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Are Nutrition Literacy and Sustainable Dietary Habits Associated with Cardiovascular Disease and Diabetes Developmental Risks?

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ABSTRACT

Objective: This study aimed to examine the association of nutritional literacy levels and sustainable nutritional behaviors with the risk of developing cardiovascular diseases and diabetes in the Turkish adult population.

Methods: Sociodemographic information, disease history, nutritional habits, and physical activity levels of 3146 volunteer individuals (male = 1590, female = 1556) between the ages of 40–75 were collected using a questionnaire form and face-to-face interviews. The sustainable nutritional behaviors of the participants were evaluated using Turkish validated scales for Sustainable and Healthy Eating Behavior (SHE) and nutritional literacy levels with the Evaluation Instrument of Nutrition Literacy on Adults (EINLA). Cardiovascular disease risks of the participants were assessed with the Atherosclerotic Cardiovascular Disease (ASCVD) Risk Estimator program and the Heart Score (SCORE) scale and type-2 diabetes risk with the Finnish Diabetes Risk Score (FINDRISC). Each participant's 24-h food consumption record was obtained using the retrospective recall method.

Results: It was determined that ASCVD and SCORE levels were significantly higher in males compared to females. It was observed that individuals with lower cardiovascular and diabetes risk scores had higher educational levels, and the risks increased significantly with age ($p < 0.05$). Anthropometric measurements such as body mass index, and waist hip circumference were significantly higher in those with higher cardiovascular and diabetes risk scores. Furthermore, in individuals with higher SCORE and FINDRISC levels, SHE and EINLA scores were significantly lower ($p < 0.05$). It was also observed that SCORE and diabetes risk scores increased with higher energy and macronutrient intakes.

Conclusion: The risk of developing cardiovascular disease and diabetes was associated with sustainable nutritional behaviors and nutritional literacy. It may be suggested that increasing nutritional literacy and encouraging sustainable nutritional behaviors may be effective strategies in the management and reduction of the prevalence of certain chronic diseases.

KEY TEACHING POINTS

- Cardiovascular diseases and diabetes are two major chronic conditions that can be managed and treated through proper nutrition.
- Increased nutritional literacy levels and sustainable dietary habits may result in reduced risk of cardiovascular diseases and diabetes.
- Nutritionists should assess the patients' nutrition literacy levels and implement sustainable, health-focused nutrition education programs to enhance their understanding of nutrition.

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KEYWORDS

Nutrition literacy; sustainable nutrition; cardiovascular disease risk; diabetes risk

Introduction

Sustainable nutrition involves a balanced intake of energy and essential nutrients in diet without posing a negative impact on the environment. Sustainable nutrition models protect food systems and public health by preserving the nutritional needs of future generations (1). The Food and Agriculture Organization (FAO) has defined sustainable healthy diets as dietary models that support the health and well-being of individuals. Sustainable diets are low in environmental impact, accessible, cost-effective, safe and equitable, and culturally acceptable. The sustainable healthy diets guiding principles, as recommended by FAO and WHO, cover the health *(minimally processed, balanced diet, with whole grains, legumes, varied vegetables and fruits, reduced animal based products, which are adequate in energy and nutrients for growth and development and reduce the risk of diet-related non-communicable diseases)*, environmental *(lower greenhouse gases, water and land use, reduce pollution, preserve bio-diversity, minimize use of plastic derivatives for packaging)* and socio-cultural aspects *(accessibility, cultural acceptance and culinary practices, reduce food loss/waste)* (2). Plant-based dietary models such as the Mediterranean diet, the Scandinavian diet, dietary approaches to stopping hypertension (DASH), and vegetarian or vegan diets are stated as sustainable diets because they use fewer natural resources and cause less damage to nature (3–6).

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Plant-based diets have been accepted to have beneficial effects on cardiovascular health due to their ameliorative effects on cardiometabolic risk factors (7–10). In the Nurses' Health Study, one of the largest cohort studies examining the relationship between the Mediterranean diet and cardiovascular disease risk, 74,886 females were followed for 20 years, and the risk of coronary heart disease was found to be 29% lower and the risk of stroke was 13% lower in women with high compliance with the Mediterranean diet (11). Various studies have indicated that plant-based diets can reduce all-cause mortality and cardiovascular disease-related mortality (12,13), as well as optimize blood pressure (14,15) and blood lipid profile (16,17), thus reducing the need for medication (16). It has been stated that low-carbohydrate vegan and vegetarian diets contribute to sustainability by reducing greenhouse gas emissions, blood HbA1c levels, and systolic blood pressure. Therefore, plant-based diets may be considered more environmentally sustainable and reduce risk factors for cardiovascular disease and diabetes complications (18).

The concept of nutrition literacy (NL) has increasingly gained importance in supporting healthy nutrition and lifestyle and has been proven that the development and improvement of NL levels lead to effective and healthy dietary changes (19,20). It is known that unhealthy eating habits constitute an important risk factor for the onset of chronic diseases such as cardiovascular diseases, cancer, diabetes, and obesity (21). Therefore, it may be inferred that the development of NL will reduce the risk of chronic diseases. Safeer et al. suggested that creating a treatment plan considering the NL and health literacy levels of patients with cardiovascular disease may be effective in combating cardiovascular diseases (22). Topan et al. reported that higher levels of nutrition literacy are associated with more positive attitudes toward cardiovascular health (23). A study conducted in Germany reported that people with low health literacy levels had a higher risk of developing type 2 diabetes (24). Low health and nutrition literacy was also found to be associated with behaviors that increased the risk of type 2 diabetes, such as smoking, a sedentary lifestyle, and unhealthy eating habits (25). Nutrition literacy was reported as an important factor in promoting and maintaining healthy eating practices (23). Moreover, high NL would enable the choice of foods that not only ensure health and well-being but also support sustainable food systems (26).

To our knowledge, there is limited study evaluating the relationship of sustainable dietary behaviors and nutrition literacy with the risk of developing cardiovascular disease and diabetes. This study was aimed to determine cardiovascular disease and diabetes developmental risk, in adults living in Turkey, and to evaluate the relationship with sustainable dietary behaviors and NL levels.

Materials and methods

Study design, settings, participants

This cross-sectional study was conducted between February and April 2024 with adults living in Turkey, aged between 40–75 years, and who had blood tests and blood pressure measurements taken in the last 3 months. A total of 3146 volunteers, 1590 males and 1556 females, participated in the study. Individuals with a history of chronic cardiovascular disease, diagnosed with diabetes, cancer, hepatic and renal diseases, on a special diet program, pregnant and breastfeeding females were excluded from the study. The flow chart of the recruitment process is given in Figure 1.

The biostatistical power analysis program G*Power 3.1 was used to determine the sample size of the study, and it was calculated that a total of 2873 people should be included in the study with 99% power, 0.08 effect size, and $\alpha = 0.05$. The significance level in the study was accepted as $p < 0.05$.

This study was approved by the Istanbul Medipol University Non-Interventional Clinical Research Ethics Committee (No:50, E-10840098-202.3.02-622 dated 18.01.2024). Informed consent forms were obtained from all adults who volunteered to participate in the study. This study was conducted in accordance with the principles of the Declaration of Helsinki.

Data collection tools and evaluation

A questionnaire form was prepared by the researchers to collect the study data and was applied to all participants via face-to-face interview method. The questionnaire included items enquiring participants' personal information, disease history, daily meal count, and eating habits such as appetite, and physical activity levels. In addition, the following measurement tools were used on all participants.

Sustainable and Healthy Eating Behavior Scale (SHE)

The sustainable eating behaviors of the participants were measured using the Turkish validated version of the Sustainable and Healthy Eating Behavior Scale (SHE). The scale had 7 sub-groups and 32 questions. It was scored on a 7-point Likert-type scale as: "never" 1 point, "very rarely" 2, "rarely" 3, "sometimes" 4, "often" 5, "very often" 6 and "always" 7 points. There was no overlapping value in the evaluation and a greater total score indicated higher sustainable and healthy eating behavior (27).

Evaluation Instrument of Nutrition Literacy on Adults (EINLA)

Nutrition literacy levels of the participants were assessed using the Turkish validated version of the Evaluation Instrument of Nutrition Literacy on Adults (EINLA) Scale. The validated tool consisted of 5 sub-groups with a total of 35 items. In the sub-groups with items regarding knowledge about general nutrition and food groups, 0–3 points were considered as insufficient, 4–7 as borderline, and 8–10 as sufficient. In the sub-group comprising of items with reading comprehension and interpretation, food label reading and numerical literacy, 0–2 points were considered as insufficient, 3–4 as borderline, and 5–6 as sufficient. Finally, in the sub-group regarding food portion sizes, 0–1 points were

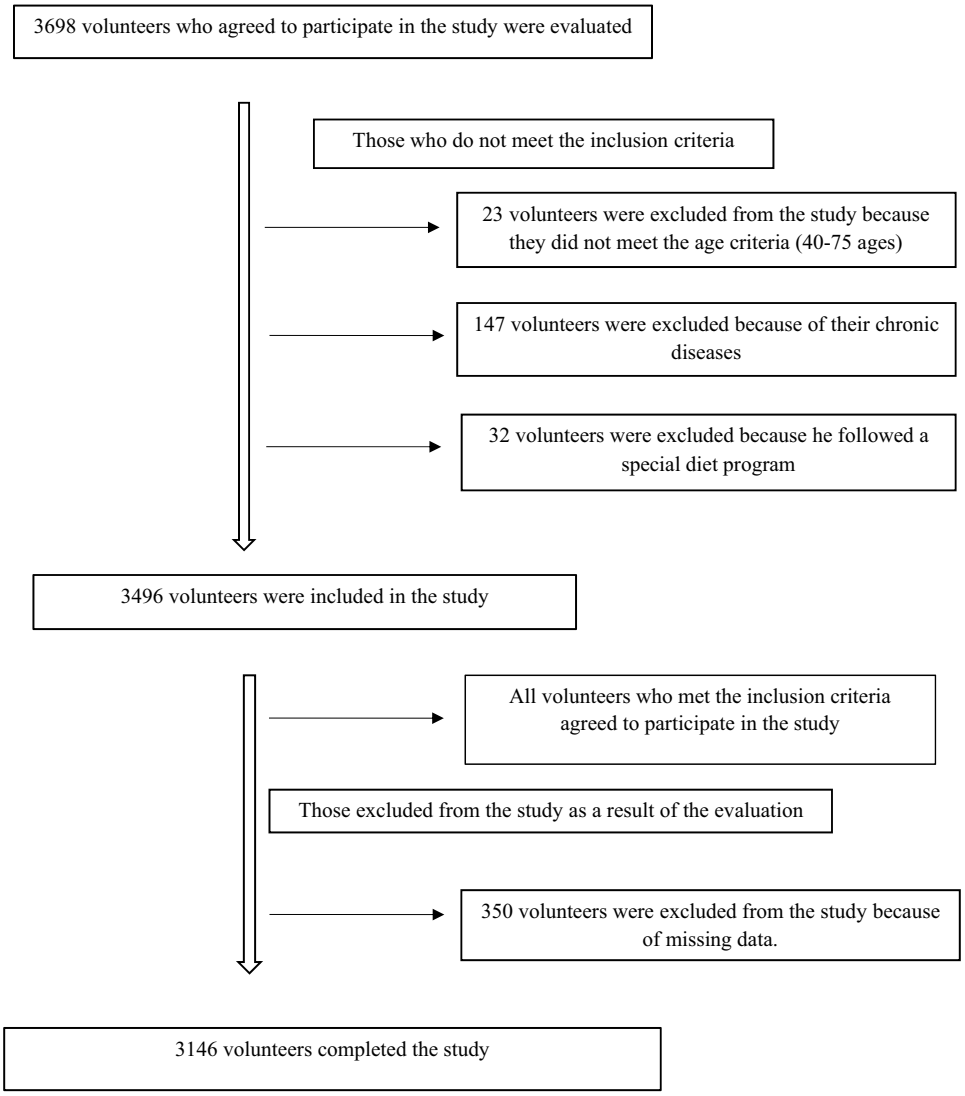

Figure 1. Flow chart of the recruitment of the participants.

considered as insufficient, 2 as borderline, and 3 as sufficient. The total EINLA score between 0–11 points was considered insufficient NL level, 12–23 borderline and between 24–35 was sufficient NL level (28).

Atherosclerotic Cardiovascular Disease (ASCVD) risk estimator and SCORE

The Atherosclerotic Cardiovascular Disease (ASCVD) risk estimator and SCORE scales were used to determine the participants' cardiovascular disease risk. The ASCVD risk estimator tool determined the optimal risk, 10-year risk, lifetime risk, and optimal risk for cardiovascular diseases. A total score of <5 was evaluated as low risk, 5–7.4 as borderline, 7.5–19.9 as moderate, and ≥20 as high risk (29). The SCORE scale, a risk assessment tool used online, developed by the European Society of Cardiology, calculated 10-year CVD risk using data on systolic blood pressure, cholesterol levels, and smoking status. A score of <1 was defined as low risk, 1–5 as moderate, ≥5 and <10 as high, and a score of ≥10 as very high risk (30).

Tip-2 Diabetes Risk Evaluation (FINDRISC)

The Type-2 Diabetes Risk Assessment (FINDRISC) tool was used to determine the risk of type-2 diabetes for the participants. The tool had 8 items with a total score between 0–26. The 10-year type-2 diabetes risk for participants was evaluated using total FINDRISC scores and were defined as low risk for a score <7 points, 7–11 as mild risk, 12–14 as medium risk 15–20 as high risk, and a total score of >20 points as very high risk (31).

The participants' 24-h food consumption records were obtained using the retrospective recall method and the "Food Photograph Catalog" (32). The data obtained from the food consumption records were evaluated using the Nutrition Information Systems Package Program (BeBiS), a software program that analyzed the nutrient content of foods. In addition to the questionnaire form, anthropometric measurements such as height, body weight, waist circumference, hip circumference and neck circumference of the participants were taken. The body mass index (BMI) of each participant was calculated with the formula "BMI = Body Weight (kg)/Height (m^2)".

Statistical analysis

IBM SPSS Statistics 22.0 was used for data analysis (33). For descriptive statistics, mean ($\bar{X}$), standard deviation (S), and lower and upper values were used. The conformity of continuous data to normal distribution was analyzed with the Kolmogorov Smirnov test. Chi-Square test was used for categorical variables in inter-group comparisons. Inter-group comparisons for continuous data were conducted with the Student's T test for normally distributed variables and the Mann Whitney U test for non-normally distributed variables. The results were evaluated at a 95% confidence interval and at a significance level of $p<0.05$.

Results

A total of 3146 individuals of which 50.5%were male and 49.5% females, between the ages of 18–65 were included in this study. The mean age of the individuals was 50.3 ± 7.8 years. Table 1 lists the SCORE, ASCVD, and FINDRISC levels as per general characteristics of the participants (gender, marital status, education level, income status, disease status, smoking, supplement use). The SCORE level of males was significantly higher than that of females ($p=0.000$). When evaluated in terms of ASCVD level, the majority of participants with high and very high ASCVD risk levels were males and the difference with females was statistically significant (68.3%, 65.3%, respectively, $p=0.000$). Participants with high level of education and income level belonged mostly to the low-risk category group for cardiovascular (SCORE, ASCVD) and diabetes risk (FINDRISC) scores as compared to the high-risk group ($p=0.000$). It was also noted, that as the average age increased, the rate of high cardiovascular (SCORE, ASCVD) and diabetes risk (FINDRISC) rose significantly ($p=0.000$).

Table 2 shows the cardiovascular disease (SCORE, ASCVD 10-year, ASCVD lifetime, ASCVD optimal risk scores) and diabetes risk levels (FINDRISC mean score) according to anthropometric measurements and physical activity of the participants. The mean BMI of those with high SCORE, ASCVD and FINDRISC levels (27.3 ± 4.2 vs 23.8 ± 4.1; 27.4 ± 4.6 vs 26.0 ± 4.2; 33.0 ± 3.7 vs 23.6 ± 2.7, respectively) was significantly higher than those in the low-risk group ($p<0.05$). Similarly, waist circumference (80.0 ± 10.5 vs 95.9 ± 15.0; 88.1 ± 13.7 vs 96.8 ± 15.4; 81.5 ± 10.7 vs 106.4 ± 13.0, respectively) and hip circumference, (97.6 ± 8.5 vs 105.9 ± 13.3; 102.2 ± 11.5 vs 105.0 ± 14.4; 97.1 ± 9.1 vs 117.5 ± 12.3, respectively) which are associated with chronic diseases were found to be significantly lower in those with low SCORE, ASCVD and FINDRISC levels compared to those in the high risk group ($p<0.05$). While it was found that cardiovascular disease risk (SCORE) and diabetes risk levels increased ($p<0.05$) with lower physical activity scores, the same relationship was not found in ASCVD risk groups. ASCVD 10-year, lifetime and optimal risk scores, as well as diabetes risk scores, were also significantly higher in those with higher SCORE levels.

Total and sub-group score means of SHE and EINLA according to the cardiovascular disease and diabetes risk levels of the participants have been provided in Table 3. While total SHE and EINLA mean scores showed a significant decrease as the SCORE and FINDRISC risk levels increased ($p<0.05$), the means of the ASCVD risk groups were not significantly different from each other ($p>0.05$).

Table 4 shows the energy, macro and micronutrient intakes of the participants and their respective cardiovascular (SCORE, ASCVD) and diabetes (FINDRISC) risk scores. The SCORE risk level of the participants was found to rise significantly with increased intake of energy (kcal), carbohydrate (g), protein (g), fat (g), saturated fat (g), cholesterol (mg), sodium (mg), and calcium (mg). However, the energy and nutrient intakes did not have significant effects on the ASCVD risk groups. Diabetes risk (FINDRISC) level of the participants rose significantly as their energy (kcal) intakes (1538.9 ± 54.9, 1562.2 ± 525.1, 1657.6 ± 571.2, 1738.9 ± 572.2 vs 1890.8 ± 694.9, respectively). However, it was determined that rise was not limited to energy alone but was also significantly affected by increased intake of carbohydrate (g), protein (g), fat (g), saturated fat (g), monounsaturated fat (mg), cholesterol (mg), sodium (mg), potassium (mg), calcium (mg) and magnesium (mg) ($p<0.05$).

The correlation relationship of cardiovascular and diabetes risk scores with SHE, EINLA, BMI and some dietary characteristics of participants have been shown in Table 5. A statistically significant weak positive correlation was found between SCORE and ASCVD and FINDRISC score ($r=0.294$, $p=0.000$; $r=0.262$, $r=0.000$, respectively). SCORE, ASCVD and FINDRISC were significantly negatively correlated with SHE (r=-0.46, $p=0.010$; r=-0.056, $p=0.002$; r=-0.155, $p=0.000$, respectively), EINLA (r=-0.220, $p=0.000$; r=-0.222; $p=0.000$; r=-0.202, $p=0.000$, respectively) scores and positively correlated with BMI ($r=0.219$, $p=0.000$; $r=0.228$; $p=0.000$; r=-0.604, $p=0.000$, respectively).

A linear regression analysis showed that every one-unit increase in the SHE scores caused a 0.03-unit decrease in FINDRISC but had no effect on SCORE and ASCVD. However, an increase in one unit of the EINLA score reduced the SCORE risk by 0.185 units, the 10-year ASCVD risk by 0.167 units, and the FINDRISC risk by 0.172 units. In addition, one unit increase in the participants' BMI mean caused an increase in SCORE, ASCVD 10-year risk, and FINDRISC risk by 0.184 units, 0.133, and 0.536 units, respectively.

Discussion

Cardiovascular disease (CVD) constitutes the number one cause of mortality in both developing and developed countries and is also among the most common causes of morbidity and premature death in people with type 2 diabetes (34, 37). Healthy nutrition and lifestyle, which is the keystone for prevention of chronic diseases, in individuals may be attributed to their demographic and socioeconomic background, education, nutrition knowledge and awareness. Association of socioeconomic status with health outcomes are multifactorial and include effects on health services, health-related behaviors, and environmental factors (38). In this study, the association of sustainable dietary behaviors and nutritional literacy, along with other socio-demographic

Table 1. SCORE, ASCVD and FINDRISC levels of the participants according to their demographical characteristics.

			SCORE					ASCVD						FINDRISC					
		n (%)	Low	Middle	High	Very high	p	Low	Borderline	Intermediate	High	No calculated	p	Low	Slightly elevated	Moderate	High	Very high	p
Gender	Female	1556 (49,5)	63 (90,0)	1183(55,7)	219(31,7)	91(34,6)	**0,000**	1295(61,0)	80(22,0)	97(19,8)	9(20,9)	75(59,1)	**0,000**	477 (50,7)	583 (45,8)	242 (49,9)	207 (54,3)	47 (69,1)	**0,000**
	Male	1590 (50,5)	7 (10,0)	940(44,3)	471(68,3)	172(65,4)		827(39,0)	283(78,0)	394(80,2)	34(79,1)	52(40,9)		463 (49,3)	689 (54,2)	243 (50,1)	174 (45,7)	21 (30,9)	
Marital Status	Married	2576 (81,9)	51(72,9)	1717(80,9)	591(85,7)	217(82,5)	**0,007**	1725(81,3)	300(82,6)	418(85,1)	36(83,7)	97(76,4)	0,145	708 (75,3)	1072 (84,3)	424 (87,4)	321 (84,3)	51 (75,0)	**0,000**
	Single	570 (18,1)	19(27,1)	406(19,1)	99(14,3)	46(17,5)		397(18,7)	63(17,4)	73(14,9)	7(16,3)	30(23,6)		232 (24,7)	200 (15,7)	61 (12,6)	60 (15,7)	17 (25,0)	
Education Level	Primary School	470 (14,9)	6(8,6)	242(11,4)	132(19,1)	90(34,2)	**0,000**	259(12,2)	55(15,2)	125(25,5)	15(34,9)	16(12,6)	**0,000**	82 (8,7)	170 (13,4)	92 (19,0)	94 (24,7)	32 (47,1)	**0,000**
	Middle School	469 (14,9)	1(1,4)	266(12,5)	144(20,9)	58(22,1)		275(13,0)	71(19,6)	100(20,4)	13(30,2)	10(7,9)		107 (11,4)	184 (14,5)	80 (16,5)	87 (22,8)	11 (16,2)	
	High School	996 (31,7)	15(21,4)	678(31,9)	228(33,0)	75(28,5)		666(31,4)	119(32,8)	160(32,6)	8(18,6)	43(33,9)		286 (30,4)	428 (33,6)	161 (33,2)	107 (28,1)	14 (20,6)	
	University and above	1211 (38,5)	48(68,6)	937(44,2)	186(26,9)	40(15,2)		922(43,4)	121(32,5)	106(21,6)	7(16,3)	58(45,7)		465 (49,5)	490 (38,5)	152 (31,3)	93 (24,4)	11 (16,2)	
Income Status	Very bad	4 (0,1)	0(0,0)	1(0,0)	3(0,4)	0(0,0)	**0,000**	2(0,1)	1(0,3)	1(0,2)	0(0,0)	0(0,0)	**0,010**	1 (0,1)	2 (0,2)	0 (0,0)	1 (0,3)	0 (0,0)	**0,000**
	Bad	105 (3,3)	2(2,9)	57(2,7)	26(3,8)	20(7,6)		67(3,2)	10(2,8)	24(4,9)	1(2,3)	3(2,4)		24 (2,6)	37 (2,9)	19 (3,9)	20 (5,2)	5 (7,4)	
	Middle	1540 (49,0)	29(41,4)	996(46,9)	371(53,8)	144(54,8)		990(46,7)	185(51,0)	276(56,2)	28(65,1)	61(48,0)		411 (43,7)	598 (47,0)	269 (55,5)	219 (57,5)	43 (63,2)	
	Good	1291 (41,0)	31(44,3)	923(43,5)	254(36,8)	83(31,6)		921(43,4)	141(38,8)	165(33,6)	13(30,2)	51(40,2)		415 (44,1)	558 (43,9)	171 (35,3)	128 (33,6)	19 (27,9)	
	Very good	206 (6,5)	8(11,4	146(6,9)	36(31,6)	16(6,1)		1420(6,7)	26(7,2)	25(5,1)	1(2,3)	12(9,4)		89 (9,5)	77 (6,1)	26 (5,4)	13 (3,4)	1 (1,5)	
Disease	No	2672 (85,9)	61(87,1)	1820(85,7)	579(83,9)	212(80,6)	**0,008**	1802(84,9)	311(85,7)	413(84,1)	33(76,7)	113(89,0)	**0,018**	844 (89,8)	1103 (86,7)	407 (83,9)	269 (70,6)	49 (72,1)	**0,000**
	Obesity	58 (1,8)	0(0,0)	30(1,4)	23(3,3)	5(1,9)		37(1,7)	9(2,5)	11(2,2)	0(0,0)	0(0,0)		1 (0,1)	11 (0,9)	7 (1,4)	34 (8,9)	5 (7,4)	
	Neurological	88 (2,8)	0(0,0)	59(2,8)	24(3,5)	5(1,9)		63(3,0)	10(2,8)	12(2,4)	1(2,3)	2(1,6)		30 (3,2)	31(2,4)	10 (2,1)	15 (3,9)	2 (2,9)	
	Thyroid	111 (3,5)	2(2,9)	76(3,6)	21(3,0)	12(4,6)		86(4,1)	8(2,2)	15(3,1)	1(2,3)	1(0,8)		18 (1,9)	46 (3,6)	25 (5,2)	17 (4,5)	5 (7,4)	
	GIS System	111 (3,5)	3(4,3)	78(3,7)	18(2,6)	12(4,6)		69(3,3)	12(3,3)	19(3,9)	2(4,7)	9(7,1)		21 (2,2)	44 (3,5)	17 (3,5)	27 (7,1)	2 (2,9)	
	Other	106 (3,4)	4(5,7)	60(2,8)	25(3,6)	17(6,5)		65(3,1)	13(3,6)	21(4,3)	6(14,0)	1(0,8)		26 (2,8)	37 (2,9)	19 (3,9)	19 (5,0)	5 (7,4)	
Smoking	Yes	1098 (34,9)	3(4,3)	564(26,6)	389(56,4)	142(54,0)	**0,000**	563(26,5)	193(53,2)	278(56,6)	22(51,2)	42(33,1)	**0,000**	337 (35,9)	432 (34,0)	167 (34,4)	144 (37,8)	18 (26,5)	0,349
	No	2048 (62,5)	67(95,7)	1559(73,4)	301(43,6)	121(46,0)		1559(73,5)	170(46,8)	213(43,4)	21(48,8)	85(66,9)		603 (64,1)	840 (66,0)	318 (65,6)	237 (62,2)	50 (73,5)	
Supplement use	Yes	1180 (37,5)	33 (47,1)	822 (38,7)	217(31,4)	108(41,1)	**0,000**	846 (39,9)	103 (28,4)	164 (33,4)	13 (30,2)	54 (42,5)	**0,001**	384 (40,9)	446 (35,1)	174 (9, 34)	150 (4, 35)	26 (2, 36)	0,502
	No	1966 (62,5)	37(52,9)	1301(61,3)	473(68,6)	155(58,9)		1276 (60,1)	260 (71,6)	327 (66,6)	30 (69,8)	73 (57,5)		556 (59,1)	826 (64,9)	311 (64,1)	231 (60,6)	42 (61,8)	
Age (*Mean ± SD)*		50,3 ± 7,8	42,0 ± 1,7	47,5 ± 5,5	55,1 ± 6,9	63,2 ± 7,4	**0,000**	47,8 ± 5,9	53,0 ± 6,8	58,6 ± 8,0	64,0 ± 9,4	49,0 ± 7,6	**0,000**	47,2 ± 6,3	50,6 ± 7,6	52,6 ± 8,2	53,3 ± 8,1	56,9 ± 8,7	**0,000**

Kruskal Wallis for means, Pearson chi-square for percentages.

Table 2. SCORE, ASCVD and FINDRISC levels of the participants according to their anthropometric measurements.

		SCORE					ASCVD						FINDRISC					
	n	Low	Middle	High	Very high	p	Low	Borderline	Intermediate	High	No calculated	p	Low	Slightly elevated	Moderate	High	Very high	p
Body weight (Mean ± SD)	76,1 ± 14,2	64,1 ± 11,6	74,7 ± 13,8	80,4 ± 13,9	80,1 ± 14,6	**0,000**	74,1 ± 13,8	81,0 ± 13,2	82,5 ± 14,2	79,4 ± 14,3	71,9 ± 12,9	0,068	68,8 ± 11,2	76,0 ± 13,2	81,3 ± 13,5	85,9 ± 15,0	89,2 ± 12,8	**0,000**
Height length (*Mean ± SD*)	169,7 ± 9,4	164,4 ± 6,8	169,3 ± 9,4	171,5 ± 9,4	169,5 ± 9,5	**0,000**	168,5 ± 9,4	172,5 ± 9,3	172,6 ± 8,9	170,5 ± 9,7	168,9 ± 9,1	0,589	170,5 ± 8,9	170,2 ± 9,5	168,8 ± 9,6	168,2 ± 9,9	164,3 ± 9,8	**0,000**
BMI (*Mean ± SD*)	26,4 ± 4,3	23,8 ± 4,1	26,0 ± 4,1	27,3 ± 4,2	27,9 ± 4,6	**0,000**	26,0 ± 4,2	27,2 ± 3,9	27,7 ± 4,3	27,4 ± 4,6	25,2 ± 4,3	**0,034**	23,6 ± 2,7	26,2 ± 3,5	28,5 ± 3,8	30,4 ± 4,6	33,0 ± 3,7	**0,000**
Waist circumference (Mean ± SD)	90,6 ± 14,3	80,0 ± 10,5	88,7 ± 13,8	95,5 ± 13,8	95,9 ± 15,0	**0,000**	88,1 ± 13,7	95,5 ± 13,0	97,9 ± 13,9	96,8 ± 15,4	87,8 ± 14,4	0,794	81,5 ± 10,7	91,1 ± 13,1	96,4 ± 12,7	101,1 ± 14,1	106,4 ± 13,0	**0,000**
Hip circumference (Mean ± SD)	102,8 ± 11,5	97,6 ± 8,5	102,2 ± 11,3	103,9 ± 11,4	105,9 ± 13,3	**0,000**	102,2 ± 11,5	103,4 ± 10,3	105,1 ± 12,3	105,0 ± 14,4	101,4 ± 10,9	0,421	97,1 ± 9,1	102,3 ± 10,2	106,9 ± 11,1	110,4 ± 12,8	117,5 ± 12,3	**0,000**
Neck circumference (Mean ± SD)	35,7 ± 4,6	32,5 ± 3,3	35,1 ± 4,5	36,9 ± 4,6	37,5 ± 4,7	**0,000**	34,9 ± 4,3	37,2 ± 4,6	37,9 ± 4,7	38,5 ± 4,5	34,5 ± 4,9	0,384	33,9 ± 4,2	35,7 ± 4,5	37,1 ± 4,4	37,8 ± 4,8	37,7 ± 4,2	**0,000**
Waist/hip ratio (Mean ± SD)	0,88 ± 0,1	0,81 ± 0,1	0,87 ± 0,1	0,92 ± 0,1	0,91 ± 0,1	**0,000**	0,86 ± 0,1	0,92 ± 0,1	0,93 ± 0,1	0,92 ± 0,1	0,86 ± 0,1	0,882	0,84 ± 0,1	0,89 ± 0,1	0,9 ± 0,1	0,92 ± 0,1	0,92 ± 0,1	**0,000**
Physical activity score (*Mean ± SD*)	2,0 ± 2,00	2,9 ± 2,4	2,1 ± 2,0	1,9 ± 1,9	1,5 ± 1,8	**0,000**	2,1 ± 2,0	1,8 ± 1,9	1,9 ± 1,9	1,6 ± 1,9	1,8 ± 2,2	0,210	2,7 ± 2,1	1,9 ± 1,9	1,5 ± 1,8	1,3 ± 1,7	0,9 ± 1,6	**0,000**
SCORE (Mean ± SD)	4,2 ± 4,0	0,1 ± 0,2	2,3 ± 1,1	6,6 ± 1,4	14,1 ± 6,3	**0,000**	2,5 ± 2,0	5,7 ± 2,5	9,4 ± 4,4	17,5 ± 9,1	2,8 ± 2,9	0,127	2,9 ± 2,9	3,9 ± 3,3	5,1 ± 4,6	6,2 ± 6,2	7,4 ± 5,0	**0,000**
ASCVD 10 years (Mean ± SD)	4,3 ± 4,7	0,4 ± 0,2	2,3 ± 2,5	7,0 ± 2,8	14,1 ± 6,2	**0,000**	1,9 ± 1,3	6,1 ± 0,7	11,3 ± 3,1	25,7 ± 8,5	0,0 ± 0,0	Not calculated	2,9 ± 3,9	4,2 ± 4,2	5,3 ± 5,4	6,2 ± 5,8	7,2 ± 5,7	**0,000**
Lifetime risk of ASCVD (Mean ± SD)	37,6 ± 13,8	26,0 ± 12,1	35,3 ± 13,3	47,3 ± 9,6	50,6 ± 14,77	**0,000**	34,7 ± 12,9	46,9 ± 8,5	51,9 ± 10,9	51,3 ± 14,1	33,4 ± 13,7	0,329	35,7 ± 14,3	37,9 ± 13,6	39,0 ± 13,4	40,4 ± 12,8	38,8 ± 13,6	0,154
ASCVD optimal risk (Mean ± SD)	2,4 ± 3,6	0,5 ± 0,2	1,5 ± 3,1	3,5 ± 3,4	6,9 ± 4,2	**0,000**	1,5 ± 3,2	2,9 ± 2,2	5,4 ± 3,5	9,9 ± 5,5	2,0 ± 3,2	0,061	1,8 ± 3,6	2,4 ± 3,3	2,8 ± 3,4	3,2 ± 4,7	3,4 ± 3,1	**0,000**
FINDRISC (Mean ± SD)	9,3 ± 4,7	6,3 ± 4,4	8,6 ± 4,4	10,7 ± 4,6	12,6 ± 4,8	**0,000**	8,7 ± 4,5	10,3 ± 4,6	11,5 ± 4,8	13,1 ± 4,7	8,0 ± 4,5	0,123	4,1 ± 1,7	8,9 ± 1,4	12,9 ± 0,8	16,7 ± 1,6	21,9 ± 1,1	**0,000**

Compare means-independent t-test.

Table 3. Total and subgroup scores of SHE and EINLA of the participants according to their SCORE, ASCVD and FINDRISC levels.

		SCORE					ASCVD						FINDRISC					
	n	Low	Middle	High	Very high	p	Low	Borderline	Intermediate	High	No calculated	p	Low	Slightly elevated	Moderate	High	Very high	p
Total SHE score *(Mean ± SD)*	4,0 ± 0,9	4,2 ± 0,9	4,0 ± 0,9	3,9 ± 0,9	3,9 ± 0,8	0,033	4,0 ± 0,9	3,9 ± 0,9	3,9 ± 0,9	3,9 ± 1,0	4,0 ± 0,8	0,825	4,2 ± 0,9	4,0 ± 0,9	3,9 ± 0,9	3,8 ± 0,8	3,7 ± 0,8	**0,000**
Quality labels	4,0 ± 1,1	4,4 ± 1,0	4,1 ± 1,1	3,9 ± 1,1	3,9 ± 1,1	**0,008**	4,1 ± 1,1	3,9 ± 1,1	4,0 ± 1,1	3,8 ± 1,2	4,1 ± 0,9	0,920	4,2 ± 1,1	4,1 ± 1,1	3,9 ± 1,1	3,8 ± 1,0	3,7 ± 1,1	**0,00**
Seasonal food	4,6 ± 1,1	4,9 ± 1,1	4,6 ± 1,0	4,6 ± 1,1	4,7 ± 1,1	0,118	4,6 ± 1,0	4,5 ± 1,1	4,6 ± 1,1	4,5 ± 1,3	4,6 ± 0,9	0,681	4,6 ± 1,1	4,6 ± 1,1	4,6 ± 1,1	4,5 ± 1,0	4,7 ± 0,9	0,410
Healthy & balanced diet	4,6 ± 1,2	4,9 ± 1,3	4,6 ± 1,2	4,5 ± 1,2	4,4 ± 1,2	**0,014**	4,6 ± 1,2	4,4 ± 1,2	4,5 ± 1,2	4,3 ± 1,3	4,6 ± 1,2	0,707	4,8 ± 1,2	4,6 ± 1,2	4,4 ± 1,2	4,3 ± 1,3	4,2 ± 0,9	**0,00**
Local food	2,9 ± 1,3	2,8 ± 1,2	2,9 ± 1,3	2,9 ± 1,4	3,0 ± 1,4	0,229	2,9 ± 1,3	2,8 ± 1,3	2,9 ± 1,4	3,4 ± 1,7	2,8 ± 1,2	0,611	2,9 ± 1,3	2,9 ± 1,„3	2,8 ± 1,3	2,7 ± 1,3	2,8 ± 1,3	0,281
Meat reduction	3,3 ± 1,3	3,2 ± 1,4	3,3 ± 1,2	3,2 ± 1,3	3,3 ± 1,3	0,660	3,3 ± 1,3	3,1 ± 1,2	3,3 ± 1,3	3,3 ± 1,2	3,3 ± 1,2	0,715	3,4 ± 1,2	3,3 ± 1,3	3,2 ± 1,2	3,2 ± 1,2	3,3 ± 1,3	0,481
Animal welfare	3,9 ± 1,4	4,2 ± 1,8	3,9 ± 1,4	3,9 ± 1,4	3,7 ± 1,4	**0,009**	3,9 ± 1,4	3,8 ± 1,4	3,9 ± 1,5	3,6 ± 14	4,1 ± 1,5	0,262	4,1 ± 1,4	3,9 ± 1,4	3,8 ± 1,4	3,6 ± 1,4	3,2 ± 1,3	**0,000**
Low fat	4,8 ± 1,2	5,3 ± 1,3	4,8 ± 1,2	4,7 ± 1,2	4,7 ± 1,2	**0,001**	4,8 ± 1,2	4,6 ± 1,2	4,7 ± 1,2	4,6 ± 1,1	4,9 ± 1,1	0,598	5,0 ± 1,2	4,7 ± 1,2	4,6 ± 1,2	4,5 ± 1,2	4,3 ± 1,2	**0,000**
EINLA (Mean ± SD)	29,8 ± 3,9	32,2 ± 2,9	30,1 ± 3,7	29,1 ± 4,0	27,8 ± 4,6	**0,000**	30,2 ± 3,7	29,4 ± 3,8	28,5 ± 4,3	26,4 ± 4,7	30,1 ± 3,9	0,751	30,6 ± 3,4	29,9 ± 3,8	29,3 ± 3,9	28,1 ± 4,3	27,8 ± 4,5	**0,000**
General nutrition knowledge	8,5 ± 1,7	9,5 ± 0,9	8,6 ± 1,6	8,2 ± 1,8	7,7 ± 2,0	**0,000**	8,6 ± 1,6	8,3 ± 1,8	7,9 ± 1,9	7,5 ± 1,9	8,7 ± 1,5	0,656	8,7 ± 1,5	8,5 ± 1,7	8,4 ± 1,7	7,9 ± 1,9	7,9 ± 19	**0,000**
Reading Comprehension and interpretation	5,3 ± 0,9	5,7 ± 0,6	5,3 ± 0,9	5,2 ± 0,9	4,9 ± 1,1	**0,000**	5,3 ± 0,9	5,2 ± 0,9	5,1 ± 0,9	4,5 ± 1,2	5,4 ± 0,9	0,427	5,4 ± 0,8	5,3 ± 0,9	5,2 ± 0,9	4,9 ± 1,1	4,8 ± 1,2	**0,000**
Food groups	9,6 ± 0,9	9,7 ± 0,6	9,6 ± 0,9	9,5 ± 0,9	9,4 ± 1,1	**0,015**	9,6 ± 0,9	9,5 ± 0,7	9,4 ± 1,1	9,3 ± 1,0	9,4 ± 1,3	0,036	9,6 ± 0,9	9,6 ± 0,9	9,5 ± 1,0	9,4 ± 0,9	9,5 ± 0,9	0,229
Portion Sizes	1,8 ± 0,7	2,0 ± 0,8	1,8 ± 0,8	1,8 ± 0,8	1,6 ± 0,8	**0,000**	1,8 ± 0,8	1,7 ± 0,8	1,7 ± 0,7	1,5 ± 0,8	1,8 ± 0,8	0,935	1,8 ± 0,8	1,8 ± 0,8	1,7 ± 0,7	1,6 ± 0,7	1,4 ± 0,8	**0,000**
Food Label and Numerical Literacy	4,7 ± 1,5	5,2 ± 1,3	4,8 ± 1,4	4,5 ± 1,5	4,2 ± 1,6	**0,00**	4,8 ± 1,4	4,6 ± 1,5	4,4 ± 1,5	3,7 ± 1,8	4,8 ± 1,3	0,697	5,0 ± 1,3	4,7 ± 1,4	4,5 ± 1,5	4,2 ± 1,6	4,1 ± 1,7	**0,00**

Compare means-Independent t test.

Table 4. Energy, macro and micronutrient intakes of the participants according to their SCORE, ASCVD and FINDRISC levels.

		SCORE					ASCVD						FINDRISC					
	N	Low	Middle	High	Very high	p	Low	Borderline	Intermediate	High	No calculated	p	Low	Slightly elevated	Moderate	High	Very high	p
Energy (kcal) (Mean ± SD)	1598,5 ± 555,0	1370,9 ± 480,7	1572,0 ± 584,2	1674,6 ± 574,7	1672,4 ± 542,6	**0,000**	1551,9 ± 539,8	1700,2 ± 526,9	1737,1 ± 591,5	1695,3 ± 613,5	1517,4 ± 590,1	0,522	1538,9 ± 54,9,	1562,2 ± 525,1	1657,6 ± 571,2	1738,9 ± 572,2	1890,8 ± 694,9	**0,000**
Carbohydrate (g) (*Mean ± SD)*	173,2 ± 78,6	145,4 ± 76,4	169,1 ± 77,8	182,5 ± 81,6	189,0 ± 72,9	**0,000**	167,3 ± 77,0	184,6 ± 73,7	193,3 ± 83,9	186,3 ± 73,1	157,5 ± 82,9	0,198	164,8 ± 78,3	167,7 ± 73,2	180,8 ± 78,9	194,4 ± 84,9	218,9 ± 100,2	**0,000**
Protein (g) (*Mean ± SD)*	67,8 ± 27,7	59,3 ± 24,6	66,9 ± 26,8	70,7 ± 29,4	69,4 ± 29,9	**0,004**	65,8 ± 26,5	71,9 ± 28,3	72,9 ± 30,2	70,6 ± 28,5	67,7 ± 30,4	0,499	66,6 ± 29,2	66,9 ± 26,4	69,5 ± 29,1	69,6 ± 25,7	75,6 ± 28,3	**0,014**
Fat (g) (Mean ± SD)	70,5 ± 29,4	61,3 ± 24,8	69,8 ± 28,9	73,5 ± 30,6	70,9 ± 30,8	**0,007**	68,8 ± 28,3	47,9 ± 30,3	74,7 ± 32,3	74,2 ± 33,8	68,5 ± 29,6	0,906	68,2 ± 29,0	69,3 ± 27,6	72,9 ± 32,0	75,9 ± 30,9	79,2 ± 33,7	**0,003**
Saturated f.a. (Mean ± SD)	27,5 ± 13,6	22,6 ± 8,8	27,1 ± 13,4	28,6 ± 14,3	27,5 ± 14,0	**0,006**	26,9 ± 13,1	28,9 ± 14,5	28,9 ± 14,6	25,7 ± 15,9	25,2 ± 13,9	0,181	26,4 ± 13,6	26,7 ± 12,5	28,6 ± 15,3	29,2 ± 13,8	33,5 ± 16,1	**0,000**
Monounsaturated f.a. (Mean ± SD)	25,0 ± 12,2	22,3 ± 10,9	24,9 ± 11,9	25,9 ± 12,4	24,5 ± 13,9	0,165	24,7 ± 11,8	26,6 ± 12,2	26,0 ± 13,6	24,0 ± 14,6	23,2 ± 11,2	0,149	24,5 ± 12,3	24,5 ± 11,2	25,8 ± 13,3	26,7 ± 12,9	28,2 ± 13,5	**0,030**
Polyunsaturated f.a. (Mean ± SD)	11,7 ± 7,2	11,5 ± 8,7	11,6 ± 7,1	12,4 ± 7,5	11,5 ± 7,3	0,970	11,4 ± 6,9	12,8 ± 7,7	12,4 ± 7,9	13,9 ± 10,9	11,1 ± 6,6	0,546	11,4 ± 7,1	11,5 ± 6,9	12,2 ± 7,6	12,9 ± 8,1	12,0 ± 6,4	0,427
Cholesterol (mg) (Mean ± SD)	363,2 ± 217,8	309,9 ± 169,2	359,4 ± 218,9	372,5 ± 217,5	384,1 ± 218,6	**0,003**	356,2 ± 216,5	376,1 ± 214,0	382,8 ± 214,3	388,9 ± 239,2	359,6 ± 251,7	0,883	358,3 ± 217,8	356,4 ± 213,9	377,4 ± 229,6	370,7 ± 214,1	415,7 ± 219,0	**0,040**
Sodium (Mean ± SD)	3334,7 ± 3083,2	2843,8 ± 1785,0	3302,2 ± 3145,7	3483,9 ± 3397,9	3336,2 ± 1621,3	**0,039**	3248,3 ± 3097,9	3593,4 ± 2716,9	3606,2 ± 3628,7	3315,3 ± 1501,1	2995,5 ± 1253,6	0,068	3185,2 ± 3044,7	3367,9 ± 3523,9	3318,2 ± 1691,0	3551,9 ± 3160,1	3677,9 ± 1644,3	**0,029**
Potassium (Mean ± SD)	2310,3 ± 1000,9	2205,8 ± 856,3	2277,3 ± 963,9	2385,5 ± 1147,2	2407,0 ± 901,4	0,087	2259,9 ± 961,9	2380,0 ± 807,3	2487,5 ± 1275,8	2433,4 ± 953,8	2226,8 ± 858,1	0,676	2232,9 ± 789,7	2276,3 ± 953,4	2447,5 ± 1504,7	2387,8 ± 798,8	2604,8 ± 839,2	**0,001**
Calcium (Mean ± SD)	689,8 ± 371,8	565,1 ± 236,2	689,9 ± 396,4	697,0 ± 320,1	703,2 ± 312,9	**0,001**	682,2 ± 394,9	715,9 ± 336,3	706,4 ± 309,3	713,9 ± 146,2	670,1 ± 287,7	0,652	654,9 ± 298,0	686,3 ± 357,7	726,2 ± 531,2	717,5 ± 327,9	823,2 ± 345,4	**0,000**
Magnesium (Mean ± SD)	258,9 ± 109,6	261,3 ± 155,9	253,4 ± 98,5	271,4 ± 121,7	269,8 ± 139,2	0,681	251,9 ± 99,9	274,7 ± 109,7	278,1 ± 136,3	263,7 ± 96,9	256,1 ± 137,2	0,735	251,7 ± 102,7	255,6 ± 104,6	265,3 ± 116,2	269,2 ± 101,7	317,4 ± 215,5	**0,000**

Compare means-independent t test.

Table 5. The correlation between SCORE, ASCVD, FINDRISC scores and SHE, EINLA, BMI and some dietary intakes of the participants.

	SCORE		ASCVD		FINDRISC		SHE		EINLA		BMI (kg/m²)		Energy (kcal)		Fat (g)		Saturated fat (g)		Cholesterol (mg)	
	r	*P*-value	r	*P*-value	r	*P*-value	r	*P*-value	r	*P*-value	r	*P*-value	r	*P*-value	r	*P*-value	r	*P*-value	r	*P*-value
SCORE			0,784	**0,000**	0,294	**0,000**	–0,46	**0,010**	–0,220	**0,000**	0,219	**0,000**	0,147	**0,000**	0,093	**0,000**	0,089	**0,000**	0,049	**0,006**
ASCVD	0,784	**0,000**			0,262	**0,000**	–0,056	**0,002**	–0,222	**0,000**	0,228	**0,000**	0,200	**0,000**	0,131	**0,000**	0,108	**0,000**	0,065	**0,000**
FINDRISC	0,294	**0,000**	0,262	**0,000**			–0,155	**0,000**	–0,202	**0,000**	0,604	**0,000**	0,121	**0,000**	0,086	**0,000**	0,092	**0,000**	0,037	**0,040**

Pearson corelation.

variables were evaluated for the risk of developing cardiovascular disease (SCORE and ASCVD) and diabetes (FINDRISC).

Results of this study indicated that risk of CVD and diabetes increased with age, lower level of education and income level. Males had a higher susceptibility to both diseases as compared to females. Several studies have also reported that education level is inversely associated with CVD in type 1 and 2 diabetes (35,36, 39). The authors have stressed providing special attention in patients particularly from lower socio-economic background to prevent CVD risk and mortality (35). Although there are studies that report high FINDRISC scores in females (40), other studies from Western Europe, North America, and Australia have reported, a higher risk of diabetes in males than in females (41,42) and a higher rate of undiagnosed diabetes especially in males (43–45). In general, there is a wide gender gap in diabetes prevalence among countries, and different biological, cultural, lifestyle, environmental, and socioeconomic factors influence the predisposition, development, and clinical presentation of diabetes (46).

Body composition and especially excessive (visceral) fat accumulation is closely related to atherosclerosis and onset of CVD. Therefore, anthropometric measurements are frequently used to evaluate the clinical course of patients and to control cardiovascular risk factors. Traditional anthropometric measurements such as total body weight, BMI, waist and hip circumference are essential to improve risk estimation and risk factor monitoring (47). In this study, BMI mean values of individuals with high SCORE, ASCVD and FINDRISC levels were found to be significantly higher than those in the low-risk group. Waist and hip circumferences were also found to be significantly lower in those with low SCORE, ASCVD and FINDRISC levels than in those in the high-risk group. At the same time, a significant positive relationship was found between BMI and the risk level of cardiovascular disease and diabetes. In a cohort study conducted on 1346 middle-aged men and followed for 10 years, Lakka et al. reported that an increase in waist circumference and BMI directly increased the risk of CVD (48). Similarly, Zen et al. reported that a BMI of ≥30 kg/m2 versus <25 kg/m2 increased the risk of CVD by 2.3 times (49).

A study conducted with 164 physicians and nurses working and volunteering at a Health Practice and Research Hospital in southeastern Turkey evaluated the relationship between type-2 diabetes risk and healthy lifestyle behaviors in healthcare workers. As the level of healthy lifestyle behaviors decreased, the risk of diabetes increased. High blood glucose values and daily exercise, along with BMI, were other predictors and were found to have a cumulative effect on diabetes risk by 65% (50). In another study investigating the relationship between healthy lifestyle behaviors of students and the risk of type-2 diabetes mellitus, the mean FINDRISC scores increased as waist/hip and waist/height ratio increased in female students. FINDRISC scores were also reported higher in students with a BMI value of ≥30 (51).

The concept of NL, derived from health literacy, may be defined as the extent to which individuals possess the ability to obtain, comprehend and adopt basic nutrition (52). Taylor et al. studied NL level of 386 patients with diet related

chronic diseases and reported that good NL enables individuals to make healthy diet choices, resulting in better health outcomes (53). Michou et al. in their study with Greek adults having chronic diseases noted that after controlling for gender, age and education, chronic disease was negatively associated with lower NL (54).

According to the results of our study, CVD risk (SCORE) level increased as the rates of adequate literacy decreased, and it was significant in all sub-groups of EINLA. Similarly, it was found that as the FINDRISC risk level increased, as EINLA levels decreased, and it was significant for all but one sub-group. A weak correlation was found between EINLA and SCORE, ASCVD and FINDRISC. There is limited study evaluating the relationship of NL specifically with the risk of developing cardiovascular disease and diabetes.

However, in a study conducted by Tseng et al. in 2017 in patients with type-2 diabetes in northern Taiwan, inadequate health literacy was found to be significantly associated with poor glycemic control (55). Various studies have shown that there is a relationship between health literacy in society and CVDs or risk factors (56–58). Nutrition therapy has a role in both prevention and treatment of chronic diseases and one of the most effective tools for successful nutrition therapy is nutritional literacy. A study conducted on a total of 150 adults with cardiovascular disease or risk factors in Turkey, it was determined that all participants had borderline NL (59).

Sustainable healthy nutrition is a low environmental impact, accessible, economical, reliable, equitable and culturally acceptable nutritional pattern that supports the health and well-being of individuals in all aspects (2). Studies show that sustainable nutrition has a protective role in preventing body weight gain, obesity and the risk of chronic diseases (60,61). Another study reported that, switching people to a sustainable diet would reduce the risk of developing cardiovascular diseases and diabetes, especially obesity, which is one of the non-communicable diseases since they would consume less processed and packaged foods that contribute to obesity, reduce their saturated fat intake, consume less animal-based foods, and prefer more plant-based foods (62). Similarly, in this study SCORE and FINDRISC risk levels significantly decreased along with a decrease in BMI in the participants as their sustainable and healthy eating habits (SHE) scores increased, however the change was not significant in ASCVD risk groups.

Healthy eating habits focus on replacing saturated fat with unsaturated fat, reducing salt intake, choosing a plant-based diet rich in fiber, consuming fish frequently, and limiting sugar-sweetened beverages and processed meat intake (63). When the energy, macro and micronutrient intakes of the participants in this study were examined according to their cardiovascular and diabetes risk scores, it was found that as the SCORE and FINDRISC risk levels increased, as their energy (kcal), carbohydrate (g), protein (g), fat (g), saturated fat (g), cholesterol (mg), sodium (mg), and calcium (mg) intakes increased significantly. However, the participants' energy and nutrient intakes did not change significantly for the ASCVD risk groups.

Another study conducted in Turkey investigated whether dietary patterns were a risk factor for cardiovascular diseases in individuals. Like this study, SCORE and ASCVD risk assessment systems were used to determine cardiovascular disease risk. The study reported that participants' increased energy, saturated fat, and carbohydrate intake increased the risk of CVD (64). Since inflammation plays a critical role in the development and progression of CVD (65) and inflammatory status is decreased by low energy intake, calorie restriction was suggested to reduce the risk of CVD (66). Hypercholesterolemia is one of the most important risk factors for cardiovascular disease. Monounsaturated fatty acid and polyunsaturated fatty acid intakes were associated with a lower risk of CVD and death, while saturated fatand trans-fat intakes were associated with a higher risk of CVD (67). Adding fructose and glucose to the diet causes weight gain and a significant increase in fat mass. However, while visceral fat tissue increases are observed in those with fructose added to the diet, subcutaneous fat accumulation increases are observed in those with glucose added. Significant data suggests that visceral fat tissue increase is associated with cardiovascular diseases and metabolic diseases such as T2DM when compared to subcutaneous fat accumulation (68). The relationship between a high-fat diet and impaired insulin has been demonstrated in many *in vivo* and *in vitro* studies. However, the cellular mechanisms responsible for the decrease in insulin sensitivity with a high-fat diet have not been fully defined. Animal and human studies show that a high-fat diet significantly impairs the effect of insulin, reduces skeletal muscle glucose metabolism, and reduces the ability of insulin to suppress hepatic glucose production. As a result, high-fat and fructose diets increase the risk of diabetes by causing an increase in blood sugar (69). Although the exact connection between fructose and cholesterol metabolism is not very well understood, recent animal studies show that high fructose diet induces an elevation of hepatic cholesterol. In a study conducted by Ya-Nan et al on hepatic carbohydrate responsive element binding protein (ChREBP) knocked-out mice, cholesterol level was found to be low, and it was suggested that ChREBP had a potential role in fructose-regulated cholesterol metabolism (70). Fructose is known to promote hepatic lipogenesis, primarily because the liver is the main organ responsible for metabolizing fructose. When fructose enters glycolysis through the formation of fructose-1-phosphate, it bypasses the key regulatory step of the pathway, which is normally controlled by phosphofructokinase. This leads to an excessive production of lipogenic intermediates, such as acetyl-CoA and glycerol-3-phosphate which eventually activates lipogenesis and cholesterol synthesis. Additionally, fructose has the ability to activate sterol regulatory element-binding protein-1c (SREBP-1c) in an insulin-independent manner, which in turn stimulates the expression of genes that are involved in de novo lipogenesis in the liver (71).

This study has several notable strengths that distinguish it in the field of dietary behavior research, as it evaluates the effects of both NL and sustainable eating behavior on the risk factors of cardiovascular diseases and diabetes in a large study sample from Turkey. Not only does it provide a unique insight into dietary patterns and behaviors regarding the risk of cardiovascular diseases and diabetes but also addresses nutritional

interventions and public health strategies, especially for individuals suffering from chronic diseases. However, this study also has some potential limitations. Firstly, the data on the questionnaire form was self-reported by the participants and may have included reporting bias. Secondly, the 24-h retrospective dietary intake record used to calculate energy and macronutrient intakes may not have accurately reflected the routine dietary habits of the participants.

Conclusion

Sustainable nutrition behaviors and NL levels were significantly lower in individuals who were at elevated risk of developing cardiovascular disease and diabetes. Moreover, it was determined that an increase in NL levels reduced the risk of developing both cardiovascular disease and diabetes, while an increase in sustainable nutrition behaviors reduced the risk of developing diabetes but had no significant effect on the risk of cardiovascular disease. As per the results, it may be recommended to determine the NL levels of individuals and provide sustainable and healthy nutrition education to increase the NL levels of individuals. The findings of this study also emphasize the importance of medical nutrition therapy by a dietician, in managing cardiovascular disease and diabetes risk factors and providing nutrition education to individuals within the scope of medical nutrition therapy. It is also recommended that risk screenings be conducted in groups with a higher risk of chronic disease in society, such as the elderly and individuals with low socio-economic status, and appropriate sustainable nutrition and nutrition education interventions be included within the program.

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Data availability statement

The datasets presented in this article are not readily available due to restrictions (e.g., their containing information that could compromise the privacy of research participants). Requests to access the datasets should be directed to NG, nedime.gunduz@medipol.edu.tr.

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