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ORIGINAL ARTICLE

Association of educational status with cardiovascular disease: Teheran Lipid and Glucose Study

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Abstract
Objective The aim of this study was to evaluate the associations between educational level and cardiovascular disease (CVD) in an older Iranian population.
Methods To estimate the odds ratio (OR) of educational level in a cross-sectional study, logistic regression analysis was used on 1,788 men and 2,204 women (222 men and 204 women positive based on their CVD status) aged ≥45 years.
Results In men, educational levels of college degree and literacy level below diploma were inversely associated with CVD in the multivariate model [0.52 (0.28–0.94), 0.61 (0.40–0.92), respectively], but diploma level did not show any significant association with CVD, neither in the crude model nor in the multivariate model. In women, increase in educational level was inversely associated with risk of CVD in the crude model, but in the multivariate adjusted model, literacy level below diploma decreased risk of CVD by 39%, compared with illiteracy.
Conclusion Our findings support those of developed countries that, along with other CVD risk factors, educational status has an inverse association with CVD among a representative Iranian population of older men and women.

Keywords Educational status · Socioeconomic status · Cardiovascular disease

Introduction

Coronary artery disease is one of the most common causes of morbidity and mortality in different communities (Castelli 1984). Data indicates that, contrary to declining trends of coronary heart disease (CHD) mortality in developed countries (Sytkowski et al. 1996), such trends have increased in Iranian adults by 20–40% (Zali et al. 1993). The risk of developing cardiovascular disease (CVD) is modified by numerous risk factors (Kelly and Weitzen 2010), one of which, according to several studies, is socioeconomic status (SES). Although there are many studies indicating the relationship of SES with cardiovascular risk factors and CVD in developed countries (Sabanayagam et al. 2009), the mechanism underlying this link is not properly understood (Koch et al. 2010). In developing countries, this link between SES and CVD is less consistent. In some low- and middle-income countries, the prevalence of CVD is actually increasing among individuals with higher SES (Clark et al. 2009). Citizens with higher SES in poor countries have more behavioral CVD risk factors, albeit higher educational status may attenuate such behavioral habits in these subjects (Okrainec et al. 2004). On the other hand, some studies demonstrate that education may have a protective effect against clinical disease through factors influencing overt disease, such as paying attention to symptoms, care-seeking behavior and adherence to medical treatment (Yan et al. 2006). Furthermore, education is the best component of SES because it is reliable and valid and can be acquired, independent of occupation or age (Panagiotakos et al. 2008), and it is also

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more strongly associated with CHD risk factors than the other socioeconomic components (Leino et al. 1999; Winkleby et al. 1992).

Considering the differences in SES levels between developed and developing countries, the aim of this study was to evaluate the associations between educational levels and CVD in an older Iranian population. Since the association between CVD and its risk factors varies by age, we focused on subjects aged ≥45 years and excluded cases of premature CVD.

Methods

Study population

Subjects in this study were selected from among participants of the Tehran Lipid and Glucose Study (TLGS), an evolving study being performed on a representative sample of 15,005 residents of district-13 of Tehran, aged 3 years and over, with the aim of determining the risk factors for non-communicable disease (Azizi et al. 2000). Among 4,340 participants, aged ≥45 years, in the first phase of the TLGS (1999–2001), 3,992 (1,788 men and 2,204 women) individuals who had complete data on history of CVD and required variables were enrolled for the current study.

Clinical and laboratory measurements

Using a standard questionnaire, a trained interviewer collected information including demographic data, past medical history, medication use and smoking behavior. Weight was measured, while subjects were minimally clothed without shoes, using digital scales (Seca 707, Seca Corp., Hanover, MD, USA; range 0.1–150 kg) and recorded to the nearest 100 g. Height was measured in a standing position without shoes, using a tape meter with shoulders in normal alignment. Body mass index (BMI) was calculated as weight (kg) divided by square of height (m^2). Waist circumference (WC) was measured at umbilical level, using an unstretched tape meter, without any pressure to body surface. Two measurements of systolic and diastolic blood pressures (SBP and DBP, respectively) were taken using a standardized mercury sphygmomanometer (calibrated by the Iranian Institute of Standards and Industrial Researches) on the right arm after a 15-min rest in a sitting position; mean of the two measurements was considered as subject's blood pressure. A blood sample was drawn between 7:00 and 9:00 AM from all study participants after 12–14 h overnight fasting. All the blood analyses were done at the TLGS research laboratory on the day of blood collection. Plasma glucose was measured using an enzymatic colorimetric method with glucose oxidase. The standard oral glucose tolerance test (OGTT) was performed for all participants, not on glucose-lowering drugs. Total cholesterol (TC) was assayed using the enzymatic colorimetric method with cholesterol esterase and cholesterol oxidase. High-density lipoprotein cholesterol (HDL-C) was measured after precipitation of the apolipoprotein B-containing lipoproteins with phosphotungstic acid. Triglycerides (TG) were assayed using an enzymatic colorimetric method with glycerol phosphate oxidase. These analyses were performed using commercial kits (Pars Azmoon Inc., Tehran, Iran) and a Selectra 2 auto analyzer (Vital Scientific, Spankeren, The Netherlands). The intra- and inter-assay coefficients of variation (CV) were both 2.2% for glucose. For both total and HDL cholesterol, intra- and inter-assay CVs were 0.5 and 2%, respectively. Intra- and inter-assay CVs were 0.6 and 1.6% for TG, respectively.

Definition of terms

The CVD was defined as "positive history of CHD or cerebrovascular accident". Diabetes mellitus was defined as fasting plasma glucose (FPG) ≥126 mg/dl, 2 h plasma glucose ≥200 mg/dl or current use of anti-diabetic drugs (Genuth et al. 2003). Hypertension reflected SBP ≥ 140 mmHg or DBP ≥ 90 mmHg or use of antihypertensive drugs (Chobanian et al. 2003). The metabolic syndrome was defined according to the 2009 scientific consensus (Alberti et al. 2009), using WC cutoff points for Iranian men and women to predict incident CVD (WC ≥ 94.5 cm in both genders) (Hadaegh et al. 2009). Smoking was categorized to two groups: those who smoked regularly or occasionally versus those who were ex-smokers or had never smoked. Literacy level of under diploma referred to the subjects who do not graduate from high school; individuals with literacy level of diploma are those who graduated from high school.

Statistical analysis

In both genders, age-adjusted mean (±SE) or frequency (± SE) of baseline characteristics were calculated using analysis of covariance (ANCOVA) or logistic regression for each category of educational level. Logistic regression analysis with the Enter method was used to examine the association between CVD and educational levels in crude and multivariate adjusted models; ORs were calculated relative to the illiterate group. Each covariate that had a P value less than 0.2 in the univariate analysis was selected to be included in the multivariate logistic regression analysis. Interactions between educational levels and the other variables were tested using the log-likelihood ratio test of models, containing first order interactions. SPSS program

(SPSS Inc., Chicago, IL, USA; Version 15) was used for data analysis, and P values <0.05 were considered statistically significant.

Results

From a total of 4,340 subjects, aged ≥45 years (mean age of 57 years), who participated in the first phase of TLGS, 3,992 subjects were enrolled in the current study. There was no difference between the participating and non-participating groups regarding their baseline characteristics. Based on their history, 426 participants (222 men and 204 women) had CVD.

Overall 22% of the study population was illiterate, whereas 60, 10.8 and 7.1% had literacy levels below diploma, or had their diplomas and college degrees, respectively.

The prevalence of illiteracy and having college degree literacy differed by gender; men had higher levels of literacy and more likelihoods to have a college degree level compared to women; 76.4% of illiterate subjects and 21.1% of individuals with college degree literacy levels were females.

The age-adjusted baseline characteristics of men and women according to their educational levels are shown in Tables 1, 2 and 3, respectively. There were significant differences in age between different educational levels in both genders. As for BMI, both men and women were on the average overweight, regardless of their academic achievements; there was no significant difference between various educational levels. However, regarding WC, the most educated men and women had lower WC; HDL-C and TC levels were not significantly different between categories of education in either gender. In men, there were no significant differences in age-adjusted prevalence of hypertension and diabetes among various educational levels. Women in higher educational levels had lower prevalence of diabetes while the rate of hypertension was not significantly different. In women, while smoking behavior was seen less in higher educated subjects, in men, there was no significant difference in smoking status

Table 1 Distribution of educational status and cardiovascular disease in the Tehran Lipid and Glucose Study population, aged 45 years and above (1991–2001)

	Illiterate	Under diploma	Diploma	College degree
Men				
Subjects (% ± SE)	11.6 ± 0.7	62.9 ± 1.0	12.9 ± 0.8	12.5 ± 0.8
CVD cases (% ± SE)	17.1 ± 2	58.1 ± 3	15.8 ± 2	9.0 ± 2
Women				
Subjects (% ± SE)	30.5 ± 1	57.7 ± 1	9.1 ± 0.6	2.7 ± 0.3
CVD cases (% ± SE)	43.6 ± 3	48.0 ± 3	7.4 ± 2	1.0 ± 0.6
All				
Subjects (% ± SE)	22.0 ± 0.6	60.0 ± 0.7	10.8 ± 0.5	7.1 ± 0.4
CVD cases (% ± SE)	29.8 ± 2	53.3 ± 2	11.7 ± 1	5.2 ± 1

Table 2 Age-adjusted mean and percentage of cardiovascular risk factors according to educational level in men, aged 45 years and above (1991–2001)

	Illiteracy (n = 208)	Under diploma (n = 1,125)	Diploma (n = 231)	College degree (n = 224)	P value
Age (years)	66.4 ± 0.6	58.6 ± 0.2	57.2 ± 0.6	54.9 ± 0.6	<0.001
BMI (kg/m^2)	26.7 ± 0.3	26.4 ± 0.1	26.4 ± 0.2	25.7 ± 0.2	0.06
Waist circumference (cm)	92.2 ± 0.7	92.2 ± 0.3	91.2 ± 0.7	90.1 ± 0.7	0.04
Smoking (%)	44.2 ± 3.4	45.2 ± 1.5	47.2 ± 3.3	45.5 ± 3.2	0.9
Hypertension (%)	47.1 ± 3.5	38.0 ± 1.4	35.9 ± 3.2	29.0 ± 3.0	0.6
Diabetes mellitus (%)	23.6 ± 2.9	21.8 ± 1.2	23.1 ± 2.8	18.8 ± 2.6	0.4
Total cholesterol (mg/dl)	210 ± 3.0	214 ± 1.2	212 ± 2.7	218 ± 2.8	0.2
HDL-C (mg/dl)	39 ± 0.7	38 ± 0.3	38 ± 0.6	39 ± 0.6	0.4
Metabolic syndrome	52 ± 2	51 ± 2	47 ± 2	46 ± 2	0.6

Continuous variables are presented as mean ± SE; categorical variables are presented as % ± SE; except age, all variables adjusted for age according to ANCOVA for continues variables and logistic regression for binary variables

BMI body mass index, *HDL-C* high-density lipoprotein cholesterol

Table 3 Age-adjusted mean and percentage of cardiovascular risk factors according to educational level in women, aged 45 years and above (1991–2001)

	Illiteracy (n = 672)	Under diploma (n = 1,271)	Diploma (n = 201)	College degree (n = 60)	P value
Age (years)	61.7 ± 0.3	54.7 ± 0.2	51.6 ± 0.5	51.5 ± 0.9	<0.001
BMI (kg/m^2)	29.2 ± 0.2	29.3 ± 0.1	30.0 ± 0.3	27.7 ± 0.6	0.009
Waist circumference (cm)	96.0 ± 0.5	94.0 ± 0.3	94.6 ± 0.8	89.0 ± 1.4	<0.001
Smoking (%)	10.9 ± 1.2	6.1 ± 0.7	6.5 ± 1.7	8.3 ± 3.6	0.01
Hypertension (%)	57.3 ± 1.9	43.2 ± 1.4	37.3 ± 3.4	31.7 ± 6.0	0.5
Diabetes mellitus (%)	31.4 ± 1.8	21.6 ± 1.1	23.4 ± 3.0	10.0 ± 3.9	0.01
Total cholesterol (mg/dl)	238 ± 2.0	242 ± 1.4	243 ± 3.5	238 ± 6.2	0.3
HDL-C (mg/dl)	45 ± 0.5	46 ± 0.3	46 ± 0.8	43 ± 1.5	0.2
Metabolic syndrome (%)	69 ± 6	60 ± 6	60 ± 5	45 ± 5	0.09

Continuous variables are presented as mean ± SE; categorical variables are presented as % ± SE; except age, all variables adjusted for age according to ANCOVA for continues variables and logistic regression for binary variables

BMI body mass index, *HDL-C* high-density lipoprotein cholesterol

between educational levels. Metabolic syndrome tends to decrease with increase in educational levels although the differences were not significant in both genders.

The characteristics of men and women with and without CVD are summarized in Table 4. Men with CVD were older and had higher levels of smoking behavior, hypertension, diabetes and metabolic syndrome compared to those without CVD. Women who had CVD, also were older and had higher TC levels, hypertension, diabetes and metabolic syndrome compared to those without CVD. Table 5 shows the association of educational levels with CVD, stratified by sex in two models, model 1 without adjustment and model 2 adjusted for, BMI, WC, TC, HDL-C, diabetes and hypertension. In men, the literacy level below diploma and college degree levels were significantly associated with CVD in the crude model; after further adjustment for other risk factors, the relationship of under diploma and college degree levels with CVD lessened but were still significant [0.61 (0.40–0.92) and 0.52 (0.28–0.94), respectively]. For women, under diploma, diploma and college degree levels, the risk of CVD decreased as compared with women under illiteracy by 45,

Table 4 Baseline characteristics of participants, aged 45 years and above with and without CVD (1991–2001)

	Men			Women		
	Without CVD (n = 1,566)	With CVD (n = 222)	P value	Without CVD (n = 2,000)	With CVD (n = 204)	P value
Age (years)	58.3 ± 9.1	63.1 ± 8.2	<0.001	56.0 ± 7.9	61 ± 7.6	<0.001
BMI (kg/m^2)	26.4 ± 3.9	26.5 ± 3.6	0.5	29.3 ± 4.6	29.4 ± 5.1	0.6
Waist circumference (cm)	91.7 ± 10.7	92.4 ± 9.6	0.4	94.4 ± 11.2	95.5 ± 11.0	0.2
Smoking (%)	44.4 ± 1.2	52.3 ± 3.5	0.03	7.5 ± 0.6	9.3 ± 2.0	0.3
Hypertension (%)	34.0 ± 1.2	63.1 ± 3.2	<0.001	43.9 ± 1.1	74.0 ± 3.1	<0.001
Diabetes (%)	19.7 ± 1.0	36.5 ± 3.2	<0.001	23.1 ± 0.9	37.7 ± 3.4	<0.001
Total cholesterol (mg/dl)	213 ± 41	219 ± 42	0.07	239 ± 48	256 ± 57	<0.001
HDL-C (mg/dl)	39 ± 10	38 ± 10	0.6	45 ± 11	44 ± 12	0.08
Metabolic syndrome	48.0 ± 1.3	64.4 ± 3.2	<0.001	60.7 ± 1.1	80.9 ± 2.7	<0.001
Educational level			0.009			<0.001
Illiteracy (%)	10.9 ± 0.8	17.1 ± 2.5		29.2 ± 1.1	43.6 ± 3.5	
Under diploma (%)	63.6 ± 1.2	58.1 ± 3.3		58.7 ± 1.1	48.0 ± 3.5	
Diploma (%)	12.5 ± 0.8	15.8 ± 2.4		9.3 ± 0.6	7.4 ± 1.8	
College degree (%)	13.0 ± 0.8	9.0 ± 1.9		2.9 ± 0.4	1.0 ± 0.7	

Continuous variables are presented as mean ± SD and compared with Student t test; categorical variables are presented as % ± SE and compared with χ^2 test

CVD cardiovascular disease, *BMI* body mass index

Table 5 Adjusted odd ratio of cardiovascular disease by different education levels in subjects aged 45 years and above (1991–2001)

	Model 1		Model 2	
	Odds ratio (95% CI)	*P* value	Odds ratio (95% CI)	*P* value
Men				
Illiteracy	Reference		Reference	
Under diploma	0.58 (0.39–0.86)	0.007	0.61 (0.40–0.92)	0.02
Diploma	0.80 (0.48–1.32)	0.38	0.88 (0.52–1.48)	0.6
College degree	0.44 (0.25–0.78)	0.005	0.52 (0.28–0.94)	0.03
Women				
Illiteracy	Reference		Reference	
Under diploma	0.55 (0.40–0.74)	<0.001	0.61 (0.45–0.85)	0.003
Diploma	0.53 (0.30–0.93)	0.03	0.66 (0.36–1.19)	0.16
College degree	0.23 (0.05–0.94)	0.04	0.30 (0.07–1.28)	0.10

Model 1: crude model, Model 2: adjusted for body mass index, waist circumference, total cholesterol, high-density lipoprotein cholesterol, smoking, diabetes and hypertension

CI confidence interval

47 and 77%, respectively; in the multivariate model, for women with a literacy level below diploma there was significant risk of CVD associated, whereas for those with diploma and college degree levels there was no risk associated with CVD.

Discussion

This study was conducted to add data to the data available on the role of educational status of women with CVD in a Middle East population. There were inverse associations between education and many of the CVD risk factors such as obesity parameters in both genders. Higher educational levels were found to have an inverse association with CVD; independent of other risk factors, literacy level below diploma level had an inverse association with CVD, in both men and women. College degree was associated with lower risk of CVD, compared to illiteracy in older men.

Educational status and CVD risk factors

The relation between educational status and CVD risk factors in this population was generally consistent with those reported in developed countries. We found that BMI and WC, independent of age, were higher among less educated men and women. In line with our findings, some other studies demonstrated that obesity parameters were inversely associated with educational levels (Leino et al. 1999; Liu et al. 1982; Luepker et al. 1993).

Similar to some other studies which demonstrated that academic subjects smoked less compared to those with a lower educational status (Leino et al. 1999; Liu et al. 1982), in this study, the rate of smoking in more educated women was lower; however, the corresponding difference was not statistically significant in men. In contrast to our results, Bahonar et al. (2010), in another Iranian population, showed that women with higher educational levels were at higher risk of smoking, necessitating further studies to explain the causes underlying this finding.

In the current study, TC tended to be non-significantly higher in more educated men and women, a finding similar to that of another study conducted in Iran, indicating that TC level increased significantly in higher educational levels in both genders (Bahonar et al. 2010). Our findings regarding lipids in individuals with different educational statuses are in contrast with some studies from developed countries; Kilander et al. (2001) demonstrated that in the least educated Swedish men, serum cholesterol was higher. In the Young Finns study, during a 12-year follow-up, a higher level of education was associated with decrease in total cholesterol (Leino et al. 1999). Higher TC levels in more educated people in the current study may be due to the finding that in developing countries individuals with higher SES have more behavioral CVD risk factors (Okrainec et al. 2004) like bad dietary habits.

While, in this study, the rate of some of the CVD risk factors were lower in individuals with higher educational class, more studies are needed to identify the exact association between CVD risk factors and education.

Educational status and CVD

Panagiotakos et al. (2008) showed that, in a Greek population, low education levels increased CVD risk, a finding partially explained by baseline clinical characteristics. In the Minnesota Heart Survey, it was shown that overall

CHD risk was strongly related to educational level, the 10-year CHD mortality being highest in the least educated group (Luepker et al. 1993). On the other hand, Yan et al. (2006) demonstrated that after adjustment for risk factors, the strength of the association between educational status and coronary artery calcification was attenuated, and it was statistically significant only for individuals with educational levels less than a high school degree. In another study, it was shown that, in a full adjusted model with risk factors, there was no significant association between education and CVD mortality (Kilander et al. 2001). The Lipid Research Clinic study, after a 12-year follow-up of 1,925 Russian men, documented that in subjects with less than high school degree, total and CHD mortality was over twice that of those who had education levels over high school (Malyutina et al. 2004). Our results showed that in men aged ≥45 years, higher education levels independent of other CVD risk factors could lessen risk of CVD. In the current study, an education level of high school diploma had no protective effect against CVD in men, neither in the crude nor in the multivariate adjusted model, compared to illiterate men; however, the exact reason is not clear to date. Because of various differences in categories of educational levels in many studies, it is not easy to compare the detailed results. In women, all educational levels were associated with lower risk of CVD compared with illiteracy, whereas in the multivariate model the effect of diploma and college degree were not longer significant; with our sample size, the non-significant association of these educational levels with CVD might be partly attributed to the limited statistical power.

Some limitations need to be considered when interpreting the results of this study. First, as this study had a cross-sectional design, we cannot infer causality from this association. These results should be further examined in prospective studies to demonstrate whether educational status increases the risk of CVD in this population. Second, we defined CVD as a positive history of CHD and CVA, which would underestimate the prevalence of CVD. Third, low-density lipoprotein cholesterol (LDL-C) was not measured directly in the TLGS; hence, we could not evaluate the LDL-C level in different educational categories. Fourth, it must be emphasized that the results drawn from this study were determined in residents in the capital city of Iran and may not accurately reflect those of very low education or SES status in other parts of the country; further studies should be conducted to determine whether our findings are applicable to other populations living in the countryside or in small towns in Iran.

In conclusion, our results confirm findings from developed countries that along with other CVD risk factors educational status has an inverse association with CVD among an older Iranian population of men and women.

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Conflict of interest The authors declare that they have no competing interests.

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