Association of Socioeconomic Status Measured by Education and Risk Factors for Carotid Atherosclerosis: Cross-sectional Study

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Aim To investigate the association between socioeconomic status and metabolic syndrome, lifestyle, clinical and biochemical characteristics, and inflammatory markers as risk factors for carotid atherosclerotic disease.

Methods This cross-sectional study, involving 657 consecutive patients with verified carotid atherosclerotic disease, was performed in Belgrade, Serbia, during the period 2006-2007. Formal education level was used as a proxy for socioeconomic status. Anthropometric parameters and data on cardiovascular risk factors were analyzed in participants with different levels of education – low (≤primary school), medium (secondary school), and high (university education). In the analysis, univariate and multivariate logistic regressions were used.

Results Multivariate analysis showed that low education was significantly positively associated with female sex (odds ratio [OR], 2.38; 95% confidence interval [CI], 1.45-3.81), increased triglycerides (OR, 1.79; 95% CI, 1.12-2.78), increased high-sensitivity C-reactive protein (hsCRP) (OR, 3.53; 95% CI, 2.17-5.88), and physical inactivity (OR, 4.24; 95% CI, 1.82-9.86) and negatively associated with former smoking (OR, 0.42; 95% CI, 0.23-0.75). Medium education was significantly positively associated with increased triglycerides (OR, 1.73; 95% CI, 1.14-2.62) and increased hsCRP (OR, 2.17; 95% CI, 1.37-3.41), and negatively with age (OR, 0.97; 95% CI, 0.94-0.99).

Conclusion Increased triglycerides and hsCRP in people with low and medium education, and high prevalence of metabolic syndrome, its components and inflammatory markers in all study participants, suggest that regular health check-up, especially for those with lower education, may be useful in early detection and treatment of any abnormality that can be associated with cardiovascular disease.

Cardiovascular diseases, especially heart disease and stroke, are the main cause of mortality in Europe. They cause over 4.3 million deaths each year, which is nearly half (48%) of the total number of deaths (1). The death rates of heart disease and stroke have been found generally higher in Central and Eastern Europe than in Northern, Southern, and Western Europe (1).

The population of Serbia is in the third stage of the "epidemiological transition," with non-communicable diseases being the predominant cause of death and disability (2). For decades cardiovascular diseases in Serbia have ranked first as a cause of death, with cardiovascular mortality rates increasing over time (3-5). In 2006, cardiovascular diseases were responsible for 57% of all causes of death (52% in men and 63% in women). Mortality rates, standardized according to age of the European population, were 632.6 per 100 000 in men and 507.6 per 100 000 in women. In the same year, standardized mortality rates for cerebrovascular diseases were 168.9 per 100 000 in men and 153.0 per 100 000 in women, while for ischemic heart disease they were 168.9 per 100 000 in men and 103.0 per 100 000 in women (5,6).

During the last few decades, many studies have shown that the socioeconomic status is related to mortality and morbidity of cardiovascular diseases (7). At the beginning of the 20th century, cardiovascular diseases were more frequent in the upper socioeconomic class (8), but from the middle of the 20th century, especially in western developed countries, cardiovascular diseases have become more frequent in the lower socioeconomic groups (9). This may be due to greater awareness of cardiovascular risk factors and adoption of preventive measures mostly among higher socioeconomic groups, but this does not provide a complete explanation (8).

There is increasing evidence that metabolic syndrome, ie, clustering of cardiovascular risk factors, such as hypertension, diabetes mellitus, dyslipidemia, and abdominal obesity can influence the progression of atherosclerosis and that subjects with metabolic syndrome have an increased risk of atherosclerotic disease morbidity and mortality (10). There are reports that metabolic syndrome may be influenced by socioeconomic status (11).

For epidemiological purposes, variables such as education, occupation, family income or their combination have been used as an indirect indicator of socioeconomic status. Some investigators especially emphasized education as a reliable indicator of socioeconomic status because it is stable, established in early adulthood, and not modified by chronic disease (12).

The effect of educational status on the risk of cardiovascular disease is not completely understood. Some studies have suggested that education is related to cardiovascular diseases primarily through undesirable lifestyle (13,14), but differences in hormonal status and psychosocial factors could also play a role (15,16). In several studies, inverse relation between various measures of socioeconomic status and carotid intima-media thickness was found (17). A recently published population-based study implied that differences in the prevalence of preclinical atherosclerosis can explain educational differences in future coronary morbidity (18). Individuals with preclinical atherosclerosis, in comparison with those without atherosclerosis, had more unfavorable cardiovascular risk factors levels regardless of education status, and association between education level and coronary events was present only in those with asymptomatic atherosclerosis. We wanted to know whether there were any differences in education status of respondents with clinically manifest atherosclerosis. Therefore, the aim of the present study was to test the hypothesis that educational status of patients with carotid atherosclerotic disease is associated with metabolic syndrome, lifestyle, clinical and biochemical characteristics, and inflammatory markers.

Methods

This cross-sectional study involved 657 consecutive patients with verified carotid atherosclerotic disease who were referred to the Dedinje Vascular Surgery Clinic in Belgrade during between April 2006 and November 2007. Patients who had symptoms of cerebral ischemia and carotid stenosis of ≥50% according to NASCET criteria (19) were included in the study. Carotid atherosclerosis was estimated by high resolution B-mode ultrasonography HDI ATL 3500 (Philips Ultrasound, Eindhoven, The Netherlands).

Patients younger than 18 and patients with malignant disease, previous endarterectomy, and rheumatoid arthritis were not included in the study. For all participants, anthropometric parameters and data on cardiovascular risk factors were collected. The study was approved by the Ethics Committee of the School of Medicine in Belgrade. All patients gave a written informed consent.

Anthropometric parameters

Body weight was assessed by a calibrated standard balance-beam, height was measured by a standard height bar, and body mass index (BMI) was calculated as weight (kg) divided by the square of height in meters (m^2) and categorized according to World Health Organization (WHO) criteria (20). Waist circumference was measured midway between the lower rib and iliac crest, and according to WHO criteria all patients were classified into two groups. One group included patients with abdominal obesity, defined by a waist circumference >102 cm (men) and >88 cm (women), and the other included patients without abdominal obesity (20). Body fat was calculated according to method proposed by Durnin and Womersley (21).

Blood pressure

Blood pressure measurements were done by appropriately sized cuffs and auscultatory method recommended by the Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure (22).

Biochemical tests

For estimation of metabolic parameters, fasting plasma glucose and lipoproteins, blood samples were obtained after an overnight fast. Levels of fasting plasma glucose, total cholesterol, serum triglycerides, high-density lipoprotein cholesterol (HDL-C), and low-density lipoprotein cholesterol (LDL-C) were estimated using commercial kits (Abbot Laboratories, Abbott Park, IL,USA) on an automated analyzer (AEROSET™, Abbot). Levels of high-sensitivity C-reactive protein (hsCRP) and fibrinogen were measured by Immunoturbidimetric fixed time test (Olympus Diagnostics, O'Callaghan's Mills Co., Clare, Ireland) and the value of hsCRP was defined according to the Center for Disease Control recommendation (≥3 mg/L) (23).

Metabolic syndrome

According to National Cholesterol Education Program III, patients were classified as having metabolic syndrome if they fulfilled 3 or more of the following criteria: 1) triglycerides ≥1.69 mmol/L; 2) HDL-C<1.03 mmol/L (men) and <1.29 mmol/L (women); 3) systolic blood pressure ≥130 mm Hg or diastolic blood pressure ≥85 mm Hg or antihypertensive drug therapy; 4) obesity, defined as a waist circumference >102 cm (men) and >88 cm (women); and 5) abnormal glucose metabolism defined as a fasting glucose ≥6.11 mmol/L (24).

Educational status

Participants were classified into three groups according to their reported education as follows: low education group – participants with incomplete or complete primary school (≤8 years of schooling); medium education group – participants with complete secondary school (9-12 years of schooling); and high education group – participants with complete university education (>12 years of schooling).

Smoking and alcohol consumption

According to self-reported data, each subject was classified as a non-smoker, former smoker, or current smoker. Current smokers were defined as individuals who smoked at least one cigarette per day or had stopped smoking within the previous 12 months. Former smokers were defined as those who had quit smoking more than a year earlier, and never smokers as those who had never smoked a cigarette in their life. The number of cigarettes smoked and duration of smoking were expressed as pack years of smoking.

Current drinkers were defined as those drinking ≥1 of any type of alcoholic drink per month (brandy – 0.5 dL; hard liquor – 0.5 dL; wine – 2.0 dL; beer – 5.0 dL). Nondrinkers (<1 drink of any type per month) were divided into former drinkers (who had consumed at least 12 alcoholic drinks of any type over their lifetime but not currently drinking), and non-drinkers who had consumed <12 alcoholic drinks over their lifetime (25). Alcohol consumption was analyzed as yes/no variable and as the total dose of alcohol consumption for each participant, which was calculated by adding all the individual beverages weighted to their alcohol content. It was assumed that alcohol content in the beverages was as follows: 30% in brandy, 40% in hard liquor, 12% in wine, and 3.5% in beer.

Physical activity

Physical activity was defined as any type of non-occupational physical exercise lasting more than 30 minutes per day during the previous month. Those, who exercised more than once per week were considered physically active. The rest of the participants were classified as physically inactive.

Depression

For the assessment of depression, Beck Depression Inventory (BDI) score was used (26). BDI consists of 21 questions and answers are given on a four-point scale (valued from 0 to 3). The BDI score theoretically ranges from 0 to 63 points and a score higher than 10 points indicates depression. BDI reliability and validity have been proven in previous psychometric studies (27).

Statistical analysis

Continuous variables were presented as mean ± standard deviation (SD). Univariate and multivariate stepwise logistic regression analyses were used with adjustment according to age and sex where appropriate. In the multivariate analyses, variables associated with dependent variable at significance level of $P \leq 0.100$ were included. The goodness-of-fit of logistic regression models was assessed by using the Hosmer and Lemeshow goodness-of-fit test, as well as likelihood ratio χ^2 test for overall model fit (G test). Goodman-Kruskal Gamma statistics was used for estimation of the non-parametric measure of correlation. Data were analyzed using Statistical Package for the Social Sciences, version 15 (SPSS Inc., Chicago, IL, USA), with significance level set to 0.05.

Results

Of 657 patients with carotid atherosclerosis, 244 (37.1%) were classified in the low, 252

(38.4%) in the medium, and 161 (24.5%) in the high education group.

In comparison with participants with high education, those with low education were significantly more frequently women, industrial workers, agricultural workers, and housewives, and significantly less frequently white-collar workers (Table 1). In comparison with the high education group, participants with medium education were significantly more frequently industrial workers, less frequently white-collar workers, and were significantly younger (Table 1).

According to univariate logistic regression analysis, participants with low and medium education had significantly more frequently metabolic syndrome and increased triglycerides than participants with high education (Table 2). There were no significant differences between the groups in the frequency of increased waist circumference, increased plasma glucose level, increased blood pressure, and low level of high-density lipoprotein cholesterol.

In comparison with high education group, participants with low education were significantly more frequently current smokers, former smokers, and physically inactive (Table 3). They also significantly more frequently had increased hsCRP, increased fibrinogen, and stroke. The groups did not significantly differ in the frequency of alcohol consumption, obesity, and depression. Participants with medium education differed from those with high education in the frequency of increased hsCRP, which was significantly higher in the medium education group. They were also significantly more frequently physically inactive.

The variables related to education at significance level of $P \leq 0.100$ according to univariate logistic regression analysis were entered in the multivariate logistic regression analysis. Occupation was excluded from further analysis due to multicollinearity. Low education was sig-

Table 1. Demographic characteristics of study participants by education status*

	Education level (No. of participants, %)				
Characteristic	low (n = 244)	P†	medium (n = 252)	P‡	high (n = 161)
Age (mean ± standard deviation)	66.1 ± 8.1	0.886	63.9 ± 8.5	0.007	66.2 ± 8.3
Sex – women	118 (48.4)	<0.001	85 (33.7)	0.102	42 (26.1)
Marital status – married	180 (73.8)	0.864	189 (75.0)	0.915	120 (74.5)
Occupation:§					
industrial worker	134 (54.9)	<0.001	112 (44.4)	<0.001	15 (9.3)
agricultural worker	18 (7.4)	0.014	0	–	0
housewife	79 (32.4)	<0.001	6 (2.4)	0.525	0
white collar worker	13 (5.3)	<0.001	134 (53.2)	<0.001	146 (90.7)

*Results of univariate logistic regression analysis.
†Low education group compared with high education group.
‡Medium education group compared with high education group.
§Each occupation was compared with all others taken together.

Table 2. Metabolic syndrome and its components in study participants by education status*

	Education level (No. of participants, %)				
Characteristic	low (n = 244)	P†	medium (n = 252)	P‡	high (n = 161)
Metabolic syndrome	152 (62.3)	0.017	139 (55.2)	0.087	74 (46.0)
Increased waist circumference§	142 (58.2)	0.357	104 (41.3)	0.269	78 (48.4)
Increased triglycerides‖	118 (48.4)	0.057	129 (51.2)	0.012	60 (37.3)
Low high-density lipoprotein cholesterol¶	156 (63.9)	0.557	163 (64.7)	0.118	90 (55.9)
Increased fasting glucose**	57 (23.4)	0.780	64 (25.4)	0.882	40 (24.8)
Increased blood pressure††	222 (91.0)	0.313	220 (87.3)	0.702	140 (87.0)

*Results of univariate logistic regression analysis. Comparison of low to high education was adjusted to sex. Comparison of medium to high education was adjusted to age.
†Low education group compared with high education group.
‡Medium education group compared with high education group.
§>102 cm in men and >88 cm in women.
‖≥150 mg/dL or 1.69 mmol/L.
¶<40 mg/dL or 1.03 mmol/L in men and <50 mg/dL or 1.29 mmol/L in women.
**≥110 mg/dL or 6.11 mmol/L.
††≥130/≥85 mm Hg or on antihypertensive drug treatment in a patient with a history of hypertension.

Table 3. Lifestyle, clinical characteristics, and inflammatory markers in study participants by education status *

	Education level (No. of participants, %)				
Characteristic	low (n = 244)	*P*†	medium (n = 252)	*P*‡	high (n = 161)
Smoking status:					
current smoker	63 (25.8)	0.043	91 (36.1)	0.348	47 (29.2)
former smoker	73 (29.9)	<0.001	88 (34.9)	0.237	70 (43.5)
Pack years of smoking (mean ± standard deviation)	39.34 ± 27.3	0.302	44.32 ± 30.49	0.637	42.73 ± 24.27
Alcohol consumption (current and former drinkers):	86 (35.2)	0.243	90 (35.7)	0.281	66 (41.0)
daily alcohol consumption, dL (mean ± SD)	0.22 ± 0.59	0.208	0.23 ± 0.56	0.149	0.16 ± 0.24
Physical activity (times per month):					
0-4	235 (96.3)	<0.001	230 (91.3)	0.042	137 (85.1)
5-8	9 (3.7)	0.001	19 (7.5)	0.068	21 (13.0)
9+	0	–	3 (1.2)	0.350	3 (1.9)
Obesity (body mass index ≥30 kg/m^2)	56 (22.9)	0.664	51 (20.2)	0.829	34 (21.1)
Stroke	103 (42.2)	0.094	98 (38.9)	0.639	59 (36.6)
Depression	62 (25.4)	0.546	53 (21.0)	0.751	37 (23.0)
Increased high sensitivity C-reactive protein (≥3 mg/L)	110 (45.1)	<0.001	98 (38.9)	0.001	38 (23.6)
Increased fibrinogen (>4 g/L)	70 (28.7)†	0.022	60 (23.8)	0.153	29 (18.0)

*Results of univariate logistic regression analysis. Comparison of low to high education was adjusted to sex. Comparison of medium to high education was adjusted to age.
†Low education group compared with high education group.
‡Medium education group compared with high education group.

Table 4. Variables significantly related to education status according to multivariate logistic regression analysis

	Low vs high education*		Medium vs high education†	
Variable	OR (95% CI)‡	*P*§	OR (95% CI)‡	*P*§
Age	–		0.97 (0.94-0.99)	0.009
Female sex	2.38 (1.45-3.81)	<0.001	–	
Former smoker	0.42 (0.23-0.75)	0.003	–	
Increased triglycerides (≥150 mg/dL or 1.69 mmol/L)	1.79 (1.12-2.78)	0.013	1.73 (1.14-2.62)	0.010
Increased high sensitivity C-reactive protein (≥3 mg/L)	3.53 (2.17-5.88)	<0.001	2.17 (1.37-3.41)	0.001
Physical inactivity	4.24 (1.82-9.86)	0.001	–	

*Hosmer and Lemeshow goodness-of-fit test, χ^2_8 = 0.431; *P* = 0.814. Likelihood ratio χ^2 test for overall model fit (G test): χ^2_8 = 74.951; *P* < 0.001.
†Hosmer and Lemeshow goodness-of-fit test: χ^2_8 = 10.368; *P* = 0.240. Likelihood ratio χ^2 test for overall model fit (G test): χ^2_8 = 25.848; *P* < 0.001.
‡Odds ratios (OR) and 95% confidence intervals (CI) according to multivariate stepwise logistic regression analysis.
§According to multivariate stepwise logistic regression analysis

nificantly positively related to female sex, increased hsCRP, and physical inactivity, and negatively related to former smoking (Table 4). Medium education was significantly positively related to increased triglycerides and increased hsCRP, and negatively related to age.

Discussion

Our study showed that metabolic syndrome was not related to education in patients with atherosclerotic carotid disease. However, one of the most frequent metabolic syndrome components, increased triglycerides, was significantly more frequent in participants with low and medium than in those with high education. The same was true for increased hsCRP, which is one of the inflammatory markers. Women and physically inactive participants were more likely to have low education.

In Western countries, metabolic syndrome related to lower socioeconomic status expressed as household income (11) or lower-grade employment (28), and this association was especially strong in women (29). It has been proposed that the increased risk of metabolic syndrome, atherosclerosis, and cardiovascular diseases in the respondents with lower socioeconomic status may be due to both undesirable health behavior (such as smoking, alcohol consumption, inadequate diet, and physical inactivity) and psychosocial stress (11,14,28,30). For example, the ATTICA study performed on healthy individuals showed the inverse association between education level and clinical and biochemical parameters related to cardiovascular disease, which was mainly explained by smoking habits, physical inactivity, increased body mass index, dietary habits, and non-compliance to treatment (14). In the present study, smoking was more prevalent among participants with high education and there were no differences in alcohol consumption according to education. Physical inactivity was more frequent among participants with low education. However, among those classified as physically active, only 6 reported to exercise more than twice per week. In the study conducted in Finland (31), middle-aged men with lower education level exercised less. In a Croatian study (32), educated people participated more in sports activities but leisure time activity was not significantly related to education. We did not collect data on diet, but there were no significant differences in obesity between the groups.

The ATTICA study also found a significant association of increased triglycerides and increased hsCRP with education status (14). The authors of the ATTICA study assumed that such findings could be potentially attributed to psychosocial factors like occupational stress or depression. We do not know whether education status was related to psychological stress in our participants, but the compared groups did not significantly differ in the frequency of depression.

Our study is limited by its cross-sectional design, which makes it difficult to judge causal relations. Another limitation is that education was used as the only indicator of socioeconomic status. It has been shown that various indicators of socioeconomic status are not interchangeable (33,34). Different indicators reflect different aspects of social stratification but none of the indicators sufficiently captures the essence of socioeconomic status (33-35). In addition, study participants were taken from a single hospital and they did not represent all patients with carotid atherosclerotic disease.

Increased triglycerides and hsCRP in people with low and medium education, and high prevalence of metabolic syndrome, its components and inflammatory markers in all study participants, suggest that regular health check-ups, especially in those with lower education, may be useful in early detection and treatment of any abnormality that can be associated with cardiovascular disease. High prevalence of smoking habits, alcohol consumption, physical inactivity and obesity, although not related to education or related to it in different direction, suggests the need for health education about the impact of unhealthy lifestyle on development of atherosclerosis and cardiovascular diseases.

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