost of their treatment, in other words, for every dollar spent in the prevention of non-communicable diseases, there are at least 7-10 dollars paid back (10). However, cardiovascular diseases are the most preventable of non-communicable diseases. The prevention of these diseases is one of the most important goals of the national health system (11). And the best way to prevent this disease is the modification of risky behaviors that make a person vulnerable to this disease (12). Recent studies have shown that cardiovascular prevention is 4 times more effective than secondary prevention measures (3).

Cardiovascular disease risk factors can be divided into three categories: non-modifiable risk factors (age, gender, family history of premature cardiovascular disease and race), behavioral risk factors (smoking, tobacco, unhealthy diet, sedentary life and the absence of suitable physical activity) and physiological risk factors (hypertension, diabetes (diabetes), obesity and weight gain, hyperlipidemia) (1). Results of the study in 2012 to assess gender differences in risk of coronary heart disease conducted in Iran showed that blood pressure and diabetes are significantly associated with cardiovascular disease (13). A study in 2011, for the purpose of calculating the share of population attributable fraction (PAF) for cardiovascular disease risk factors, the highest population Attributable fraction was attributed to hypertension and high blood pressure and diabetes (women and men) were given priority for preventive strategies of CVD (14).

Population attributable fraction is a proportion of disease in the population that can be attributed to a particular risk factor and if eliminated, exposure to the risk will be potentially preventable (15). This index helps to measure the effects of risk factors on public health and evaluate the potential impacts of preventive interventions on public health. And as a combinational value of the power of the factor and the frequency of exposure, makes it possible to estimate the relationship between risk factor and the disease in the society (16). As for the role of various risk factors in cardiovascular disease and the importance of this index in prioritizing preventive interventions, this study aimed to compare the population attributable fraction for cardiovascular diseases risk factors in Iran, USA and Spain. Findings can suggest some interventions to prevent these diseases in Iran.

2. PATIENTS AND METHODS

This study was a comparative study in which printed and electronic documents and articles published in Persian and English in the period 2007-2015 were used. The articles were indexed in reliable bases such as PubMed, Thompson Reuters, Google Scholar, SID, and Magiran.

The population attributable fraction calculated for cardiovascular disease risk factors in this study, has been extracted from a study by Taheri et al in 2015, with the aim of evaluating the application of "population attributable fraction" index to prevent cardiovascular disease (17). In this review, criteria such as the proportion of the disease burden to the population, mortality, the diseases trend, and the index of the population attributable fraction for cardiovascular disease risk factors were used to study selected countries.

Statistical analysis

Of the methods of calculating population attributable fraction, if the data are obtained from incidence and prevalence of risk factors in cohort studies, is using the following formula.

$$P_{OP}AR\% = \frac{Pe \times (OR-1)}{Pe \times (OR-1)+1}$$

In this formula P_e indicates the prevalence of risk factors in healthy people and RR indicates adjusted relative risk for each risk factor (17).

3. RESULTS

According to the WHO data (2012-15) on demographic features, mortality from cardiovascular disease, adjusted mortality, economic indices and disease burden, including Disability-adjusted life years (DALYs) which is the sum of years of life lost due to premature mortality (YLL) and years of healthy life lost due to disability (YLD) are presented in Table 1 (18, 19).

Index	Iran	USA	Spain
WHO region	EMRO	AMRO	EURO
Population(thousands)	76424	318000	46755
Urban population (%)	69.1	82.4	77.4
30-70 Population ratio (%)	41.8	50.3	55.7
GDP per capita (US dollars)	15	53	31
Health sector's share of GDP (%)	6.9	17.1	8.9
Health expenditure per capita (US dollars per year)	1414	9146	2846
Life expectancy at birth (years)	74	79	82
Healthy life expectancy at birth	64	70	73
total number of deaths per year	395000	2656000	398000
Percentage of non-communicable disease deaths in total mortality per year (%)	76	88	92
Percentage of cardiovascular mortality in non-communicable disease deaths (%)	46	31	31
DALYs	4733	18929	2434
YLD per 100,000	0.67	1.08	1.21
YLL per 100,000	5.54	4.95	4
cardiovascular diseases' rank in ten factors related to non-communicable disease burden	First	Second	First
CVD age-standardized death rate per 100,000	350	140	98
The number of CVD deaths under 70 years of age (thousands)	59	203	15

Table 1. Demographic indexes, health and economic indexes in selected countries

The percentage of non-communicable disease deaths in total mortality per year in Iran is lower than USA and Spain. On the other hand, the percentage of deaths caused by cardiovascular disease comparing with other non-communicable diseases in Iran is more than USA and Spain.

GDP per capita in Spain is larger than both USA and Iran. USA allocates a larger share of GDP to health sector, however,

the life expectancy and healthy life expectancy at birth in Spain is higher than USA; while it allocates a smaller percentage of GDP to health care and has lower health costs per capita compared to USA. Finally, it seems in this index Spain has the most appropriate status among studied countries.

Based on YLL and YLD data, premature deaths associated with cardiovascular disease in Iran and Spain are more, compared to the disabilities caused by the disease. And the rate in Iran is higher than other studied countries, while in USA, premature deaths due to cardiovascular disease are less than disabilities associated with this disease.

Spain, USA and Iran had respectively more death due to cardiovascular disease based on the age-standardized mortality rates. Although all three countries showed a steady downward trend from 2000 to 2012, Iran with 350 death per 1000000 dramatically illustrated more CVD than USA and Spain with 140 and 98 per 1000000, respectively. Women in Iran had more mortality rate than men due to CVD in 2000 but a gender pattern change observed in studied time period;

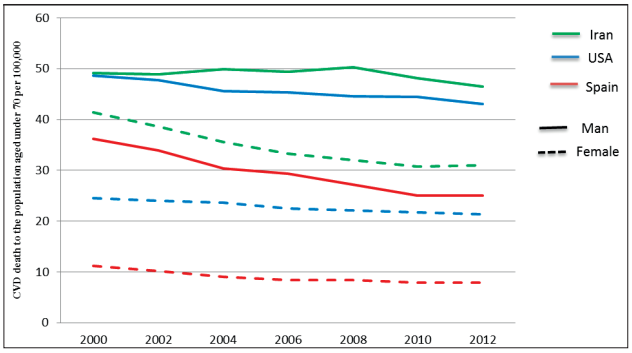

Figure 1. Percentage of death related to cardiovascular disease to the population aged under 70 In Iran, USA and Spain in 2000-2012 (18).

Female mortality rate decreased more than male, so in 2012 men had more CVD related death in Iran (18, 19).

Information about the number of deaths from cardiovascular disease in people less than 70 years of age in both men and women is depicted in Figure 1. It indicates that between 2000- 2012 in Iran this index was higher than other studied countries. The mortalities due to these diseases decreased during 2000-2012 in all three countries and both genders. However, the number of deaths in men, in 2004 and 2008, in Iran slightly increased.

Physiological risk factors' attributable fraction of in association with the CVD including hypertension, diabetes (diabetes), hyperlipidemia (high cholesterol) and obesity are presented in Table 2.

Country	Hypertension	High cholesterol	Diabetes	Overweight
Iran	11.73	6.85	7.32	5.91
United States	54	13	13	-
Spain	60	20	18	-

Table 2. Population attributable fraction (% PAF) cardiovascular disease risk factors in the countries studied

According to gathered data, three risk factors including high blood pressure, diabetes and high cholesterol, respectively, in the studied countries looks to have the highest contribution in the cardiovascular diseases' incidence. In all three countries, hypertension has a greater share than other risk factors for the development of cardiovascular disease and this index for Spain shows more association than Iran and USA.

4. DISCUSSION

According to the population of the countries studied, the PAF associated with cardiovascular disease risk factors in Iran was been calculated lower than the other two. The cause could be poor follow-up system which effects on complications' incidence in younger age, increase in the severity and the percentage of disability in addition to premature deaths and finally leads to a substantial increase in indirect losses caused by cardiovascular diseases.

The results of this study show that based on the index of population attributable fraction of physiological factors, the highest incidence of CVD can be attributed to high blood pressure risk factor. High blood pressure risk factors include: age over 60, diabetes, smoking, dyslipidaemia, family history of premature cardiovascular disease, male sex and female postmenopausal age (12). Several studies indicate the need for effective interventions to change lifestyle in order to control and reduce blood pressure. In Saber Moghadam et al study (2013), inactivity, stress, obesity and poor nutrition mentioned as the most important factors affecting the incidence of hypertension (20). In Mansourian et al study (2012), a significant relationship was observed between the dimensions of lifestyle (physical activity, nutrition, spiritual growth, interpersonal communication and stress management) and hypertension (21). People with high blood pressure should regularly monitor their blood pressure daily and avoid arbitrary discontinuing use of prescribed drugs (12). Although by controlling other cardiovascular diseases' risk factors these diseases incidence can be reduced, due to the high prevalence of hypertension in the community, controlling blood pressure appears to be much more reasonable in terms of the effectiveness.

In this study, the population attributable fraction for diabetes in the incidence of cardiovascular diseases, respectively, for Spain, USA and Iran has the highest rate. Risk factors for type II diabetes include genetic factors, obesity, age 45 years and older, race, hypertension, low birth weight, stress, diet and smoking (22, 23). Retrospective clinical studies have shown patients, with insulin resistance or diabetes, are more prone to high blood pressure (24). Prevalence of hypertension in people with diabetes is twice that of non-diabetic individuals. Between 30 to 75 per cent of diabetes complications are caused by high blood pressure (25). However, several prospective studies showed that lifestyle changes related to obesity, dietary behaviors, physical activity, stress reduction and smoking cessation play a major role in the prevention and controlling of type II diabetes (22, 23).

Based on the results of this study, of all the CVD occurrences, the population attributable fraction associated with high cholesterol, respectively in Spain, USA and Iran is the highest. According to studies, serum cholesterol (low HDL, high LDL, high triglycerides) in developing countries is increasing. These changes could be largely attributed to a higher intake of fat in meals, inactivity and eating habits (26, 27). Ten per cent increase in serum cholesterol, increases

risk of cardiovascular disease about 20-30% (1). In this case the first therapeutic advice is to control the increase of blood lipids and weight loss. Diet, exercise and finally, Statins are the subsequent treatment steps (12).

In this study, obesity, with 5.91 per cent is known as the fourth risk factor for CVD events in Iran. The prevalence of obesity is higher in diabetics. Mortality in obese individuals compared to normal people is between 25 to 75 per cent (1, 28, 29). Obesity is a multifactorial disease that factors such as heredity, gender, birth weight, duration of breast feeding, age of complementary feeding, age and education of parents, parental eating behaviors, family size and economic status play role in its creation (30). Obesity can cause diabetes along with high blood pressure and elevated blood cholesterol, and decrease HDL, all of which are a risk factor for cardiovascular disease. For every 5-unit increase in BMI, the risk of high blood pressure increases by 10% (31). The results of a study by Robinson et al in order to reduce watching and playing of television, video and computer games, found that after 7 months of follow-up, BMI of children decreased significantly in the intervention group compared to the control group (32). Another study by Azadi et al (2008), entitled "Influence of health promotion program in schools on controlling of risk factors" concluded that using health promotion program in schools were effective in controlling risk factors associated with obesity regarding dietary pattern and physical activity (33).

According to the WHO, Deaths from cardiovascular disease in proportion to the total deaths occurred in a year especially in those under 70 years of age in Iran is more than USA and Spain (18). Besides Based on burden of diseases index, YLLs for CVDs in Iran is calculated higher than other two countries, While YLDs for these diseases are lower (19). Several studies have shown that cardiovascular mortality in developing countries occurs about one or two decades earlier than developed countries (34). In the same time, these diseases in high-income countries have been declining (35). This difference can be attributed to the early incidence of these diseases, lack of suitable screening and detection systems for people at risk and insufficient medical care for patients in developing countries, alongside with success in primary prevention methods and novel therapeutic approaches in developed countries.

It seems that the most important action in preventing cardiovascular diseases to educate people about the risk factors, symptoms, and widespread and severe complications of these diseases, in order to inform people about them. These educations can promote a healthy lifestyle. In addition, encouraging regular physical activity will significantly prevent the development of the diseases such as high blood pressure, diabetes, cholesterol, obesity. Moreover, following considerations can reduce the incidence of hypertension and diabetes: maintaining a normal weight (2-10 scores reduction of systolic blood pressure for every 5 kg of weight loss), Reducing tobacco consumption and not being exposed to tobacco and finally managing stress in healthy ways, such as meditation, proper exercise and healthy social relationships (36, 37).

For implementing projects intended for the prevention of cardiovascular disease, programs in USA such as "life simple 7", "HHER (Heart Healthy and Ethnically Relevant)", "CARMEN", which are associated with promoting a healthy lifestyle among the people, schools and staff could be modeled (38-41).

These educations can be done through different media within a short time (10.5 minutes) in the interval between television broadcasts particularly popular entertainment programs to attract more people. Also brochures can be distributed with touching images and health advices regarding the risk factors of cardiovascular diseases in the population covered by health centres. Of other solutions can be mentioned is increased physical and financial access for people and patients to the required care and services through various means such as the development of diagnostic and therapeutic services in urban and rural health centres, increasing the coverage of services related to cardiovascular diseases. And medications welcomed by doctors and as well as providing access to home blood pressure measurement device, which while increasing the alertness of the patients about blood pressure control itself, leads to controlling it more efficiently.

On the other hand, by developing sport facilities in each city properly for its population and providing free counselling services and health advices by trained individuals in these centres associated with risk factors for non-communicable diseases, especially hypertension risk factor and identifying people at risk in these places and introducing them to health centres for follow up and care, this diseases can be addressed. These activities in turn can decrease the costs of reduced productivity, disability and premature death due to cardiovascular disease. Comparing the performance of different service units and creating a competitive environment among the units and making personnel's activities competitive and motivated can be effective in better implementation of these plans.

The main limitation in this study was the lack of access to population attributable fraction values regarding various cardiovascular disease risk factors in Iran which caused only PAF of physiological risk factors be compared. On the other hand, even though smoking in Iran has the highest population attributable fraction in cardiovascular diseases (16.14%) in males (30), but for reasons such as the lack of statistics about smoking women in PAF calculation of this risk factor, cigarette smoking status as a behavioral risk factor could not be compared with the other countries (42).

5. CONCLUSION

Based on the index of population Attributable fraction, the main risk factors associated with cardiovascular disease were including hypertension, diabetes, high cholesterol and obesity. High blood pressure was the most relevant risk factor to cardiovascular diseases among physiological factors. Therefore, emphasis on codification of comprehensive policies, appropriate educational interventions on lifestyle modification, Screening and surveillance and sufficient attention to health promotion programs in all parts of the health system, especially health centres should be considered as imperative actions. These actions could be forward steps towards reducing disability and death from cardiovascular diseases and improving the health. Implementing these interventions needs planning and prioritizing health interventions, accountability for policies applied, administrative cooperation and public participation.

- Conflict of interest: none declared.

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