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Original Article

Estimation of 10-Year Risk of Cardiovascular Diseases Using WHO Risk Prediction Charts: A Population-Based Study in Southern Iran

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Abstract

Background: An effective strategy for primary prevention of Cardiovascular Disease (CVD) is accurate diagnosis and the subsequent evidence-based treatment for high-risk people. This study aimed to estimate the 10-year risk of CVD and its related factors.

Methods: The baseline data of 8138 participants of the Pars cohort study (PCS) in southern Iran were used. Risk scores were calculated using the updated 2019 WHO CVD risk prediction charts. The scores were determined based on age, gender, current smoking status, systolic blood pressure (SBP), diabetes status, and total serum cholesterol. Demographic and socioeconomic variables, physical activity, and anthropometric indices were measured and analyzed. Multivariable logistic regression was applied to estimate the adjusted odds ratio (aOR) and 95% confidence intervals (CI).

Results: The mean (SD) age of the participants was 51.65 (9.06) years, and 53.44% were female. The 10-year CVD risk for 23.89% of participants was ≥10%. The prevalence of hypertension, diabetes, hypercholesterolemia, and smoking was 12.79%, 8.38%, 12.80%, and 14.41%, respectively. Having abdominal obesity, having low or moderate physical activity, being illiterate or having diplomas or lower degrees, and being in the third quartile of the wealth score group were associated with a higher 10-year risk of CVD.

Conclusion: About one-fourth of the participants had moderate risk and higher. Due to the relatively high prevalence of CVD risk factors in the middle-aged population, the modifiable risk factors are recommended to be adjusted. Additionally, individual- and community-based educational policies are essential to create a healthy lifestyle.

Keywords: Cardiovascular diseases; Prediction model; Socioeconomic factors; Life style; Cohort studies

Introduction

Cardiovascular Diseases (CVD) are chronic and non-communicable diseases, which are responsible for more than 12% of the global burden of disease (1). The number of CVD patients is expected to increase due to lifestyle changes in the coming years (2, 3). This increase is not limited to low- and middle-income countries, and the leading cause of disease burden is related to CVD even in high-income countries (3). In 2015, 422.7 million cases of CVD and 17.92 million CVD deaths occurred in the world (4). Furthermore, 1.4 million CVD deaths occurred in the Eastern Mediterranean Region (5). In Iran, CVDs are quite prevalent, accounting for 50% of all deaths and 79% of deaths related to chronic diseases each year (6, 7).

Hypertension, diabetes, obesity, smoking, and hypercholesterolemia are the most important risk factors for CVD. These risk factors can be prevented and controlled by implementing some effective interventions (8). Since the treatment of such diseases imposes high costs on healthcare systems, it is essential to evaluate the risk factors of CVD. Many tools, including the Framingham risk score (FRS) and World Health Organization/International Society of Hypertension (WHO/ISH), have been developed to predict CVD risk. These tools can help identify people at risk and, as a result, increase their awareness of disease prevention.

In 2007, WHO/ISH risk charts were published for all WHO epidemiological sub-regions. WHO updated CVD risk charts based on recently validated risk prediction models to determine the risk of CVD in 21 Global Burden of Disease (GBD) regions in 2019 (9). For this version, data were recalibrated by region-specific incidences from GBD and country-specific risk factors from non-communicable disease Risk Factor Collaboration (NCD-RisC) (10).

Since the prevalence of CVD is high in low- and middle-income countries like Iran, primary prevention has been considered the most useful and cost-effective strategy due to the high burden and therapeutic cost of CVD. International clinical guidelines for accurate identification and subsequent evidence-based treatment of people at high risk for CVD have recommended the application of CVD risk assessment tools in routine clinical practice (11). In Iran, some studies have used different CVD risk prediction models such as FRS and WHO charts (12-14). In 2017, a risk chart for CVD in Eastern Mediterranean Region was presented by Sarrafzadegan et al (15). Considering that CVD is the most important cause of death in the Iranian population, the present study aims to estimate the 10-year risk of CVD and its related factors in the Pars cohort population using WHO risk prediction charts updated in 2019.

Materials and Methods

Participants and Settings

The present study was a part of the Pars cohort study (PCS). The PCS was designed and implemented in collaboration with research teams from the Non-Communicable Diseases Research Center (NCDRC) of Shiraz University of Medical Sciences (SUMS) and the Digestive Diseases Research Institute (DDRI) of Tehran University of Medical Sciences (TUMS). In this study, the baseline data of PCS were used, in which all residents of Valashahr aging 40-75 years (9721 individual) were invited to participate in 2014. Eventually, 9264 individuals (95%) went to the Pars Cohort Center for interviews and limited physical examinations. For all participants, demographic characteristics, lifestyle variables, and disease history were registered by trained interviewers. Anthropometric indices such as height, weight, and also blood pressure (BP) were measured. For biochemical tests, a blood sample was taken. Further details of the study protocol and the preliminary results have already been published (16). Ihe cases with a history of CVD or stroke were excluded. The final sample size included 8138 cases.

Ethics approval
This study was approved by the Ethics Committee of Shiraz University of Medical Sciences (IR.SUMS.REC.1398.860). All participants were required to sign informed consent forms and the data were gathered anonymously.

WHO risk prediction charts
There are two versions of the WHO risk chart based on the presence or absence of cholesterol. The version used in this study was based on the presence of cholesterol data. To calculate the risk of fatal and non-fatal events of CVD (i.e., myocardial infarction and stroke) using WHO risk assessment, age, gender, current smoking status, SBP in mmHg, diabetes status, and total serum cholesterol (in mmol/L) were used. In the WHO risk models, the individuals were classified into very low (<5%), low (5 to <10%), moderate (10% to <20%), high (20% to <30%), and very high risk (≥30%) groups (9). It is worth mentioning that the authors have already estimated the FRS for this population (13).

Definition of Variables
In addition to the variables used to determine the 10-year CVD risk, other variables were also examined, including education, wealth score, physical activity, and abdominal obesity. These variables were collected at baseline.

Smoking status was obtained from the interview. Blood samples were measured for biochemical tests in a fasting state for 8 to 12 hours. Diabetes was determined according to past medical histories or fasting blood sugar (FBS) ≥126 mg/dl (17). Cholesterol has been tested in the laboratory. Hypercholesterolemia was defined as total cholesterol level ≥6.21 mmol/L (18). BP was measured in the sitting position using a mercury sphygmomanometer after five minutes of rest. For each person, BP was measured twice on each arm and the average value was recorded (13, 14). According to the JNC8 criteria, hypertension was defined as SBP ≥ 140 mmHg, or diastolic blood pressure (DBP) ≥ 90 mmHg (19), or taking medications. Age was categorized into two groups; i.e., <55 and ≥55 years. Education level was categorized into three groups, namely illiterate, diplomas or lower degrees, and academic. The wealth score was calculated for each participant based on a combination of different parameters given different weights. These parameters included having a personal car, motorbike, TV, refrigerator, freezer, vacuum cleaner, and washing machine as well as having a house and its size and structure. Occupation was considered for the calculation of the wealth score. This method was described by Islami et al (20). The wealth score was divided to five quintiles. Physical activity was measured using the metabolic equivalent rate (METs) of self-report daily activities using the International Physical Activity Questionnaire (IPAQ). Then, MET scores were categorized into three thirties: low, moderate, and high physical activity. Abdominal obesity was defined as a waist to hip ratio ≥0.9 for males and ≥0.85 for females (19).

Statistical Analysis
Continuous and discrete variables were presented with mean ± standard deviation (SD), and percentage, respectively. For categorical and continuous variables, chi-square and t-test were used, respectively. The prevalence of CVD risk factors and the 10-year CVD risk were calculated. The participants were divided into two risk groups of <10% and ≥10%. Crude and adjusted odds ratios (aOR) and their 95% CI were estimated. Variables were included in the multivariable logistic regression according to a bivariate P-value < 0.25. Data analysis was performed in 2020. Statistical analyses were performed using Stata, version 14.0 for Windows (Stata Corp., College Station, TX, USA). The significance level was set at 0.05.

Results

In this study, 53.44% of the participants were female, and 66.45% were <55-years. The prevalence of smoking was 14.41%. The prevalence of hypertension and diabetes was 12.79% and 8.38%, respectively. See Table 1 for an overview.

Table 1: Baseline demographic, anthropometric, and metabolic characteristics of the study participants

Variables	*Total (n=8138)*	*Males (n=3789)*	*Females (n=4349)*	*P-value*
	N (%)	N (%)	N (%)	
Age range (yr)				
<55	5408 (66.45)	2491 (65.74)	2917 (67.07)	0.205
≥55	2730 (33.55)	1298 (34.26)	1432 (32.93)	
Education level				
Illiterate	3795 (46.63)	1107 (29.22)	2688 (61.81)	<0.001
≤diploma	4081 (50.15)	2438 (64.34)	1643 (37.78)	
University	262 (3.22)	244 (6.44)	18 (0.41)	
Wealth score				
Quintile 1	1911 (23.48)	748 (19.74)	1163 (26.74)	<0.001
Quintile 2	1360 (16.71)	610 (16.10)	750 (17.25)	
Quintile 3	1742 (21.41)	813 (21.46)	929 (21.36)	
Quintile 4	1463 (17.98)	732 (19.32)	731 (16.81)	
Quintile 5	1662 (20.42)	886 (23.38)	776 (17.84)	
Physical activity				
Low	2715 (33.36)	849 (22.41)	1728 (39.73)	<0.001
Medium	2711 (33.31)	1058 (27.92)	1665 (38.28)	
High	2712 (33.33)	1882 (49.67)	956 (21.98)	
Smoking (now)				
No	6965 (85.59)	2644 (69.78)	4321 (99.36)	<0.001
Yes	1173 (14.41)	1145 (30.22)	28 (0.64)	
Hypertension				
No	7097 (87.21)	3517 (92.82)	3580 (82.32)	<0.001
Yes	1041 (12.79)	272 (7.18)	769 (17.68)	
Diabetes				
No	7456 (91.62)	3585 (94.62)	3871 (89.01)	<0.001
Yes	682 (8.38)	204 (5.38)	478 (10.99)	
DBP (Mean mmHg ± SD)	73.16±11.77	73.44±11.61	72.92±11.91	0.045
SBP (Mean mmHg ± SD)	111.19 ± 18.68	110.78±17.50	111.54±19.64	0.066
Hypercholesterolemia				
No	7096 (87.20)	3476 (91.74)	3620 (83.24)	<0.001
Yes	1041 (12.80)	313 (8.26)	729 (16.76)	
Abdominal obesity				
No	1578 (19.39)	1114 (29.40)	464 (10.67)	<0.001
Yes	6560 (80.61)	2675 (70.60)	3885 (89.33)	

DBP=diastolic blood pressure; SBP=systolic blood pressure.

The 10-year CVD risk according to the examined variables has been presented in Table 2. Accordingly, the majority of cases (76.11%) were in the very low- and low-risk group. In addition, 18.17%, 4.58%, and 1.14% of the participants belonged to the moderate, high, and very high risk groups, respectively.

Table 2: The prevalence of 10-year cardiovascular risk in the study participants based on the study variables

Variables	*Very Low risk N (%)*	*Low risk N (%)*	*Moderate risk N (%)*	*High risk N (%)*	*Very high risk N (%)*	*Total N (%)*
Total	3796(46.65)	2397 (29.46)	1479 (18.17)	373 (4.58)	93 (1.14)	8138 (100)
Age range (years)						
<55	3744 (69.23)	1419 (26.24)	234 (4.32)	8 (0.15)	3 (0.06)	5408 (100)
≥55	52(1.91)	978 (35.82)	1245 (45.60)	365 (13.37)	90 (3.30)	2730 (100)
Gender						
Male	1151(40.93)	1236 (32.62)	730 (19.27)	201 (5.30)	71 (1.87)	3589 (100)
Female	2245(51.62)	1161 (26.70)	749 (17.22)	172 (3.95)	22 (0.51)	4349 (100)
Education level						
Illiterate	1178(31.04)	1224 (32.25)	1026 (27.04)	295 (7.77)	72 (1.90)	3795 (100)
≤diploma	2457(60.21)	1097 (26.88)	429 (10.51)	77(1.89)	21 (0.51)	4081 (100)
University	161(61.45)	76 (29.01)	24 (9.16)	1 (0.38)	0 (0)	262 (100)
Wealth score						
Quintile 1	815(42.65)	547 (28.62)	407 (21.30)	120 (6.28)	22 (1.15)	1911 (100)
Quintile 2	602(44.26)	407 (29.93)	254(18.68)	72 (5.29)	25 (1.84)	1360 (100)
Quintile 3	755(43.34)	529 (30.37)	342 (19.63)	91 (5.22)	25 (1.44)	1742 (100)
Quintile 4	721(49.28)	441 (30.14)	237(16.20)	51 (3.49)	13 (0.89)	1463 (100)
Quintile 5	903(54.33)	473 (28.46)	239(14.38)	39(2.35)	8 (0.48)	1662 (100)
Physical activity						
Low	1219(44.90)	688 (25.34)	582 (21.44)	177 (6.52)	49 (1.80)	2715 (100)
Medium	1286(47.44)	813 (29.99)	470 (17.34)	110 (4.06)	32 (1.18)	2711 (100)
High	1291(47.60)	896 (33.04)	427(15.74)	86 (3.17)	12 (0.44)	2712 (100)
Abdominal obesity						
No	887(56.21)	418 (26.49)	209 (13.24)	50 (3.17)	14 (0.89)	1578 (100)
Yes	2909(44.34)	1979 (30.17)	1270 (19.36)	323 (4.92)	79 (1.20)	6560 (100)

The CVD risk increased by age. The majority of <55-year-old cases (95.47%) were in the very low- and low-risk group, while 45.60%, 13.37%, and 3.30% of the ≥55-year-old cases belonged to the moderate-, high-, and very high-risk groups, respectively. There was a larger number of males (1.87%) in the very high-risk groups compared to females (0.51%).

The crude and adjusted effect of independent variables on the 10-year risk for CVD has been presented in Table 3. The adjusted model shows that the 10-year CVD risk was higher in illiterate people (aOR; 5.79, CI; 3.77–8.88) and individuals with diplomas or lower degrees (aOR; 1.54, CI; 1.003-2.35) compared with those with academic degrees. The 10-year CVD risk was higher in the third quartile (aOR;1.25, CI; 1.04–1.49) compared with those within the highest wealth score group. In the Participants with abdominal obesity, the 10-year risk of CVD was higher (aOR;1.36, CI; 1.17–1.59) compared with those without abdominal obesity. Also, Participants with low (aOR;1.76, CI; 1.54–2.01) and moderate (aOR;1.17, CI; 1.02–1.34) physical activity had a higher 10-year risk of CVD than others.

Table 3: Crude and adjusted effect of independent variables on 10-year risk for CVD

Variables	*CVD risk <10% N=6193*	*CVD risk ≥10% N=1945*	*Crude OR*		*Adjusted OR*	
	N (%)	N (%)	OR(95% CI)	P-value	OR(95% CI)	P-value
Education level						
Illiterate	2402 (63.29)	1393 (36.71)	5.50(3.62-8.34)	<0.001	5.79(3.77-8.88)	<0.001
≤diploma	3554 (87.09)	527 (12.91)	1.41(0.92-2.14)	0.114	1.54(1.003-2.35)	0.048
University	237 (90.46)	25 (9.54)	Ref.	Ref.	Ref.	Ref.
Wealth score						
Quintile 1	1362 (71.27)	549 (28.73)	1.94(1.65-2.27)	<0.001	1.12(0.94-1.34)	0.189
Quintile 2	1009 (74.19)	351 (25.81)	1.67(1.40-1.99)	<0.001	1.13(0.93-1.36)	0.217
Quintile 3	1284 (73.71)	458 (26.29)	1.72(1.45-2.02)	<0.001	1.25(1.04-1.49)	0.014
Quintile 4	1162 (79.43)	301 (20.57)	1.25(1.04-1.49)	0.016	1.06(0.87-1.28)	0.527
Quintile 5	1367 (82.79)	286 (17.21)	Ref.	Ref.	Ref.	Ref.
Physical activity						
Low	1907 (70.24)	808 (29.76)	1.76(1.55-2.00)	<0.001	1.76(1.54-2.01)	<0.001
Medium	2099 (77.43)	612 (22.57)	1.21(1.06-1.38)	0.004	1.17(1.02-1.34)	0.021
High	2187 (80.64)	525 (19.36)	Ref.	Ref.	Ref.	Ref.
Abdominal obesity						
No	1305 (82.70)	273 (17.30)	Ref.	Ref.	Ref.	Ref.
Yes	4888 (74.51)	1672 (25.49)	1.63(1.42-1.88)	<0.001	1.36(1.17-1.59)	<0.001

Discussion

The main objective of present study was to estimate the 10-year CVD risk in the Pars cohort population. The results showed that 23.89% of the study population were in the moderate, high, and very high-risk groups for CVD. Most of the studies that used WHO risk charts, revealed that many people were in the low-risk group. In studies conducted in Iran and Bangladesh, the risk of CVD ≥10% was reported to be 9.8%, and 14.8%, respectively (21, 22). We used revised models to estimate risk in 21 global regions. The observed differences might be attributed to different WHO risk prediction models or different study populations. Given the fact that most participants in the present study aged less than 55 years and since other studies have shown an increase in the CVD risk by age (21), many participants were in the low-risk group.

In this study, the prevalence of hypertension, diabetes, and hypercholesterolemia was 12.79%, 8.38%, and 12.80%, respectively. In Iran, the prevalence of hypertension and diabetes was 15.7% and 9.6%, respectively (21, 23). In the present study, smoking prevalence was 14.41%. Smoking was about 47 times higher in males than in females (30.22% vs. 0.64%). In Iran, the prevalence of smoking was 22.9% in males and 0.6% in females (24), and the minimum onset age for smoking was six and seven years old (25, 26). Also, smoking was more prevalent in boys than girls (27).

The results of the adjusted model showed that the 10-year risk of CVD was significantly higher in participants with abdominal obesity, those who are illiterate or in individuals with diplomas or lower degrees, and those who have low or moderate physical activity. Also, the 10-year risk of CVD was higher among the participants who were in the third quartile of the wealth score group.

We observed that the 10-year risk of CVD was significantly higher in participants who had abdominal obesity. In Iran, about two-thirds of females have abdominal obesity (28). Since abdominal obesity is associated with an increased risk of death (29), it is essential to evaluate the factors determining general and abdominal obesity. Also, the 10-year risk of CVD was significantly higher in participants who were in the third quartile of the wealth score group. Another study showed that the prevalence of diabetes, hypercholesterolemia, obesity, and fat intake was significantly higher in the richest group compared to the poorest group (30).

Participants with low or moderate physical activity had a higher 10-year CVD risk than others. The 10-year risk of CVD was ≥10% in 29.76% of the people with low physical activities and 19.36% of those with high physical activities. Given the importance of physical activity in the prevention of diseases, such as diabetes, cancer, and CVD, and because increasing the physical activity level is a very simple, practical, and low-cost global strategy leading to a reduction in CVD and mortality in middle ages (31), it is necessary to implement health programs and appropriate interventions to control and prevent chronic diseases by determining the factors related to the duration and type of physical activity.

The current study showed that the 10-year risk of CVD was significantly higher in illiterate people. Illiterate people about six times more likely to have CVD risk within the next 10-years than those with academic degrees. Also, in individuals with diplomas or lower degrees, the risk of CVD was higher compared with those with academic degrees. The results of another study consistently confirmed an inverse relationship between education level and CVD and its risk factors. Accordingly, low education level was associated with hypertension, diabetes, and a higher incidence of CVD-related deaths (32). Therefore, it is necessary to increase people's awareness and knowledge about the risk factors and prevention methods of CVD.

The WHO charts can help classify people into different levels of risk. Population-based lifestyle modification strategies can be applied to low-risk populations, while individual consultations and repeated follow-up assessments are needed for moderate-risk populations. Besides, more rigorous treatment strategies are needed for high-risk and very high-risk populations (33).

Iran is a developing country experiencing a rapid phase of urbanization and industrialization and is undergoing social and economic transformations. This rapid transformation is accompanied by changes in nutritional and physical activity habits, increasing the prevalence of non-communicable diseases like hypertension and diabetes (34, 35). Since the roles of physical activity, hypertension, and diabetes in the development of CVD are well known, it is important to emphasize the adjustment of modifiable variables and educational policies for a healthier lifestyle.

The main strength of the present study was the large sample size and utilization of data from a population-based study. Therefore, the results could be generalized to other populations. Also, as we know this study is the first study with a large sample size in Iran that applied new WHO risk prediction models to estimate the 10-year risk of CVD. However, the main limitation of the present study was its cross-sectional nature.

Therefore, a cohort study is needed to confirm the findings. Besides, since the participants were ≥40 years old, the results could not be generalized to people under 40 years.

Conclusion

About one-fourth of the participants had moderate risk and higher of developing CVDs within the next 10-years. The prevalence of CVD risk factors was relatively high. Additionally, education level, physical activity, wealth score, and abdominal obesity may be related to the 10-year risk of CVD. Therefore, it is necessary to increase people's awareness and knowledge about CVD and its risk factors. It is also essential to implement a lifestyle modification strategy in the study population. In order to reduce the burden of CVD and its consequences, individuals with a ≥10% CVD risk should be identified and be provided with individual counselling and treatment services. Also, future longitudinal cohort studies with an adequate follow-up period are recommended to confirm the findings.

Journalism Ethics considerations

Ethical issues (Including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc.) have been completely observed by the authors.

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Conflict of interest

The authors declare that there is no conflict of interest.

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