Cent Eur J Public Health 2024; 32 (1): 25–30

ASSOCIATION OF CARDIOVASCULAR HEALTH AND EDUCATIONAL STATUS IN A SCREENING COHORT

Sarah Wernly[1], Georg Semmler[2], Maria Flamm[3], Andreas Völkerer[1], Ralf Erkens[4], Elmar Aigner[5], Christian Datz[1], Bernhard Wernly[1, 3]

[1]Department of Internal Medicine, General Hospital Oberndorf, Teaching Hospital of the Paracelsus Medical Private University, Oberndorf, Austria
[2]Division of Gastroenterology and Hepatology, Department of Medicine III, Medical University of Vienna, Vienna, Austria
[3]Institute of General Practice, Family Medicine and Preventive Medicine, Paracelsus Medical University, Salzburg, Austria
[4]Department of Cardiology, Pulmonology and Vascular Medicine, Medical Faculty, Heinrich Heine University Duesseldorf, Duesseldorf, Germany
[5]Clinic I for Internal Medicine, University Hospital Salzburg, Paracelsus Medical University, Salzburg, Austria

SUMMARY

Introduction: The global burden of chronic diseases, including cardiovascular disease, remains a significant public health challenge. The Life's Simple 7 (LS7) score was developed as a tool to evaluate cardiovascular health behaviours and habits and identify high-risk individuals. The present study aimed to assess the distribution of LS7 scores among educational strata.

Methods: The study population consisted of 3,383 asymptomatic individuals screened for colorectal cancer at a single centre in Austria. We split patients into lower (n = 1,055), medium (n = 1,997), and higher (n = 331) education, based on the International Standard Classification of Education (ISCED). Cox regression models were utilized to determine the association between education and mortality over a median follow-up period of 7 years.

Results: Individuals with higher educational status had a significantly higher prevalence of ideal cardiovascular health metrics, as defined by the LS7 score, compared to those with medium and lower educational status: n = 94 (28%) vs. n = 347 (17%) and n = 84 (8%), respectively, (p < 0.001). In the Cox regression analysis, both medium (HR = 0.61, 95% CI: 0.43–0.84, p < 0.001) and higher educational status (HR = 0.44, 95% CI: 0.19–1.01, p = 0.06) were associated with all-cause mortality, as was the LS7.

Conclusion: Our findings highlight a significant association between lower educational status and poorer cardiovascular health, as assessed by LS7, which persisted even after multivariable adjustment. Additionally, both educational status and LS7 were associated with increased mortality, underscoring the significance of our results. These findings have important implications for public health, as screening and prevention strategies may need to be tailored to meet the diverse educational backgrounds of individuals, given the higher prevalence of unhealthy lifestyle behaviours among those with lower educational status.

Key words: education, Simple 7, cardiovascular health, public health

Address for correspondence: R. Erkens, Department of Cardiology, Pulmonology and Vascular Medicine, Heinrich Heine University Düsseldorf, Moorenstraße 5, 40225 Düsseldorf, Germany. E-mail: Ralf.Erkens@med.uni-duesseldorf.de

https://doi.org/10.21101/cejph.a7818

INTRODUCTION

Chronic diseases are a major public health challenge, with cardiovascular disease being one of the leading causes of mortality worldwide (1). In order to understand the distribution of cardiovascular healthy behaviour, the Life's Simple 7 (LS7) score was initially developed for the U.S. population as a tool to assess cardiovascular health behaviours and habits and later validated for the European population (2–4). The LS7 score consists of seven components, including smoking status, physical activity, diet, body mass index, blood pressure, glucose, and cholesterol levels. These components provide a comprehensive evaluation of cardiovascular health and help to identify individuals at risk for cardiovascular disease. Prevention is a major aim in tackling the non-communicable disease pandemic (5). By promoting healthy behaviours and habits, individuals can reduce their risk of developing chronic diseases, including cardiovascular disease. This not only improves health outcomes for individual patients, but also contributes to reducing overall healthcare costs by preventing the onset of disease and reducing the need for medical intervention (6, 7). Screening tools like the LS7 are essential in understanding gaps in cardiovascular health and in goal setting for individual patients. The LS7 provides a comprehensive evaluation of cardiovascular health and helps healthcare providers identify individuals at risk for disease (8–11). By using screening tools like the LS7, healthcare providers can work with patients to set realistic goals and develop personalized plans for improving cardiovascular health and reducing the risk of chronic disease. On a population level, understanding the distribution of LS7 scores can help decision-makers to focus preventive measures on specific weaknesses. By identifying areas where the population has lower LS7 scores, public health policies and programmes can be developed to address these specific health behaviours and habits.

Socioeconomic status is known to be associated with adverse cardiovascular risk and outcomes, and educational status has been established as a proxy for socioeconomic status (12, 13). Understanding the distribution of LS7 scores and its individual components among different educational strata is important for public health decision-making and tailoring preventive strategies (14).

The aim of this study was to evaluate the distribution of LS7 scores and its individual components among patients with lower, medium, and higher education according to the International Standard Classification of Education (ISCED). We hypothesize that even in Central Europe, with its relatively fair socioeconomic status, unhealthy behaviours may be distributed differently among educational strata. The results of this study could provide valuable information for public health decision-making, as well as for counselling individual patients. By understanding the distribution of LS7 scores among different educational strata, public health policies and programmes can be tailored to address specific health behaviours and habits. Additionally, healthcare providers can use the information to better understand the cardiovascular health of their patients and provide targeted counselling and interventions. Another aim of this study was to determine whether educational status and LS7 were independently associated with mortality.

MATERIALS AND METHODS

Subjects

We included participants from the Salzburg Colon Cancer Prevention Initiative (Sakkopi), which is a cohort of asymptomatic patients screened for colorectal cancer between January 2007 and March 2020 at a single centre in Austria. The total cohort consisted of 5,977 consecutive patients. We included 3,383 in this analysis for whom we could calculate all the items of the LS7. Clinical as well as laboratory parameters were obtained in all participating subjects (15, 16). We calculated the ACC/AHA 10-year risk for an initial hard atherosclerotic cardiovascular disease (ASCVD) event for each patient (17). Also, patients completed a questionnaire about their medical history. All individual body parameters were assessed by our study team. We defined and calculated body mass index (BMI), arterial hypertension, smoking status, as well as metabolic syndrome according to current guidelines (18). Briefly, the metabolic syndrome was characterized by the confluence of insulin resistance, visceral adiposity, atherogenic dyslipidaemia, and endothelial dysfunction, along with the simultaneous presence of multiple established cardiovascular risk factors, such as insulin resistance, obesity, atherogenic dyslipidaemia, and hypertension. The patients' deaths were queried through the Austrian Death Register. Cardiovascular death was determined and obtained through telephone contact with the general practitioner or the deceased person's relatives. We categorized the patients' educational status into lower, medium, and higher education, based on a recent publication by Schneider (19). Specifically, patients with ISCED 1 and 2 were categorized into low, 3 and 4 into medium, and 5 and 6 into high education.

Life's Simple 7

The LS7 metric consists of seven components including smoking status, body mass index, blood pressure, cholesterol, fasting glucose, physical activity, and diet. The physical activity and diet classification were modified from the original LS7 definitions. A physical activity <1 hour/week was considered poor (1 point), 1 to 3 hours intermediate (2 points), and ≥ 3 hours good (3 points) health. For the diet classification we first dichotomized vegetable consumption (daily vs. less than daily), fruit consumption (daily vs. less than daily), salt consumption (<1.5 g salt vs. ≥ 1.5 g salt daily), alcohol consumption (<2 drinks/day vs. ≥ 2 drinks/day), and fast food consumption (<1 weekly vs. ≥ 1 weekly). We then added these binary items up yielding a dietary score ranging from 0 (healthy diet) to 5 (unhealthy diet), and then we trichotomized this variable into poor diet (4 and 5 points), intermediate diet (2 and 3 points), and healthy diet (0 and 1 points). Each LS7 component was given a score of 0, 1, or 2, with 0 representing poor health, 1 representing intermediate health, and 2 representing ideal health. The overall LS7 score was calculated as the sum of the component scores, with a possible range of 0 to 14. This overall score was classified as poor (0–4), intermediate (5–9), or ideal (10–14) cardiovascular health.

Statistical Analysis

Most continuous variables were found to be non-normally distributed. Continuous data are given as median ± interquartile range (IQR), and compared using Mann's Whitney U-test or mean ± standard deviation (SD), and compared using Student's t-test accordingly. Categorical data are given as numbers (percentage) and compared using the chi-square test. The primary exposure was the educational status with the lower educational status as reference category. We fitted two regression models, an univariable model (Model 1), a model adjusting for age and sex (Model 2). For the logistic regression models, we defined poor cardiovascular health (LS7 0-4) as binary endpoint and dependent variable. For the linear regression models, the LS7 was the dependent variable, taken as continuous variable.

For the Cox proportional hazard models, the primary binary endpoint (dependent variables in the regression models) was the overall mortality. We adjusted for age and sex. We obtained (adjusted) odds or hazard ratios (OR) and respective 95% CIs. All tests were two-sided, and a p-value of <0.05 was considered statistically significant. Stata/IC 17 was used for all statistical analyses.

Ethics Statement

We performed the study and all procedures according to the principles of the Declaration of Helsinki. The local Ethics Committee for the Salzburg Province approved the study protocol (approval no. 415-E/1262). Written informed consent was obtained from every participant.

RESULTS

The analysis included 3,383 participants, among which 1,055 (31.2%) had lower education, 1,997 (59.1%) had medium education, and 331 (9.8%) had higher education. The mean age was higher in those with lower education (59 ± 9) compared to those with medium education (57 ± 9) and higher education (55 ± 8) ($p < 0.001$). The prevalence of hypertension, steatosis on ultrasound, diabetes, and metabolic syndrome was significantly higher in those with lower education ($p < 0.001$). The 10-year risk for atherosclerotic cardiovascular disease was significantly higher in those with lower education (20 ± 15) compared to those with medium education (17 ± 14) and higher education (13 ± 12) ($p < 0.001$). Furthermore, cardiovascular mortality was more common in those with lower education (2%) compared to those with medium education (1%) and higher education (0%), ($p = 0.001$). All-cause mortality did also differ in those with lower education (9%) compared to those with medium education (3%) and higher education (2%), ($p < 0.001$) (Table 1).

With the exception of cholesterol levels, which were similarly distributed across educational groups, individuals with lower educational status demonstrated poorer cardiovascular health across all domains of the LS7 (Table 2). The prevalence of ideal cardiovascular health metrics, as defined by the LS7 score, was higher in the higher education group – n = 94 (28%) compared to the medium education group – n = 347 (17%) and lower education group – n = 84 (8%), ($p < 0.001$).

In the linear regression analysis, the LS7 as continuous variable was associated with both medium ($r = 0.83$, 95% CI: 0.69–0.97, $p < 0.001$) and higher ($r = 1.47$, 95% CI: 1.23–1.70, $p < 0.001$) educational status compared to lower education and remained so after multivariable adjustment for age and sex. In the logistic regression, both medium (aOR = 0.49, $p < 0.001$) and higher (aOR = 0.22, $p < 0.001$) education had significantly lower odds for poor cardiovascular health compared to patients with lower education (Table 3).

Both medium (HR = 0.61, 95% CI: 0.43–0.84, $p < 0.001$) and higher educational status (HR = 0.44, 95% CI: 0.19–1.01, $p = 0.06$) were associated with the all-cause mortality in the univariate Cox regression analysis, as was the LS7 (Table 4). In the age- and sex-adjusted model the hazard for mortality remained significantly lower in the medium education stratum compared to the lower education group (Table 4). Of note, the LS7 remained associated with all-cause mortality after age- and sex-adjustment (Table 4).

DISCUSSION

In this study, we found a robust association between lower educational status and poorer cardiovascular health, as assessed by the LS7. The association persisted even after multivariable adjustment for age and sex. Furthermore, both educational status and LS7 were associated with increased mortality, suggesting important implications of our study. Our results highlight the higher prevalence of unhealthy lifestyle behaviours in patients with lower educational status, even in a relatively socioeconomically balanced system like Austria. This has implications for public health, as both screening and prevention strategies could be tailored specifically to individuals with different educational backgrounds.

In a previous US study, an association between lower educational status and poorer cardiovascular health was shown, with correction for different ethnicities (20). In our study, such correction was not possible, as the overwhelming majority of our patients were of Central European origin, based on our clinical experience. A similar robust association between lower educational status and poorer cardiovascular health behaviours and risk factors was also confirmed in another study that evaluated Asian Americans (21). Still, our study provides an important confirmation of the previous American studies: even in a Central European country with a strong public health system and a relatively egalitarian education system, lower educational attainment is associated with poorer cardiovascular health. Indeed, educational attainment has a protective effect on cardiovascular health, yet the advantages of education may not endure consistently among various racial and ethnic groups (20).

Apart from the different healthcare economics, ethnic, and sociopolitical settings, our study adds another important aspect:

Table 1. *Baseline characteristics of patients categorized by educational status*

	Lower education n = 1,055 n (%)	Medium education n = 1,997 n (%)	Higher education n = 331 n (%)	p-value
Age (years), mean (SD)	59 (9)	57 (9)	55 (8)	< 0.001
Female (yes/no)	525 (50)	830 (42)	139 (42)	< 0.001
BMI (kg/m^2), mean (SD)	28 (5)	27 (5)	26 (4)	< 0.001
Hypertension (yes/no)	644 (61)	1,106 (55)	139 (42)	< 0.001
Steatosis on ultrasound (yes/no)	546 (52)	889 (45)	114 (34)	< 0.001
Diabetes (yes/no)	164 (16)	229 (11)	23 (7)	< 0.001
Hba1c, mean (SD)	5.6 (0.6)	5.4 (0.5)	5.3 (0.3)	< 0.001
Metabolic syndrome (yes/no)	776 (74)	1,613 (81)	247 (75)	< 0.001
Creatinine (mg/dL), mean (SD)	0.9 (0.2)	0.9 (0.2)	0.9 (0.2)	0.060
10-year-risk for ASCVD, mean (SD)	20 (15)	17 (14)	13 (12)	< 0.001
Cardiovascular mortality (yes/no)	20 (2)	14 (1)	0 (0)	0.001
Mortality (yes/no)	98 (9)	62 (3)	6 (2)	< 0.001

ASCVD – atherosclerotic cardiovascular disease

Table 2. Baseline characteristics of patients categorized by educational status

	Lower education n = 1,055 n (%)	Medium education n = 1,997 n (%)	Higher education n = 331 n (%)	p-value
BMI categories				
BMI ≥ 30	281 (27)	454 (23)	43 (13)	< 0.001
BMI 25 to 29	456 (43)	820 (41)	123 (37)	
BMI < 25	318 (30)	723 (36)	165 (50)	
Cholesterol categories				
Cholesterol ≥ 240 mg/dL	338 (32)	636 (32)	106 (32)	0.740
Cholesterol 200 to 239 mg/dL or treated	494 (47)	906 (45)	145 (44)	
Cholesterol < 200, untreated	223 (21)	455 (23)	80 (24)	
Physical activity categories				
< 1 hour	257 (24)	176 (9)	6 (2)	<0.001
1 to < 3 hours	719 (68)	1,530 (77)	279 (84)	
≥ 3 hours	79 (7)	291 (15)	46 (14)	
Fasting glucose categories				
> 125 mg/dL	86 (8)	145 (7)	16 (5)	< 0.001
100–125 mg/dL	398 (38)	637 (32)	88 (27)	
< 100 mg/dL	571 (54)	1,215 (61)	227 (69)	
Smoking LS7 categories				
Smoker	330 (31)	399 (20)	56 (17)	< 0.001
Ex-Smoker	519 (49)	737(37)	102 (31)	
Never smoker	206 (20)	861 (43)	173 (52)	
Blood pressure LS7 categories				
RR ≥ 140 or ≥ 90 mmHg	512 (49)	891 (45)	116 (35)	< 0.001
RR intermediate	489 (46)	1,075 (54)	214 (65)	
RR < 120/80 mmHg	54 (5)	31 (2)	1 (0)	
Diet LS7 categories				
Poor diet	106 (10)	133 (7)	7 (2)	< 0.001
Intermediate diet	631 (60)	1,223 (61)	226 (68)	
Healthy diet	318 (30)	641 (32)	98 (30)	
LS7, mean (SD)	7 (2)	8 (2)	8 (2)	< 0.001
LS categories				
Poor LS7	102 (10)	105 (5)	8 (2)	< 0.001
Intermediate LS7	869 (82)	1,545 (77)	229 (69)	
Ideal LS7	84 (8)	347 (17)	94 (28)	

Table 3. Odds for poor cardiovascular health

	Model 1			Model 2		
	OR	95 % CI	p-value	OR	95% CI	p-value
Lower education	ref			ref		
Medium education	0.52	0.39–0.69	< 0.001	0.49	0.37–0.65	< 0.001
Higher education	0.23	0.11–0.48	< 0.001	0.22	0.11–0.46	< 0.001

Model 1 – unadjusted; Model 2 – age and sex

Table 4. All-cause mortality for different educational status and within different models

	Hazard ratio with all-cause mortality					
	Univariable model			Age- and sex-adjusted model		
	HR	95% CI	p-value	HR	95% CI	p-value
Lower education	Ref			Ref		
Medium education	0.61	0.43–0.84	<0.001	0.71	0.51–0.99	0.040
Higher education	0.44	0.19–1.01	0.060	0.73	0.32–1.69	0.470
LS7 (per unit)	0.85	0.79–0.82	<0.001	0.90	0.83–0.97	0.008

we were able to demonstrate that the association between LS7 and educational status is not just a theoretical concept, but rather has concrete effects on our patients. In our study, lower educational status was associated with increased mortality. It should be noted, however, that there were differences in age and sex between the educational strata, but the negative impact of lower education on mortality persisted even after adjusting for age and sex. Furthermore, the LS7 was also associated with all-cause mortality. In a multivariable model that integrated both LS7 and educational status, only medium education, not higher education compared to lower education, was associated with lower mortality. However, we attribute this primarily to the low event rate and consider our study underpowered for this question. We are convinced that in our population, lower educational status is indeed associated with higher mortality. A similar association has already been demonstrated in other studies, indicating that the educational status significantly contributes to the inadequate management of cardiovascular risk factors (20, 22) and, moreover, even in healthy adults with an ideal LS7 score, the promotion of an optimal lifestyle is influenced by the educational status (4, 23).

The LS7 was developed to evaluate cardiovascular risk and develop specific strategies to mitigate the risk. Previous studies have shown that LS7 is associated with stroke (10), atrial fibrillation (9), peripheral artery disease (24), insulin resistance (11), and fatty liver (8), and it has established itself as a sensitive, albeit unspecific, screening tool for cardiometabolic risk factors. We believe that the LS7 and a better understanding of its distribution can also serve as a guide. Clinicians could review the components of the LS7 with patients and formulate realistic health goals based on it. Some goals may require medication intervention (blood pressure, hypercholesterolemia, hyperglycaemia), while others (exercise, smoking, diet) are more in the hands of the patient. Ideally, a multimodal concept is developed, or one focuses only on “high-yield” approaches.

CONCLUSION

Studies such as the present one, which provide a better understanding of the local distribution of cardiovascular risk factors, could help decision-makers in healthcare systems to develop tailored screening and prevention programmes. We believe that our study reinforces the importance of educational status as a relevant health policy variable. Furthermore, we emphasize the importance of scoring tools such as LS7 for research. We also believe that the associations of educational status and LS7 with mortality, even in a relatively egalitarian social system like Austria, are a call to action for clinicians and healthcare decision-makers to further intensify their efforts towards “health for all”.

Conflicts of Interest

CD is a member of the scientific advisory board of SPAR Austria.

Authors’ Contributions

SW, BW and CD conceived the presented idea. All authors contributed to the final version of the manuscript and approved the final version.

REFERENCES

1. Vaduganathan M, Mensah GA, Turco JV, Fuster V, Roth GA. The global burden of cardiovascular diseases and risk: a compass for future health. J Am Coll Cardiol. 2022 Dec 20;80(25):2361-71.
2. Sacco RL. The new American Heart Association 2020 goal: achieving ideal cardiovascular health. J Cardiovasc Med (Hagerstown). 2011 Apr;12(4):255-7.
3. Díaz-Gutiérrez J, Martínez-González MÁ, Alonso A, Toledo E, Salas-Salvadó J, Sorlí JV, et al. American Heart Association's life simple 7 and the risk of atrial fibrillation in the PREDIMED study cohort. Nutr Metab Cardiovasc Dis. 2023 Jun;33(6):1144-8.
4. Nève G, Wagner J, Knaier R, Infanger D, Klenk C, Carrard J, et al. Ideal Life's Simple 7 score relates to macrovascular structure and function in the healthy population. Nutrients. 2022 Sep 1;14(17):3616. doi: 10.3390/nu14173616.
5. Visseren FLJ, Mach F, Smulders YM, Carballo D, Koskinas KC, Bäck M, et al. 2021 ESC Guidelines on cardiovascular disease prevention in clinical practice. Eur Heart J. 2021 Sep 7;42(34):3227-337.
6. Barton P, Andronis L, Briggs A, McPherson K, Capewell S. Effectiveness and cost effectiveness of cardiovascular disease prevention in whole populations: modelling study. BMJ. 2011 Jul 28;343:d4044. doi: 10.1136/bmj.d4044.
7. Chokshi DA, Farley TA. The cost-effectiveness of environmental approaches to disease prevention. N Engl J Med. 2012 Jul 26;367(4):295-7.
8. Fan H, Xu C, Li W, Huang Y, Hua R, Xiong Y, et al. Ideal cardiovascular health metrics are associated with reduced severity of hepatic steatosis and liver fibrosis detected by transient elastography. Nutrients. 2022 Dec 16;14(24):5344. doi: 10.3390/nu14245344.
9. Garg PK, O'Neal WT, Chen LY, Loehr LR, Sotoodehnia N, Soliman EZ, et al. American Heart Association's Life Simple 7 and risk of atrial fibrillation in a population without known cardiovascular disease: the ARIC (Atherosclerosis Risk in Communities) Study. J Am Heart Assoc. 2018 Apr 12;7(8):e008424. doi: 10.1161/JAHA.117.008424.
10. Garg PK, O'Neal WT, Ogunsua A, Thacker EL, Howard G, Soliman EZ, et al. Usefulness of the American Heart Association's Life Simple 7 to predict the risk of atrial fibrillation (from the REasons for Geographic And Racial Differences in Stroke [REGARDS] Study). Am J Cardiol. 2018 Jan 15;121(2):199-204.
11. Chevli PA, Mehta A, Allison M, Ding J, Nasir K, Blaha MJ, et al. Relationship of American Heart Association's Life Simple 7, ectopic fat, and insulin resistance in 5 racial/ethnic groups. J Clin Endocrinol Metab. 2022 May 17;107(6):e2394-404. doi: 10.1210/clinem/dgac102.
12. Ross CE, Wu CL. The Links between education and health. Am Sociol Rev. 1995 Oct;60(5):719-45.

13. Zajacova A, Lawrence EM. The Relationship between education and health: reducing disparities through a contextual approach. Annu Rev Public Health. 2018 Apr 1;39:273-89.
14. Shen R, Zhao N, Wang J, Guo P, Shen S, Liu D, et al. Association between socioeconomic status and arteriosclerotic cardiovascular disease risk and cause-specific and all-cause mortality: data from the 2005-2018 National Health and Nutrition Examination Survey. Front Public Health. 2022 Nov 22;10:1017271. doi: 10.3389/fpubh.2022.1017271.
15. Wernly S, Semmler G, Völkerer A, Rezar R, Datz L, Radzikowski K, et al. Cardiovascular risk assessment by SCORE2 predicts risk for colorectal neoplasia and tumor-related mortality. J Pers Med. 2022 May 23;12(5):848. doi: 10.3390/jpm12050848.
16. Semmler G, Wernly S, Wernly B, Mamandipoor B, Bachmayer S, Semmler L, et al. Machine learning models cannot replace screening colonoscopy for the prediction of advanced colorectal adenoma. J Pers Med 2021 Sep 29;11(10):981. doi: 10.3390/jpm11100981.
17. Goff DC Jr, Lloyd-Jones DM, Bennett G, Coady S, D'Agostino RB, Gibbons R, et al.; American College of Cardiology/American Heart Association Task Force on Practice Guidelines. 2013 ACC/AHA guideline on the assessment of cardiovascular risk: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines. Circulation. 2014 Jun 24;129(25 Suppl 2):S49-73.
18. Huang PL. A comprehensive definition for metabolic syndrome. Dis Model Mech. 2009 May-Jun;2(5-6):231-7.
19. Schneider SL. The classification of education in surveys: a generalized framework for ex-post harmonization. Qual Quant. 2022 Jun;56(3):1829-66.
20. Johnson AE, Herbert BM, Stokes N, Brooks MM, Needham BL, Magnani JW. Educational attainment, race, and ethnicity as predictors for ideal cardiovascular health: from the National Health and Nutrition Examination Survey. J Am Heart Assoc. 2022 Jan 18;11(2):e023438. doi: 10.1161/JAHA.121.023438.
21. Alam MT, Echeverria SE, DuPont-Reyes MJ, Vasquez E, Murillo R, Gonzalez T, et al. Educational attainment and prevalence of cardiovascular health (Life's Simple 7) in Asian Americans. Int J Environ Res Public Health. 2021 Feb 4;18(4):1480. doi: 10.3390/ijerph18041480.
22. Adam HS, Merkin SS, Anderson MD, Seeman T, Kershaw KN, Magnani JW, et al. Personal Health Literacy and Life Simple 7: the Multi-Ethnic Study of Atherosclerosis. Am J Health Educ. 2023 Nov 2;54(6):451-62.
23. Nève G, Komulainen P, Savonen K, Hassinen M, Männikkö R, Infanger D, et al. Adherence to Life's Simple 7 is associated with better carotid properties. Atherosclerosis. 2022 Nov;360:21-6.
24. Unkart JT, Allison MA, Criqui MH, McDermott MM, Wood AC, Folsom AR, et al. Life's Simple 7 and peripheral artery disease: the Multi-Ethnic Study of Atherosclerosis. Am J Prev Med. 2019 Feb;56(2):262-270.

Received April 3, 2023
Accepted in revised form February 27, 2024