The burden of Ischemic Heart Disease and the Epidemiologic Transition in the Eastern Mediterranean Region: 1990-2019

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Abstract

Introduction The purpose of this study is to investigate the trends of the burden of ischemic heart disease (IHD) in the Eastern Mediterranean Region (EMR) countries from 1990 to 2019. Method Prevalence, disability-adjusted life years (DALYs), death, DALYs attribution risk factors, healthcare access and quality index (HAQ), and universal health care (UHC) were extracted from the database of the Global Burden of Disease study (GBD) for the EMR countries. Data stratification is based on the social demographic index (SDI). Cardiac rehabilitation data was obtained from the International Council of Cardiovascular Prevention and Rehabilitation (ICCPR) and other information was obtained by an advanced search of individualized countries’ data. Result IHD age-standardized prevalence increased from 4.96% to 5.31% in the EMR from 1990-2019 while it decreased at the global level. In the EMR, the trend of age-standardized IHD death and DALYs rates decreased by 11.39% and 15.36% between 1990 and 2019 respectively, however, both rates were higher than the global rates. The burden of IHD in males was higher than females. The highest decrease of IHD age-standardized prevalence, death and DALYs rate in the EMR countries occurred in Bahrain (-3.72%, -64.95% and -69.08%, respectively). However, the most increase of prevalence happened in Oman with a change of 14.40% and for death and DALY rates was in Pakistan (29.62% and 31.93%, respectively) in the studied period. The top three attributed risk factor to IHD DALYs in the EMR in 2019 were high systolic blood pressure, high low-density lipoprotein cholesterol, and particulate matter pollution. The 29-year trend of an attributed risk factor to IHD DALYs in the EMR (1990-2019) showed that the two factors of high fasting plasma glucose (64.03%) and high BMI (23.39%) had an increasing trend, respectively. Conclusion Our results showed an increased trend of the prevalence of IHD in the EMR that requires well planned prevention and treatment strategies. Developing and implementing programs to address the risk factors through health promotion and education, preventive programs, and medical care should be a priority for countries in this region.

Introduction

Ischemic heart disease (IHD) is one of the main causes of the global burden of disease, which has devastating consequences for human health worldwide (1). Globally, IHD has been the leading cause of mortality in men and women in recent decades (2). In most regions of the world, disability-adjusted life years (DALYs) attributable to IHD are substantially higher in men than women. (3). Patients diagnosed with IHD need special services that are costly and require timely interventions to avoid multiple complications (4).

The Eastern Mediterranean Region (EMR) has a wide variation in culture, language, political and social context, historical background, and economic status (5). Healthy Life expectancy in the EMR in 2019 is estimated to be 60.2 and 60.7 years for males and females, respectively. Average health expenditure in the region is $ 695.3, ranging between $ 36 and $ 2106 (6). 

EMR countries are divided to 5 social demographic index (SDI) level including high (3 countries), High middle (6 countries), middle (5 countries) and low middle (3 countries) and low (4 countries) by the
GBD (7).

It has been estimated that in the next decade, IHD prevalence, DALYs and deaths will increase more significantly in EMR than in any other region of the world (8). The different prevalence of IHD in the EMR countries may reflect the healthcare system capacity and resources available to control the risk factors of the disease. For instance, attributed risk factor to DALYs of IHD in the EMR might be due to behavioral factors such as unhealthy lifestyle (poor diet, low physical activity and smoking habit), metabolic factors (hypertension, diabetes, and hypercholesterolemia), and environmental factors (e.g. air pollution) (8-10). Further, implementation of preventive strategies and patient follow-up also vary significantly in the EMR countries. This is evidenced in the availability of cardiac rehabilitation (CR), a guideline-recommended secondary preventive strategy, that controls IHD risk factors and reduces death by 20% (9).

Understanding the epidemiological transition and the burden of IHD in this region is essential for decision making and future plans for IHD prevention and therapeutic strategies (10, 11). This study aims to present the trend of the burden of IHD that consists of prevalence, DALYs and death. In addition, we present the burden measures by sex and (SDI) groups in the EMR countries from 1990 to 2019.

**Methods**

In current epidemiological study, data on IHD compiled from online query tool from the Institute for Health Metrics and Evaluation (IHME, GBD compare) dataset and advanced search in databases (PubMed, Google Scholar, EMR countries’ websites) in EMR countries between 1990 and 2019.

The EMR represents 22 countries in the region with 583 million people (12). In our study, information from Palestine was not available and not include. We assigned countries into 5 socio-demographic Index (SDI), high SDI (Kuwait, United Arab Emirates, Qatar), high middle SDI (Libya, Jordan, Saudi Arabia, Lebanon, Bahrain, Oman), middle SDI (Tunisia, Iran (Islamic Republic of), Iraq, Syrian Arab Republic, Egypt), low middle (Djibouti, Morocco, Sudan) and low SDI (Somalia, Pakistan, Yemen, Afghanistan) (7).

The main source of data was obtained through an online query tool from the Institute for Health Metrics and Evaluation (IHME, GBD compare) by extracting age-standardized IHD prevalence, death, DALYs rate, DALYs attribution risk factors (behaviors, environmental and metabolic) stratified by sex and SDI status and healthcare access and quality index (HAQ) and also extracted universal healthcare coverage (UHC) stratified by SDI status (8). UHC is Universal Health Coverage (UHC) Index is average coverage of necessary services including non-communicable diseases, infectious diseases, reproductive, maternal, newborn and child health, and service capacity and access (13). HAQ is a measure of health access and quality of care derived using death rates from 32 causes of death that could be prevented with timely medical care (14).

In addition, we obtained cardiac rehabilitation need (CR) from publications of the International Council of Cardiovascular Prevention and Rehabilitation (ICCPR) and for obtaining angiography, primary percutaneous coronary intervention (PPCI) and preventive community-based interventions (PCBI) were
used advanced search in databases (PubMed, Google Scholar, EMR countries’ websites). PPCI refers to the strategy of taking a patient who presents with STEMI directly to the cardiac catheterization laboratory to undergo mechanical revascularization (15).

EMR counties have different infrastructure and equipment/facility in primary health care and hospitals and private sectors. Then other indicators such as UHC, PCBI, PPCI facility, cardiac rehabilitation (CR) program number and CR capacity could compare EMR countries. CR capacity calculated using median number of patient’s program could serve per year (from survey) multiplied by the number of programs in the country (16).

We used R Statistical Software version 4.2.1 (R Core Team, 2022) used for statistical analysis.

**Results**

In this study, the age-standardized prevalence of IHD in the EMR increased by 7.06% between 1990 and 2019, while there was a decrease of 3.44% in the age-standardized prevalence for IHD at global level (figure1, Appendix2). Generally, the trend of 29 years of age-standardized IHD prevalence demonstrated that highest decrease and highest increase were Bahrain (-3.72%) and Oman (14.40%), respectively (Table1, figure2). Additionally, the percentage of age-standardized prevalence was higher in males compared to females and older patients had higher prevalence in the EMR (Appendices 3- 5).

There was a decrease of 11.39%, 15.36%, of IHD age-standardized of death and DALYs from 1990 to 2019 in EMR, respectively (Table 2,3). The age-standardized death and DALYs rate for males and older age patients was higher in 2019 in EMR (Appendices 6-9). Generally, the trend of 29 years of age-standardized IHD death and DALY demonstrated that highest decrease and highest increase were Bahrain (-64.95%, -69.08%) and Pakistan (29.62%, 31.93%), respectively (Tables 2, 3 / Figures 1, 2). Details about age-standardized deaths rate for males and females by SDI status and EMR countries are stated in Appendices 8, 9. Older patients had higher death and DALY in the EMR (Appendix3).

The 29 years change percentage of DALYs attributable risk factors showed that Bahrain had highest decrease in metabolic (-68.78%) and behavioral (-71.76%) and environmental (-70.99%). Pakistan had highest increase of 29 years change percentage for metabolic (42.54%) and behavioral (28.26%) and environmental (24.04%). (Appendix10, figure3).

Among the behavioral risk factors, three risk factors of dietary risk, low activity and tobacco, Pakistan had highest increase in trend of dietary and low physical activity in 1990-2019 (30.96% and 32.76%, respectively) while Djibouti had highest increase in trend of tobacco (11.78%). The highest decrease of trend in dietary and low physics and tobacco was in Bahrain (-71.70%, -64.85% and -76.90%, respectively) (Appendix11).

The top three risk factors for attributable IHD DALYs rate in the EMR were high systolic blood pressure, high LDL-C and particulate matter air pollution during the study years. The result of relative change of
29-year trend of attributed risk factor to IHD DALYs in the EMR (1990-2019) showed that the two factors of high fasting plasma glucose (64.03%) and high BMI (23.39%) had an increasing trend, respectively (Appendix12).

The result of relation of HAQ index and DALYs (1990-2015) showed in Somalia, Djibouti and especially Pakistan, DALYs has increased probably with increasing HAQ but in Bahrain, DALYs has decreased probably with increasing HAQ (Appendix13). With considering lag time between HAQ and burden indicators we cannot conclude this relation with confidence.

The trend of percentage of relative change of UHC (1990-2019) showed that Pakistan had lowest (7.78%) and Sudan (88.69%) had highest changes. Also in this part lag time is important. In the EMR countries, angiography and angioplasty facilities were available in the region. Primary preventive community-based intervention programs were done in the majority of countries in the region. Regarding to qualify CR in EMR, Iran (Islamic Republic of) had the highest number of CR programs (Table4).

**Discussion**

Our study showed that although the trend of IHD age-adjusted death and DALY rates in the EMR decreased between 1990-2019, however its prevalence increased. These changes in the burden could be attributed to several general factors such as aging and the increasing epidemic of risk factors and the EMR specific factors. In addition, different lifestyle, socioeconomic status, poverty, weakness of planned screening for risk factors and detection of early sign of disease by health system, more active involvement of private hospital and offices versus public hospitals and weak sustainability of educative program such as healthy city to increase general population knowledge are many important points in the EMRO countries that can influence on IHD burden (17). Healthy EMR needs stable social and political communities, investment in health and inhibition of conflicts. Some EMR countries have challenges such as social and political unrest, war, revolutions, economic sanctions that can lead to psychological problem and disturbance of therapeutic and preventive programs. Beside unrest conduce to movement of people and health professionals and weakening of health system which may ultimately increase the IHD burden in this area.

Due to the growing epidemic of NCD especially IHD in the EMR in the last decades, knowing the trend of the burden of IHD can help countries in the region to know present situation in comparison to world and other EMR countries to consider finances and human resource for IHD prevention, control and treatment as their health priority. An earlier study showed that EMR countries with higher age-standardized DALYs of IHD had a lower index of quality and access to healthcare facilities (18). In addition, it showed that medical care in high-income countries improved life-expectancy to the point where population with more risk factors will have more IHD prevalence but lower IHD mortality. People in middle socio-demographic range are surviving longer than low-income ones so they might get IHD, however they may have less access to optimal therapeutic modality then more death occurs compared to high income communities (19). In the EMR, 25% people living under the international poverty line and 70% live in cities
and there is different level of literacy (females are more illiterate). Many countries, especially low income ones, are facing severe problems in establishing qualified health service for all inhabitants without economic burden. Then they cannot afford prevention and hence delay of diagnosis and poor outcomes detect. In the other hand, low-income people may die due to other diseases before getting older.

The age-standardized prevalence of IHD was higher in the EMR than global and its trend increased in the last 20 years especially in high and middle SDI. Generally, higher prevalence of IHD in males was in alignment with other studies(20). Aging of the population seemed to have a considerable impact to increase the prevalence but in our study age-standardized IHD prevalence showed ascending slope too. Reasons of increasing prevalence of IHD in the EMR region might be related to the lack of educative and community-based intervention programs regarding risk factor screening, management and control (5). Previous studies showed the association between high burden of IHD and low socioeconomic status, the reason for this difference might be related to the epidemiologic transition that started sooner in high socioeconomic countries and more unhealthy life style in low socioeconomic countries (21). During the past decades, the gulf countries in EMR experienced a rapid socioeconomic transition toward urbanization and unhealthy lifestyle. The burden of IHD in Europe increased then decreased following better treatment methods and risk factors control.(22). However, many rich countries enable people to consume more calories with less activity which ultimately lead to more obesity, diabetes and other risk factors (23, 24). IHD risk factors are on the rise in the EMR. This region has the uppermost age-standardized DALYs for diabetes among WHO regions. Although high income countries except Oman and some middle income countries such as Jordan, Islamic Republic of Iran, and Tunisia plan a practical strategies for its control, yet, 50 percent of countries lack countrywide strategies for diabetes control (25).

Around 25 percent of adults in the EMR has high blood pressure and with a range of 14% in Lebanon to 52% in Islamic Republic of Iran have high total cholesterol (26, 27). Published findings show that the prevalence of physical inactivity is 44.5% in the EMR (highest in United Arab Emirate with 70% and lowest in Morocco with 27%) at 2016 and is more frequent in women (28). In 70% of the EMR countries, more than 50% of adults are overweight (27). One of relative successful preventive programs in the region is tobacco control that prevalence is lower than other WHO regions but it increase in recent years (29). These numbers are strong motivators for policy makers to plan and perform wide range of preventive strategies as well as healthy lifestyle promotion in the EMR countries. Better control of IHD risk factors in many countries could decrease the prevalence of IHD specifically with good education of the community about IHD risk factors screening and control.

Age-standardized IHD death rate in the EMR was 1.78 times more than global level. During the past 3 decades age-standardized IHD death rate in the EMR showed lowest decrease than other parts of the world except Africa (5). High-income countries report most considerable improvement in IHD death rates (30, 31). While high-income EMR countries had the highest IHD age-standardized death rate in 1990, however, in 2019 they reported the lowest age-standardized death rate. This might be related to improved capacity to control and treat IHD. On the other hand, establishment of more schools of medicine and
related fields that led to increased number of qualified healthcare professionals, i.e. medical and paramedical students, increased number of hospital and emergency departments with catheterization services and adoption of secondary preventive strategies such as CR programs could lower death rate(32). Although these improvements were reported but health system in EMR have some problems. More than 50% of EMR countries don't meet standards like the least level of doctors and nurse per 10000 inhabitants (27). In many EMR countries, private health service and hospitals play a considerable role in the treatment of patients. In some low and medium income countries outpatient service is about 76% of health pressure. Different practice between private and public practice is a grave problem in some EMR countries and majority of them undergo from deficiency in essential medicine in both private and public section (27). Government doesn't take in private section in planning health system and have small amount of data regarding observation on quality and conformation and data in private health.

Beside different technologies used in the treatment of patients with IHD, such as the emergency or primary percutaneous coronary intervention (PCI), coronary artery bypass graft (CABG) and good access to evidence-based medication are not equally distributed in the EMR countries (17). Based on previous study in the EMR, medications are underutilized in patients, even in high-income countries like Saudi Arabia (30). Low drug intake is a function of problems in acceptability, availability, affordability, accessibility and quality of medications, in addition to adherence to evidence-based drug prescription by patients (31, 33-35). According to trend of death rate of age-standardized IHD in the period of 1990 to 2019 Pakistan had the most increase and Bahrain had the most decrease. These results may be due to different approach to IHD treatments, therefore policy makers in EMR countries with high mortality such as Pakistan must reconsider different aspects of IHD treatment strategies.

From 1990 to 2019 age-standardized DALYs of IHD in the EMR are almost twice the global level which means the EMR countries should pay more attention on preventive and treatment strategies of IHD. The age-standardized DALYs rate of IHD declined in the world. Similarly, in the EMR we saw a decline in IHD age-standardized DALYs but with slower slope. Studies have shown ongoing epidemiologic and socio-demographic shift happening in the EMR countries but as EMR countries started their policies for IHD control with delay and efforts were not organized in most countries, therefore, we saw fewer changes in this period than changes at global level (24). Similar to other published studies in the world, males in the EMR revealed higher age-standardized of DALYs rate than females because males generally develop IHD at a younger age and have a higher propensity of developing coronary heart disease than women (21). Most improvement in IHD age-standardized DALYs during this period is related to Bahrain and least improvement is Pakistan. DALYs has decreased with increasing HAQ in Bahrain with Steep downhill slope. In general, lower income countries in the EMR had the highest DALYs rate from 1990 to 2019. These countries need more attention to preventive/therapeutic strategies and providing suitable infrastructure in their primary health care systems for more control of IHD risk factors.

Bahrain had the best improvement in the three burden indicators in our study and can be a successful role model for other EMR counties. Policymakers in other EMR countries need to pay more attention to well-designed preventive programs beside well-equipped hospitals and secondary prevention and
rehabilitation and to develop operational multispectral national policy and action plans for better control of IHD prevalence, death and risk factors (36, 37). In other hand Pakistan had unfavorable trend situation in death rate and DALYs that must evaluate for cause of this results.

The persisting high burden of IHD in the world especially in lower middle-income countries mainly due to key risk factors comprising high blood pressure, smoking, dietary habits, obesity and low physical inactivity (38). The attributed risk factor to DALYs of IHD in metabolic, behavioral and environmental risk factors in EMR countries are different between countries, which could have its effects on burden of IHD in these countries. In all of the studied period the top three risk factors for IHD in the EMR are high systolic blood pressure, high LDL-C and particulate matter pollution. In the EMR, the prevalence of hypertension is highest after Africa, and hypercholesterolemia is third among the six WHO regions (39, 40). Among behavioral risk factors, EMR had highest physical inactivity rate, considerable prevalence of unhealthy dietary habits, especially high sodium intake (41, 42). Obesity in EMR is third highest prevalence globally (43). With urbanization and more environmental pollutants, EMR faces particulate matter pollution among other problems. A study in 2015 has shown that this region will not reach the 25 percent reduction of CVD mortality until 2025 unless all major target risk factors be controlled ( high systolic blood pressure, smoking, elevated body mass index and diabetes) and health system is re-considered (44-46). In our study, lower SDI countries had the higher attributed risks of metabolic, behavioral and environmental factors, so their death rate and DALYs was higher but regarding prevalence we saw confusing pattern which could be due to lack of data and resource in these countries and in their health care systems and lower survival of inhabitants due to other disease. High-middle SDI countries in the EMR had invested resources for the reduction of metabolic, behavioral and environmental risk from 1990 to 2019, which could play an important role in the reduction of the burden of IHD.

In IHD patients, comprehensive education, risk factor control and secondary prevention with evidence-based treatment can reduce the burden of disease and recurrent events, but in the EMR, suboptimal management of the disease after hospital discharge was recognized (47). In the PURE study, EMR involved countries same as other participants showed drug use for secondary prevention was insufficient (48).

Only 8 countries in the EMR had cardiac rehabilitation (CR) programs for IHD patients, although the cost-benefit of CR is proven (49, 50). Despite high IHD prevalence and the low number of CR service in the EMR, the obtainability is lower than other regions then this region need more CR implementation (51-53).

**Limitations**

The limitation of study can be modeling and estimates and statistics which gathered by GBD on primary data. Another limitation is lack of published papers and high-quality registered data regarding burden of IHD in EMR countries. We could not include Palestine in our analyses due to lack of data. Regarding CR, we count our CR services, not exact quality of them in this study. Beside we know lag time between DALYs and HAQ but in this study, we evaluate relation in 2019 for a general view, and perhaps in future
studies, must change of HAQ with DALY discussed. The last limitation is lack of decomposition analysis for showing what leading change in burden is: changing, aging, population growth or risk factors.

**Conclusion**

Our results showed the age-standardized IHD prevalence had increased and its age-standardized DALYs and death rates had decreased in the EMR. Despite the improvement in age-standardized IHD burden in EMR countries, it is above of the world, then our findings suggest there is a need for interventions and strategies to more reduce the IHD incidence/prevalence and better treatment ways to lower mortality and IHD burden in this region. Most countries in EMR had treatment modalities such as angiography and angioplasty equipment for IHD that are favorable but community and health center programs for prevention and rehabilitation were undesirable. Therefore, in the EMR region, evidence-base medicine and cost-benefit interventions primary and secondary prevention and cardiac rehabilitation programs are needed to mitigate the impact of IHD. Moreover, governments should adopt policies to reduce IHD risk factors, especially those dominant in the EMR countries including diabetes and obesity by community-based educative program as well as with involvement of private part and social media. In EMR programs with focus on family members can improve disease control. Although most EMR countries have launched plans to decrease the burden of IHD, but they didn't start extensive initiative to battle IHD. The EMR policymakers need to focus on well qualified registered data system such as IHD and risk factor surveillance for taking valid and correct data in health systems.

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Tables

Tables 1-4 are available in the supplementary files section.

Figures

Figure 1

Trend of age-standardized deaths rate, disability-adjusted life years (DALYs) rate and prevalence of IHD for males and females during 1990 to 2019 worldwide and in EMR
Figure 2

Comparison of age-standardized prevalence, death and disability-adjusted life years (DALYs) rate for IHD (per 100,000) in 1990, 2005 and 2019 by SDI level and geographical area.
Figure 3

Comparison of age-standardized attributed risk factor to disability-adjusted life years (DALYs) rate (per 100,000) for behavioral, metabolic and environmental risk factors by SDI level and geographical area.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- Appendix.docx
- Tables.docx