Decomposition of Socioeconomic Inequality in Cardiovascular Disease Prevalence in the Adult Population: A Cohort-based Cross-sectional Study in Northwest Iran

Farhad Pourfarzi¹, Telma Zahirian Moghadam², Hamed Zandian²³
¹Digestive Disease Research Center, Ardabil University of Medical Sciences, Ardabil, Iran; ²Social Determinants of Health Research Center, Ardabil University of Medical Sciences, Ardabil, Iran; ³Department of Community Medicine, School of Medicine, Ardabil University of Medical Sciences, Ardabil, Iran

Objectives: The incidence of cardiovascular disease (CVD) mortality is increasing in developing countries. This study aimed to decompose the socioeconomic inequality of CVD in Iran.

Methods: This cross-sectional population-based study was conducted on 20,519 adults who enrolled in the Ardabil Non-Communicable Disease cohort study. Principal component analysis and multivariable logistic regression were used, respectively, to estimate socioeconomic status and to describe the relationships between CVD prevalence and the explanatory variables. The relative concentration index, concentration curve, and Blinder-Oaxaca decomposition model were used to measure and decompose the socioeconomic inequality.

Results: The overall age-adjusted prevalence of CVD was 8.4% in northwest Iran. Multivariable logistic regression showed that older adults, overweight or obese adults, and people with hypertension and diabetes were more likely to have CVD. Moreover, people with low economic status were 38% more likely to have CVD than people with high economic status. The prevalence of CVD was mainly concentrated among the poor (concentration index, -0.077; 95% confidence interval, -0.103 to -0.060), and 78.66% of the gap between the poorest and richest groups was attributed to differences in the distribution of the explanatory variables included in the model.

Conclusions: The most important factors affecting inequality in CVD were old age, chronic illness (hypertension and diabetes), marital status, and socioeconomic status. This study documented stark inequality in the prevalence of CVD, wherein the poor were more affected than the rich. Therefore, it is necessary to implement policies to monitor, screen, and control CVD in poor people living in northwest Iran.

Key words: Cardiovascular disease, Socioeconomic factors, Health inequities, Prevalence, Risk assessment

INTRODUCTION

Cardiovascular disease (CVD) is a leading cause of death in developing countries, and its incidence is rising every year [1]. Socioeconomic status (SES) has been inversely related to CVD and mortality [2]. In developed countries, the decline in CVD is more evident among individuals from higher socioeconomic groups, and the difference in the incidence of CVD compared to lower socioeconomic groups is widening [3]. There is ample evidence of an inverse relationship between SES and cardiovascular risk factors in developing countries [4]. Therefore,
preventive activities to reduce CVD can have a major impact on the health of people from lower socioeconomic groups [5].

In Iran, despite a growing young population, the mortality rate for CVD is high, accounting for 25% of deaths, and it is the third leading cause of death after accidents and cancers [6]. In 2014, a community-based intervention program was launched in Iran with the aim of preventing and controlling CVD through changes in lifestyle and other primary risk factors. This was the first attempt to identify methods to prevent and control chronic CVD in Iran [7] by promoting a healthy lifestyle, including nutrition and daily physical activity [8].

A few studies have investigated the relationship between SES and cardiovascular risk factors in Iran, as a country with a high prevalence of catastrophic health expenditures [9]. Although the dimensions of SES are interrelated, they have individual impacts on the prevalence of CVD, depending on the culture and customs of people from different countries and regions. Several studies have shown inverse relationships between academic achievement and certain CVD risk factors such as lipid profile, blood pressure, and weight [10]. In contrast, numerous studies have shown positive associations between low education levels and the risk factors for CVD [11]. Rose and Marmot [12] reported that age, smoking, height, body mass index (BMI), systolic blood pressure, cholesterol, and blood glucose had only modest effects on reducing the inverse relationship between class and the risk of CVD. Najafi et al. [13] showed that the prevalence of obesity, a risk factor for CVD, was 26.7% among Iranian adults and was more concentrated among the rich. Since then, Franks et al. [14] have shown that the risks for SES-related diseases were less strongly reduced by improvements in traditional, biological, and behavioral risk factors.

It has been argued that SES can affect health, independent of known risk factors, and has important implications for public health research and policy [15].

It has also been shown that different environmental and socioeconomic risk factors, as well as inequalities in the social determinants of health, play a significant role in the distribution and regional variations in the prevalence of CVD. Few studies have explored the importance of socioeconomic variables (such as parental education/occupation and income) as key outcome predictors for non-communicable diseases (NCDs), which have a substantial effect on health and health inequalities, especially for CVD in Iran.

Identifying risk factors for CVD plays an important role in prevention, especially if risk factor control begins in adolescence and delays the onset of the disease and slows or reduces the progression of the disease in its early stages [16]. It has been shown that various environmental and socioeconomic factors, as well as inequalities in the social determinants of health, play an important role in the distribution of health [13,17]. However, few studies have examined the importance of socioeconomic variables (such as parental education/occupation and income) as major predictors of NCD outcomes, even though they have a significant impact on health and health inequalities, especially in relation to CVD in Iran. The prevalence of CVD is expected to sharply increase in Iran because of several factors including an aging population, and the anticipated increase in the burden of CVD will be about 45.4% to 72.0% in the near future [18,19]. However, the impact of socioeconomic inequality and its related factors on the prevalence of CVD is unclear. In this study, we measured the prevalence of CVD and used decomposition techniques to identify the factors related to socioeconomic differences in CVD. We decomposed the SES inequality of CVD and its risk factors in 20,519 men and women aged 35 years to 70 years in Ardabil, Iran.

**METHODS**

**Study Setting**

This study was conducted in Ardabil (the capital of Ardabil Province) in northwest Iran. Ardabil has a population of approximately 532,000 people. This study used data extracted from the Prospective Epidemiological Research Studies in Iran (PERSIAN) cohort study.

**Study Design**

This was a cross-sectional study based on national-level cohort study data. In 2013, the Iranian Ministry of Health and Medical Education decided to conduct a national cohort study (i.e., PERSIAN) to develop the context needed to modify healthcare policies in the field of NCDs. The PERSIAN cohort consists of participants dwelling in various sites across Iran. The details of the sampling design can be found elsewhere [20].

The Ardabil Non-Communicable Disease (ArNCD) cohort study is 1 of the 18 geographically distinct study areas of the PERSIAN cohort study. The study participants are mainly of Azerbaijani ethnicity. Based on the PERSIAN cohort study goals and its comprehensive protocol, 20,519 adult men and women be-
tween the ages of 35 years and 70 years, living in the city of Ardabil from May 2017 to February 2020, were enrolled. Exclusion criteria included non-Iranian citizens, those who were deaf or blind, and people with palsies, mental disorders, intellectual disabilities, or any acute psychiatric illnesses. Trained interviewers administered the cohort questionnaire. Excluding questionnaires with missing data, the final sample size of the study was 20,519 people.

Variables

Health outcomes

CVD was the dependent variable (health outcome) of this study. CVD within the past year was evaluated to determine its prevalence, and it was defined as a clinical diagnosis of or hospitalization for CVD (International Classification of Diseases, 10th revision codes I00-I99 and 9th revision codes 390-459). The outcome variable was determined by a self-reported diagnosis of CVD in response to the following question: “Has a doctor or other health professional ever told you that you had CVD, otherwise known as coronary artery disease such as angina and myocardial infarction (commonly known as a heart attack)?” The answer was scored 1 for “yes” and 0 for “no.”

Socioeconomic and social determinants of health inequalities

We used data from the PERSIAN cohort study, where all variables were defined in detail [20]. This study used principal component analysis (PCA) [21] to estimate the SES of the study participants. Filmer and Pritchett [22] popularized the use of PCA for estimating wealth levels using asset indicators to replace income or consumption data. The estimation of relative wealth using PCA is based on the first principal component. Formally, the wealth index for household \( i \) is the linear combination,

\[
y_i = a_1 \left( \frac{x_1 - \bar{x}_1}{s_1} \right) + a_2 \left( \frac{x_2 - \bar{x}_2}{s_2} \right) + \cdots + a_k \left( \frac{x_k - \bar{x}_k}{s_k} \right)
\]

where, \( \bar{x}_k \) and \( s_k \) are the mean and standard deviation of asset \( x_k \), and \( \alpha \) represents the weight for each variable \( x_k \) for the first principal component. The first principal component variable across households or individuals has a mean of zero and a variance of \( \lambda \), which corresponds to the largest eigenvalue of the correlation matrix of \( x \). The first principal component or wealth index can take positive as well as negative values. Assets and housing characteristics (e.g., housing situation, number of bedrooms at home, family assets), education level, and job were the explanatory variables in the PCA. Based on the wealth score, samples were divided into 5 quintiles from the poorest to the richest (first quintile as the poorest and fifth quintile as the richest) SES.

Social determinants of inequality in CVD morbidity included factors with known or plausible links to CVD and to individual financial conditions. In several studies, different variable categories were used to analyze the socioeconomic inequality of NCDs such as CVD [17], including demographic variables (gender, age), socioeconomic conditions (SES quintiles, education), hypertension and diabetes as predictor variables of CVD, and health-related behaviors and status (smoking, obesity/BMI) [18]. All independent variables in this study were categorical and coded as follows: age (continuous from 35 to 70 years), gender (men/women), marital status (single/married/other), education status (illiterate/primary and secondary school/high school/academic degree), smoking status (yes/no), diabetes (yes/no), BMI (normal/overweight/obese), and SES (poorest/poor/middle/rich/richest).

Statistical Analysis

This study used PCA [21] to estimate the SES of the study participants. Assets and housing characteristics (e.g., housing situation, number of bedrooms in the home, family assets, foreign and domestic trips, number of books read, and owning a car, motorcycle, bicycle, personal computer, CD/DVD player, washing machine, or microwave), education level, and job were the initial variables included in the PCA. Based on their SES score, study participants were divided into 5 quintiles from the poorest to the richest (first quintile as the poorest and fifth quintile as the richest).

Measuring socioeconomic inequality in CVD

Multivariable logistic regression was used to describe the relationship between CVD prevalence and each explanatory variable. We examined the socioeconomic differences in CVD prevalence among participants using the relative concentration index (RCI) and concentration curve (CC) [23]. The RCI was used to measure and decompose the socioeconomic inequality in CVD prevalence among Ardabil adults (35 to 70 years of age). In addition, the CC was used to investigate the socioeconomic inequality in CVD prevalence graphically. The CC plots the cumulative percentage of SES ranked participants on the x-axis and the cumulative percentage of a health interest variable.
(CVD prevalence score in our case) on the y-axis. The curve’s deviation from the line of equality indicates the severity of inequality. The RCI is equivalent to twice the area between the perfect equality line (45° line) and the CC. RCI values range from -1 to 1 and are positive when the CC lies below the line of perfect equality and vice versa. A positive value of the RCI indicates that the diabetes prevalence score is concentrated more among the richest. Following Wagstaff et al. [23], RCI was separated for normalization. For this calculation, \( \mu \) is assumed to be the measure of diabetes prevalence. There is a relationship between the prevalence of CVD and other factors:

\[
y = \alpha + \sum_k \beta_k x_k + \varepsilon
\]  

(1)

where \( x_k \) describes the explanatory variables discussed in the previous section. Thus the RCI for diabetes prevalence has been decomposed as follows [24]:

\[
RC = \sum_k \left( \frac{\beta_k}{\mu} \right) RC_k + \frac{AC_k}{\mu}
\]  

(2)

Where \( RC \) is the relative concentration index of CVD prevalence, \( \bar{x}_k \) the mean of \( x_k \) determinants, \( C_k \) is the \( RC \) for explanatory variables, and \( \varepsilon \) \( \left( \frac{\beta_k}{\mu} \right) RC_k \) is the elasticity of CVD prevalence in relation to the explanatory variable \( x_k \). \( \sum_k \left( \frac{\beta_k}{\mu} \right) RC_k \) presents the contribution of the explanatory factor \( x_k \) to the \( RC \). The last term, \( \frac{AC_k}{\mu} \), is the residual component. Since the RCI normalizes the calculation of inequality, the following equation was used for the decomposition analysis [24].

\[
RC = \sum_k \left( \frac{\beta_k}{\mu} \right) RC_k + \frac{AC_k}{1-\mu}
\]  

(3)

Multivariate regression was used to determine the marginal impact of the determinants in the decomposition analysis. Statistical research was performed using Stata version 12.0 (StataCorp., College Station, TX, USA). The variables were considered significant at \( p < 0.05 \).

**Ethics Statement**

The Research and Ethics Committee of Ardabil University of Medical Sciences (ARUMS) approved the study protocol with reference number (IR.ARUMS.REC.1399.072).

**RESULTS**

Of the 20 519 participants in the study, 45.8% were men and 54.2% were women, and most (37.1%) were in the 46-55 years age group. The mean age of participants was 49.04 years (95% confidence interval [CI], 48.92 to 49.15) overall, 49.71 years (95% CI, 49.53 to 49.88) for men, and 48.47 years (95% CI, 48.31 to 48.63) for women. Of the total participants, 16.0% were smokers, 42.5% were obese, and 20.8% had hypertension (Table 1).

**Table 1.** Descriptive characteristics and prevalence of cardiovascular disease in the ArNCD cohort study (n = 20 519)

| Characteristics | n (%) | Prevalence (95% CI) |
|-----------------|-------|---------------------|
| **Age (y)**     |       |                     |
| <35             | 402 (2.0) | 2.7 (1.5, 4.9) |
| 35-45           | 6833 (33.3) | 2.7 (2.4, 3.2) |
| 46-55           | 7619 (37.1) | 6.7 (6.2, 7.3) |
| 56-65           | 4605 (22.4) | 15.9 (14.9, 17.0) |
| ≥66             | 1060 (5.1) | 27.5 (24.9, 30.3) |
| **Gender**      |       |                     |
| Men             | 9409 (45.8) | 8.5 (8.0, 9.1) |
| Women           | 11 113 (54.1) | 8.4 (7.9, 9.0) |
| **Marital status** |     |                     |
| Single          | 342 (1.7) | 2.0 (0.0, 4.2) |
| Married         | 18 668 (90.9) | 8.1 (7.7, 8.5) |
| Divorced/Widowed| 1511 (7.4) | 14.7 (13.0, 16.6) |
| **Years of schooling (y)** |     |                     |
| Illiterate      | 6455 (32.0) | 8.3 (7.7, 9.0) |
| Primary (1-5)   | 4517 (22.4) | 8.6 (7.7, 9.3) |
| Intermediate (6-9) | 3018 (14.9) | 8.5 (7.8, 9.6) |
| Secondary (10-12) | 3407 (16.9) | 8.8 (7.9, 9.8) |
| Academic (≥13)  | 2755 (13.7) | 8.6 (7.6, 9.7) |
| **Smoking status** |     |                     |
| Smoker          | 3292 (16.0) | 11.6 (10.5, 12.7) |
| Non-smoker      | 17 230 (84.0) | 7.9 (7.5, 8.3) |
| **Body mass index (kg/m^2)** |     |                     |
| Normal weight   | 3248 (16.1) | 7.9 (7.1, 8.9) |
| Overweight      | 8317 (41.3) | 8.7 (8.1, 9.3) |
| Obese           | 8563 (42.5) | 8.6 (8.0, 9.2) |
| **Hypertension** |     |                     |
| Yes             | 4249 (20.8) | 21.8 (20.1, 23.1) |
| No              | 16 218 (79.2) | 5.0 (4.7, 5.3) |
| **Socioeconomic status** |     |                     |
| Poorest         | 4100 (20.0) | 10.7 (9.8, 11.8) |
| Poor            | 4100 (20.0) | 9.4 (8.6, 10.4) |
| Middle          | 4099 (20.1) | 8.4 (7.6, 9.3) |
| Rich            | 4098 (19.9) | 7.4 (6.7, 8.3) |
| Richest         | 4099 (20.0) | 6.5 (5.8, 7.3) |

ArNCD, Ardabil Non-Communicable Disease; CI, confidence interval.
The age-adjusted prevalence of CVD was 8.4% (95% CI, 8.1 to 8.9) overall, 8.9% (95% CI, 8.4 to 9.4) for women and 8.1% (95% CI, 7.5 to 8.6) for men.

The results of multivariable logistic regression are presented in Table 2. Some included explanatory variables had a statistically significant relationship with CVD ($p < 0.05$). The oldest age group (65 years and older) reported more CVD than those aged 35-44 years (adjusted odds ratio [aOR], 6.18; 95% CI, 3.31 to 11.54). Divorced people were 2.05 (95% CI, 1.94 to 4.46) as likely to have CVD than single people, and smokers were 51% more likely to have CVD than non-smokers. Obese people, people with hypertension, and people with diabetes were, respectively, 1.17 (95% CI, 1.01 to 1.25), 3.46 (95% CI, 3.10 to 3.87), and 1.61 (95% CI, 1.41 to 1.82) times more likely to have CVD. Additionally, people with poor economic status were 38% more likely to have CVD than rich people.

Based on the study results, the concentration index for all participants was -0.077 (95% CI, -0.103 to -0.060) overall, -0.066 (95% CI, -0.104 to -0.020) for men, and -0.087 (95% CI, -0.103 to -0.060) for women.

Table 2. Association between explanatory variables and the prevalence of cardiovascular disease (logistic regression model)

| Variables                  | Crude         | Adjusted          | p-value |
|----------------------------|---------------|-------------------|---------|
| Age (y)                    |               |                   |         |
| <35                        | 1.00 (reference) | 1.00 (reference) |         |
| 35-45                      | 1.00 (0.94, 1.06) | 0.91 (0.89, 1.07) | 0.010  |
| 46-55                      | 2.54 (1.39, 4.67) | 1.78 (0.98, 3.27) | 0.051  |
| 56-65                      | 6.69 (3.65, 12.3) | 3.54 (1.92, 6.52) | 0.001  |
| ≥66                        | 13.4 (7.23, 24.7) | 6.18 (3.31, 11.54) | 0.001  |
| Gender                     |               |                   |         |
| Men                        | 1.00 (reference) | 1.00 (reference) |         |
| Women                      | 0.93 (0.84, 1.03) | 0.93 (0.83, 1.03) | 0.063  |
| Marital status             |               |                   |         |
| Single                     | 1.00 (reference) | 1.00 (reference) |         |
| Married                    | 4.21 (1.99, 8.92) | 1.78 (0.83, 3.82) | 0.067  |
| Divorced/Widowed           | 8.23 (3.84, 17.6) | 2.05 (1.94, 4.46) | 0.001  |
| Years of schooling (y)     |               |                   |         |
| Illiterate                 | 1.00 (reference) | 1.00 (reference) |         |
| Primary (1-5)              | 1.02 (0.89, 1.17) | 1.01 (0.88, 1.17) | 0.234  |
| Intermediate (6-9)         | 1.02 (0.87, 1.19) | 1.02 (0.87, 1.20) | 0.178  |
| Secondary (10-12)          | 1.06 (0.91, 1.23) | 1.09 (0.93, 1.28) | 0.108  |
| Academic (≥13)             | 1.02 (0.87, 1.20) | 1.07 (0.90, 1.27) | 0.099  |
| Smoking status             |               |                   |         |
| Non-smoker                 | 1.00 (reference) | 1.00 (reference) |         |
| Smoker                     | 1.52 (1.35, 1.71) | 1.51 (1.32, 1.72) | 0.004  |
| Body mass index (kg/m²)    |               |                   |         |
| Normal weight              | 1.00 (reference) | 1.00 (reference) |         |
| Overweight                 | 1.02 (0.93, 1.13) | 1.09 (0.93, 1.28) | 0.142  |
| Obese                      | 1.02 (0.92, 1.12) | 1.17 (1.01, 1.25) | 0.025  |
| Hypertension               |               |                   |         |
| No                         | 1.00 (reference) | 1.00 (reference) |         |
| Yes                        | 5.27 (4.76, 5.83) | 3.46 (3.10, 3.87) | <0.001 |
| Diabetes                   |               |                   |         |
| No                         | 1.00 (reference) | 1.00 (reference) |         |
| Yes                        | 3.19 (2.84, 3.58) | 1.61 (1.41, 1.82) | <0.001 |
| Socioeconomic status       |               |                   |         |
| Poorest                    | 1.00 (reference) | 1.00 (reference) |         |
| Poor                       | 0.87 (0.75, 1.00) | 0.85 (0.84, 1.14) | 0.137  |
| Middle                     | 0.77 (0.66, 0.89) | 0.86 (0.74, 1.00) | 0.060  |
| Rich                       | 0.67 (0.57, 0.78) | 0.79 (0.68, 0.92) | 0.003  |
| Richest                    | 0.58 (0.49, 0.68) | 0.62 (0.52, 0.72) | <0.001 |

Values are presented as odds ratio (95% confidence interval).
-0.121 to -0.050) for women, indicating no significant difference between men and women (Supplemental Material 1). Figures 1 and 2 show the CC for all participants (Figure 1) and separately for men and women (Figure 2).

The estimated value for the age-adjusted slope index of inequality (SII) was 0.11 (95% CI, 0.09 to 0.12) and the age-adjusted and sex-adjusted SII was 0.07 (95% CI, 0.06 to 0.11). The estimated value of the relative index of inequality was 1.64 (95% CI, 1.41 to 1.91) when it was adjusted for age and 1.45 (95% CI, 1.23 to 1.69) when adjusted for age and gender (Supplemental Material).

### Table 3. Decomposition of the gap between the low and high socioeconomic groups in the prevalence of CVD in the ArNCD cohort study by the Blinder-Oaxaca decomposition model

| Variables                              | Explained       |       | Unexplained     |       |
|----------------------------------------|-----------------|-------|-----------------|-------|
|                                        | Prediction (%). | p-value | % gap | Prediction (%). | p-value | % gap |
| Prevalence of CVD in the poorest group | 10.11           | <0.001 | -     | -                | -       | -     |
| Prevalence of CVD in the richest group | 6.54            | <0.001 | -     | -                | -       | -     |
| Total gap (difference)                 | 3.57            | <0.001 | -     | -                | -       | -     |
| Age (y)                                |                 |       |       | Reference        |         |       |
| <35                                    | -1.28           | 0.168  | -0.95 | -0.24            | 0.322   | -1.06 |
| 35-45                                  | -0.98           | 0.058  | -0.75 | -0.47            | 0.441   | -1.71 |
| 46-65                                  | 5.27            | 0.001  | 6.66  | -0.31            | 0.467   | -1.93 |
| ≥66                                    | 7.08            | 0.002  | 9.08  | -0.21            | 0.571   | -0.64 |
| Gender                                 | -20.63          |       |       | 0.62             | 0.331   | 5.02  |
| Men                                    | Reference       |         |       | Reference        |         |       |
| Women                                  | -2.84           | 0.108  | -4.59 | 0.62             | 0.331   | 5.02  |
| Marital status                         |                 |       |       | Reference        |         |       |
| Single                                 | 4.11            | 0.073  | 5.11  | -4.42            | 0.322   | -6.30 |
| Married                                | 8.77            | 0.011  | 9.09  | -0.70            | 0.179   | -1.06 |
| Divorced/Widowed                       | 1.91            |       |       |                   |         | 3.17  |
| Years of schooling (y)                 |                 |       |       | Reference        |         |       |
| Illiterate                             | -0.12           | 0.221  | -2.25 | 0.17             | 0.346   | 1.56  |
| Primary (1-5)                          | 1.10            | 0.412  | 2.19  | 0.32             | 0.451   | 2.11  |
| Intermediate (6-9)                     | 1.14            | 0.203  | 3.11  | 0.42             | 0.723   | 1.89  |
| Secondary (10-12)                      | 2.11            | 0.107  | 4.13  | 0.67             | 0.776   | 2.42  |
| High (≥13)                             |                 |       |       | Reference        |         |       |
| Smoking status                         | 6.57            |       |       | Reference        |         | -1.65 |
| Non-smoker                             | 6.45            | 0.023  | 8.01  | 0.87             | 0.661   | 1.77  |
| Smoker                                 | Reference       |         |       | Reference        |         |       |
| Body mass index (kg/m^2)               |                 |       |       | -19.73           |         | 32.62 |
| Normal weight                          | Reference       |         |       | Reference        |         |       |
| Overweight                             | -9.11           | 0.105  | -12.71| -14.25           | 0.507   | -7.15 |
| Obese                                  | 27.11           | 0.004  | 75.44 | -20.11           | 0.375   | -12.11|
| Hypertension                           | 12.11           |       |       |                   |         | -2.81 |
| No                                     | Reference       |         |       | Reference        |         |       |
| Yes                                    | 4.17            | 0.002  | 3.14  | -1.32            | 0.641   | -0.44 |
| Diabetes                               | 11.75           |       |       |                   |         | -3.84 |
| No                                     | Reference       |         |       | Reference        |         |       |
| Yes                                    | 3.11            | 0.028  | 5.29  | -0.12            | 0.871   | 1.44  |
| Subtotal gap (explained part)          | 7.11            | 78.66  | 4.51  | 13.06            |         |       |
| Constant                               | 73.65           | 0.403  | 69.51 |                   |         |       |

CVD, cardiovascular disease; ArNCD, Ardabil Non-communicable Disease.
utina et al. [29] found that the prevalence of CVD was higher and more common in low-education and low-income groups. In a study of the PERSIAN cohort center, patients was relatively high.

In our study, the prevalence of these risk factors in CVD patients was significantly more common in patients with heart disease. Kanitz et al. [39] found that smoking was the most important risk factor for developing CVD. Pourreza et al. [40] also showed that smoking was the most important risk factor for developing CVD. Pourreza et al. [40] also showed that smoking was significantly more common in patients with heart disease. In our study, the prevalence of these risk factors in CVD patients was relatively high.

The present study confirmed an association among the risk factors for CVD (smoking, hypertension, diabetes, and obesity), which have been widely studied in various combinations [17]. Studies by Western research groups have shown that economic and social inequalities form a major part of the socioeconomic slope of CVD [37]. The high prevalence of some risk factors in the population over 35 years old has also led to the economic problems in Iran, which more often affect men as heads of household [35]. Our study result showing that CVD was more prevalent in married people is in line with the findings of a similar study in Lebanon, which postulated that marital or parenting stress may be causing increased CVD [36].

The present study confirmed an association among the risk factors for CVD (smoking, hypertension, diabetes, and obesity), which have been widely studied in various combinations [17]. Studies by Western research groups have shown that economic and social inequalities form a major part of the socioeconomic slope of CVD [37]. The high prevalence of some risk factors in the population over 35 years old has also led to the economic problems in Iran, which more often affect men as heads of household [35]. Our study result showing that CVD was more prevalent in married people is in line with the findings of a similar study in Lebanon, which postulated that marital or parenting stress may be causing increased CVD [36].

The present study had a few limitations. First, although the data were collected by experts in the PERSIAN cohort center,
the data were self-reported. Another limitation was that all heart diseases were considered except myocardial infarction (MI), and data were not provided for MI. Finally, the findings of this study were based on the data of a cross-sectional study, thus preventing the inference of causation. Although the orientation of some of the reported associations was clear (e.g., age and heart disease), because of the cross-sectional nature of the study design, inverse causality could not be ruled out.

Despite its limitations, this was the first study to examine the socioeconomic inequalities in CVD in northwest Iran. The results suggest that people with lower education and income levels were more susceptible to developing CVD, independent of medical risk factors. They also suggest that other identified socioeconomic factors and mechanisms may mediate CVD. Clarifying these mechanisms and, more importantly, improving education while reducing poverty could be important steps toward establishing effective prevention strategies against CVD in developing countries. This study can serve as an incentive for future population-based group studies on the risk factors of CVD in developing countries.

Overall, the age-adjusted prevalence of CVD was higher in northwest Iran than in other developed and developing countries. In addition, the high prevalence was unequally distributed among the poor and the rich in such a way that the prevalence of CVD affected the poor more deeply than the rich. The most important factors affecting the prevalence of CVD were age, chronic diseases such as hypertension and diabetes, marital status, and SES. Therefore, health/medical/nutritional policies and interventions are needed to monitor, screen, and control this disease in the low-income groups of this region. More attention should be paid to inequality in the prevalence of CVD among socioeconomic groups, particularly during global economic crises. The benefits of CVD prevention and treatment should be available to all socioeconomic groups, not only to the rich. CVD prevention and treatment interventions should focus on health-related behaviors (smoking, diet, and physical activities) and healthcare effectiveness (e.g., access to health care services, early detection of hypertension, and prompt treatment). There also remains a need for more research on the impact of the many other specific factors of CVD.

**SUPPLEMENTAL MATERIALS**

Supplemental materials are available at https://doi.org/10.3961/jpmph.22.051.

**CONFLICT OF INTEREST**

The authors have no conflicts of interest associated with the material presented in this paper.

**FUNDING**

This project was financially supported by the National Institute for Medical Research Development (NIMAD: 962249). In addition, a part of this work was funded by the Ardabil University of Medical Sciences (ARUMS).

**ACKNOWLEDGEMENTS**

The funders had no role in the study design, data analysis, decision to publish, or preparation of the manuscript.

**AUTHOR CONTRIBUTIONS**

Conceptualization: Zahirian Moghadam T, Zandian H, Pourfarzi F. Data curation: Zandian H, Pourfarzi F. Formal analysis: Zahirian Moghadam T, Zandian H. Funding acquisition: Zahirian Moghadam T, Zandian H, Pourfarzi F. Methodology: Zandian H, Pourfarzi F. Project administration: Pourfarzi F, Zahirian Moghadam T. Visualization: Zandian H. Writing – original draft: Zahirian Moghadam T, Zandian H, Pourfarzi F. Writing – review & editing: Zahirian Moghadam T, Zandian H, Pourfarzi F.

**ORCID**

Farhad Pourfarzi https://orcid.org/0000-0001-6442-6340
Telma Zahirian Moghadam https://orcid.org/0000-0003-1290-4202
Hamed Zandian https://orcid.org/0000-0002-1284-5823

**REFERENCES**

1. Ruan Y, Guo Y, Zheng Y, Huang Z, Sun S, Kowal P, et al. Cardiovascular disease (CVD) and associated risk factors among older adults in six low- and middle-income countries: results from SAGE Wave 1. BMC Public Health 2018;18(1):778.
2. de Mestral C, Stringhini S. Socioeconomic status and cardiovascular disease: an update. Curr Cardiol Rep 2017;19(11):115.
3. Lopez AD, Adair T. Is the long-term decline in cardiovascular-disease mortality in high-income countries over? Evidence
from national vital statistics. Int J Epidemiol 2019;48(6):1815-1823.
4. Davari M, Maracy MR, Khorasani E. Socioeconomic status, cardiac risk factors, and cardiovascular disease: a novel approach to determination of this association. ARYA Atheroscler 2019;15(6):260-266.
5. Stewart J, Manmathan G, Wilkinson P. Primary prevention of cardiovascular disease: a review of contemporary guidance and literature. JRSM Cardiovasc Dis 2017;6:2048004016687211.
6. Sadeghi M, Haghdoost AA, Bahrampour A, Dehghani M. Modeling the burden of cardiovascular diseases in Iran from 2005 to 2025: the impact of demographic changes. Iran J Public Health 2017;46(4):506-516.
7. Alizadeh G, Gholipour K, Khosravi MF, Khodayari-Zarnaq R. Preventive community-based strategies of cardiovascular diseases in Iran: a multi-method study. Soc Work Public Health 2020;35(4):177-186.
8. Soltani S, Saraf-Bank S, Basirat R, Salehi-Abargouei A, Mohammadi Fard N, Sadeghi M, et al. Community-based cardiovascular disease prevention programmes and cardiovascular risk factors: a systematic review and meta-analysis. Public Health 2021;200:59-70.
9. Rezaei S, Hajizadeh M. Measuring and decomposing socioeconomic inequality in catastrophic healthcare expenditures in Iran. J Prev Med Public Health 2019;52(4):214-223.
10. Rahmanian K, Shojaie M. The prevalence of pre-hypertension and its association to established cardiovascular risk factors in south of Iran. BMC Res Notes 2012;5:386.
11. Veronesi G, Ferrario MM, Kuulasmaa K, Bobak M, Chambless LE, Salomaa V, et al. Educational class inequalities in the incidence of coronary heart disease in Europe. Heart 2016;102(12):958-965.
12. Rose G, Marmot MG. Social class and coronary heart disease. Br Heart J 1981;45(1):13-19.
13. Najafi F, Pasdar Y, Hamzeh B, Rezaei S, Moradi Nazar M, Soofi M. Measuring and decomposing socioeconomic inequalities in adult obesity in Western Iran. J Prev Med Public Health 2018;51(6):289-297.
14. Franks P, Tancredi DJ, Winters P, Fiscella K. Including socioeconomic status in coronary heart disease risk estimation. Ann Fam Med 2010;8(5):447-453.
15. Braveman PA, Cubbin C, Egerter S, Chideya S, Marchi KS, Metzler M, et al. Socioeconomic status in health research: one size does not fit all. JAMA 2005;294(22):2879-2888.
16. Orkaby AR, Onuma O, Qazi S, Gaziano JM, Driver JA. Preventing cardiovascular disease in older adults: one size does not fit all. Cleve Clin J Med 2018;85(1):55-64.
17. Zahirian Moghadam T, Zandian H, Pourfarzi F, Poustchi H. Environmental and economics-related factors of smoking among Iranian adults aged 35-70: a PERSIAN cohort-based cross-sectional study. Environ Sci Pollut Res Int 2021;28(33):45365-45374.
18. Mahdavi-Roshan M, Rezaadzeh A, Joukar F, Naghipour M, Hassanipour S, Mansour-Ghanaei F. Comparison of anthropometric indices as predictors of the risk factors for cardiovascular disease in Iran: the PERSIAN Guilan Cohort Study. Anatol J Cardiol 2021;25(2):120-128.
19. Alipour V, Zandian H, Yazdi-Feyzabadi V, Avesta L, Moghadam TZ. Economic burden of cardiovascular diseases before and after Iran's health transformation plan: evidence from a referral hospital of Iran. Cost Eff Resour Alloc 2021;19(1):1.
20. Poustchi H, Eghtesad S, Kamangar F, Etemadi A, Keshkta AA, Hekmatdoost A, et al. Prospective epidemiological research studies in Iran (the PERSIAN Cohort Study): rationale, objectives, and design. Am J Epidemiol 2018;187(4):647-655.
21. Kolenikov S, Angeles G. Socioeconomic status measurement with discrete proxy variables: is principal component analysis a reliable answer? Rev Income Wealth 2009;55(1):128-165.
22. Filmer D, Pritchett LH. Estimating wealth effects without expenditure data--or tears: an application to educational enrollments in states of India. Demography 2001;38(1):115-132.
23. Wagstaff A, Paci P, van Doorslaer E. On the measurement of inequalities in health. Soc Sci Med 1991;33(5):545-557.
24. Monteiro CN, Beenackers MA, Goldbaum M, de Azevedo Barros MB, Gianini RJ, Cesar CL, et al. Socioeconomic inequalities in dental health services in Sao Paulo, Brazil, 2003-2008. BMC Health Serv Res 2016;16(1):683.
25. World Health Organization. Closing the gap in a generation: health equity through action on the social determinants of health - final report of the commission on social determinants of health; 2008 [cited 2021 Dec 1]. Available from: https://www.who.int/publications/i/item/WHO-IER-CSDH-08.1
26. Zandian H, Takian A, Rashidian A, Bayati M, Zahirian Moghadam T, Rezaei S, et al. Effects of Iranian economic reforms on health - final report of the commission on social determinants of health; 2008 [cited 2021 Dec 1]. Available from: https://www.who.int/publications/i/item/WHO-IER-CSDH-08.1
27. Yusuf S, Joseph P, Rangarajan S, Islam S, Mente A, Hystad P, et al. Modifiable risk factors, cardiovascular disease, and mortality in 155 722 individuals from 21 high-income, middle-income, and low-income countries (PURE): a prospective cohort study.
28. Emadi M, Delavari S, Bayati M. Global socioeconomic inequality in the burden of communicable and non-communicable diseases and injuries: an analysis on global burden of disease study 2019. BMC Public Health 2021;21(1):1771.
29. Malyutina S, Bobak M, Simonova G, Gafarov V, Nikitin Y, Marmot M. Education, marital status, and total and cardiovascular mortality in Novosibirsk, Russia: a prospective cohort study. Ann Epidemiol 2004;14(4):244-249.
30. Koch E, Romero T, Romero CX, Akel C, Manríquez L, Paredes M, et al. Impact of education, income and chronic disease risk factors on mortality of adults: does ‘a pauper-rich paradox’ exist in Latin American societies? Public Health 2010;124(1): 39-48.
31. Chang WC, Kaul P, Westerhout CM, Graham MM, Armstrong PW. Effects of socioeconomic status on mortality after acute myocardial infarction. Am J Med 2007;120(1):33-39.
32. McFadden E, Luben R, Wareham N, Bingham S, Khaw KT. Occupational social class, risk factors and cardiovascular disease incidence in men and women: a prospective study in the European Prospective Investigation of Cancer and Nutrition in Norfolk (EPIC-Norfolk) cohort. Eur J Epidemiol 2008;23(7):449-458.
33. Verdonk P, Benschop YW, de Haes HC, Lagro-Janssen TL. From gender bias to gender awareness in medical education. Adv Health Sci Educ Theory Pract 2009;14(1):135-152.
34. Regitz-Zagrosek V, Lehmkuhl E, Weickert MO. Gender differences in the metabolic syndrome and their role for cardiovascular disease. Clin Res Cardiol 2006;95(3):136-147.
35. Mehramiri A, Parand S, Haghpanah S, Karimi M. Attitudes of haemophilic patients towards their health and socio-economic problems in Iran. Haemophilia 2012;18(1):122-128.
36. Ramahi T, Khawaja M, Abu-Rmeileh N, Abdulrahim S. Socioeconomic disparities in heart disease in the Republic of Lebanon: findings from a population-based study. Heart Asia 2010; 2(1):67-72.
37. Psaltopoulou T, Hatzis G, Papageorgiou N, Androulakis E, Briassoulis A, Tousoulis D. Socioeconomic status and risk factors for cardiovascular disease: Impact of dietary mediators. Hellenic J Cardiol 2017;58(1):32-42.
38. Williams CT, Latkin CA. Neighborhood socioeconomic status, personal network attributes, and use of heroin and cocaine. Am J Prev Med 2007;32(6 Suppl):S203-S210.
39. Kanitz MG, Giovannucci SJ, Jones JS, Mott M. Myocardial infarction in young adults: risk factors and clinical features. J Emerg Med 1996;14(2):139-145.
40. Pourreza A, Barat A, Hosseini M, Akbari Sari A, Oghbaie H. Relationship between socioeconomic factors and coronary artery disease among under-45 year-old individuals in Shahid Rajaee Hospital, Tehran, Iran: a case-control study. J Sch Public Health Inst Public Health Res 2010;7(4): 25-32 (Persian).