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RESEARCH ARTICLE



Lipid profile in young people

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ABSTRACT

Introduction. Metabolic risk factors for non-communicable chronic diseases develop from an early age, while the clinical manifestations of cardiovascular diseases associated with these risk factors appear later in life. Dyslipidemia is a modifiable risk factor for cardiovascular diseases. The purpose of the study was to evaluate the lipid profile in young people as an early risk factor for cardiovascular disease.

Material and methods. The study was conducted on 693 healthy young individuals: 71.4% (495) women and 28.6% (198) men, aged between 17 and 30 years. The measured parameters included total cholesterol, HDL-cholesterol, LDL-cholesterol, and triglycerides, measured using the spectrophotometric method. Non-HDL cholesterol was calculated with the formula: non-HDL-C = TC – HDL-C (mmol/l).

Results. A total of 8.2% of young people had total cholesterol levels above the normal threshold (5.0 mmol/l). HDL-cholesterol below the gender-specific threshold values was recorded in 52.5%. Among women, 58.8% had HDL-cholesterol levels ≤ 1.29 mmol/l, and among men, 36.9% had levels below 1.03 mmol/l. Non-HDL cholesterol exceeded the threshold value (3.8 mmol/l) in 5.9% of young people. For 21.4% of participants, LDL-cholesterol was above the threshold (2.59 mmol/l), and 8.2% had triglyceride levels above the normal threshold (1.7 mmol/l).

Conclusions. The study demonstrated that over half of the young people (52.5%) had HDL-cholesterol below the gender-specific thresholds. Deviations in the lipid profile increase the atherogenic potential of plasma, highlighting the need for early preventive interventions in this age group.

Keywords: lipids, young people, risk factors, cardiovascular risk, chronic non-communicable diseases, early prevention.

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Key messages

What is not yet known about the issue addressed in the submitted manuscript

The lipid profile in the young population is not sufficiently documented. The behavior of metabolic risk factors in young people remains poorly understood, particularly since this group is not typically included in screening programs.

The research hypothesis

Young individuals experience changes in their lipid profile from childhood, which later evolve into specific disease entities as life progresses.

The novelty added by manuscript to the already published scientific literature

The reported study presents the characteristics of the lipid profile among young people in the Republic of Moldova.

Introduction

Alterations in the lipid spectrum are a major cause of atherosclerosis [1]. Numerous epidemiological studies have confirmed a direct link between dyslipidemia and the incidence of cardiovascular events, which are recorded both in apparently healthy individuals and in those with a history of cardiovascular disease. There is also evidence that dyslipidemia can be an independent predictor of cardiovascular events, as well as act in conjunction with other risk factors. Longitudinal studies have demonstrated the persistence of dyslipidemia throughout life, favoring the continuous progression of subclinical atherosclerosis. Scientific evidence supports the relationship between hyperlipidemia and changes in the arterial intimal layer at an early age, further strengthening the hypothesis that atherosclerosis begins early and is a chronic, progressive process [2-5]. Alterations in the lipid spectrum begin early, from childhood and adolescence, persist into youth, and clinical manifestations become apparent in adulthood [6, 7]. Dyslipidemia, particularly characterized by low levels of HDL-cholesterol (HDL-C) and elevated triglycerides (TG), is frequently observed among young people, with a prevalence ranging between 13% and 30% [8-10]. The increase in LDL-C, total cholesterol, and non-HDL-C levels observed during adolescence and youth is associated with a higher long-term cardiovascular risk [8]. Some studies conducted among young populations have shown that cumulative exposure to hyperlipidemia during youth increases the risk of developing coronary heart disease later in life, even in cases where there are only moderate increases in LDL cholesterol [9, 10]. Dyslipidemia is a modifiable cardiovascular risk factor, and early identification, along with prompt intervention, can significantly reduce overall cardiovascular risk, as well as the incidence of fatal and non-fatal events. The aim of the study was to evaluate the lipid profile in young people as an early cardiovascular risk factor.

Material and methods

The cross-sectional study was conducted on a sample of 693 apparently healthy young individuals (495 women and 198 men) aged between 17 and 30 years, who were first-year students at *Nicolae Testemițanu* State University of Medicine and Pharmacy (SUMF), from all integrated study programs: Medicine, Public Health, Pharmacy, and Dentistry. The study received approval from the Research Ethics Committee of *Nicolae Testemițanu* State University of Medicine and Pharmacy (Minutes no. 9 from November 20, 2012) and was carried out between September and November 2011. To analyze the lipid profile, the following parameters were assessed: total cholesterol (TC), HDL-cholesterol (HDL-C), non-HDL cholesterol (non-HDL-C), LDL-cholesterol (LDL-C), and triglycerides (TG). Venous blood was collected in the morning after at least 8 hours of fasting; the serum was separated, aliquoted, and stored at -70°C . The period before freezing did not exceed 6 hours. Serum lipids were determined in the INVITRO Diagnostics Laboratory. Tests were performed using ABBOTT Architect ci8200 equip-

ment. Triglyceride concentration was determined using the enzymatic-colorimetric method (Triglycerides Mono SL NEW, ELITech Clinical Systems, France, and ARCHITECT Triglyceride, 7D74-21, Abbott). Total cholesterol was assessed by the enzymatic method (Cholesterol SL ELITech Clinical Systems, France, and ARCHITECT Cholesterol, 7D62-21, Abbott). HDL-cholesterol concentration was estimated by the enzymatic-spectrophotometric method with precipitation (HDL-Cholesterol ELITech Clinical Systems, France, and ARCHITECT ULTRA HDL, 3K33-21, Abbott). LDL-cholesterol content was measured directly (ARCHITECT Direct LDL, 1E31-20, Abbott). Non-HDL cholesterol was calculated using the formula: non-HDL-C = TC – HDL-C (mmol/l) [11]. The evaluation of changes in the lipid spectrum was carried out according to the recommendations of the European Society of Cardiology and the National Clinical Protocol for Dyslipidemias [12, 13] (Table 1).

Table 1. Threshold values for interpretation of lipid parameters (mmol/l)

	TC	LDL-C	HDL-C	non-HDL-C	TG
Normal level	< 5.0	< 2.6	$\geq 1.0^*$ $\geq 1.3^{**}$	< 3.8	< 1.7
Modified level	≥ 5.0	≥ 2.6	< 1.0* < 1.3**	≥ 3.8	≥ 1.7

Note: * – men; ** – women; TC – total cholesterol; LDL-C – LDL-cholesterol; HDL-C – HDL-cholesterol; non-HDL-C – non-HDL cholesterol; TG – triglycerides.

The R programming environment was used to calculate the statistical parameters, employing the EpiTool applications [14-16]. The differences between the statistically significant mean values ($p < 0.05$) and their 95% confidence intervals were calculated.

Results

The stratified analysis of the lipid profile of the evaluated young people showed that total cholesterol (TC) values ranged from 1.71 to 6.89 mmol/l, with a mean value of 3.89 ± 0.845 mmol/l. In men, TC ranged from 1.88 to 6.89 mmol/l, and in women from 1.71 to 6.52 mmol/l ($p = 0.5239$). The mean value of TC was higher in women (3.90 ± 0.855 mmol/l) than in men (3.85 ± 0.845 mmol/l) ($p = 0.4354$). Mean HDL cholesterol (HDL-C) was 1.22 ± 0.328 mmol/l, with a range between 0.53 and 2.80 mmol/l. HDL-C values ranged from 0.57 to 2.01 mmol/l in men and from 0.53 to 2.80 mmol/l in women ($p = 0.0068$). In women, the mean HDL-C value was higher (1.26 ± 0.337 mmol/l) compared to men (1.14 ± 0.328 mmol/l), the difference being statistically significant ($p = 3.56 \times 10^{-6}$). Non-HDL cholesterol (non-HDL-C) in the study group had a mean value of 2.66 ± 0.718 mmol/l, with limits ranging from 0.62 to 5.76 mmol/l. In men, non-HDL-C values ranged from 1.18 mmol/l to 5.76 mmol/l, while in women from 0.62 mmol/l to 4.92 mmol/l ($p = 0.2885$). Mean non-HDL-C was higher in men (2.70 ± 0.685 mmol/l) than in women (2.65 ± 0.731 mmol/l) ($p = 0.334$). The LDL-cholesterol (LDL-C) content ranged from 0.30 to 5.04 mmol/l, with a mean value of 1.94 ± 0.787 mmol/l. LDL-C values ranged from 0.47 mmol/l to

5.04 mmol/l in men and from 0.62 mmol/l to 4.92 mmol/l in women ($p = 0.1304$). The mean LDL-C was higher in men (2.00 ± 0.787 mmol/l) compared to women (1.92 ± 0.807 mmol/l) ($p = 0.2079$). Triglyceride (TG) concentration ranged from 0.18 mmol/l to 7.16 mmol/l, with a mean value

of 1.16 ± 0.572 mmol/l. In women, TG values ranged from 0.24 mmol/l to 7.16 mmol/l and from 0.18 mmol/l to 5.24 mmol/l in men ($p = 0.130$). Mean TG content was significantly higher ($p = 0.0042$) in men (1.26 ± 0.572 mmol/l) than in women (1.13 ± 0.586 mmol/l) (Table 2).

Table 2. Comparative characteristics of lipid parameters (n = 693).

Statistical parameter	Sex	TC mmol/l	HDL-C mmol/l	non-HDL-C mmol/l	LDL-C mmol/l	TG mmol/l
Range of variation	Total	1.71–6.89	0.53–2.80	0.62–5.76	0.30–5.04	0.18–7.16
	M	1.88–6.89	0.57–2.01	1.18–5.76	0.47–5.04	0.18–5.24
	F	1.71–6.52	0.53–2.80	0.62–4.92	0.30–3.97	0.24–7.16
Median	Total	3.96	1.19	2.69	2.03	1.27
	M	3.99	1.11	2.75	2.06	1.32
	F	3.95	1.21	2.64	2.00	1.24
Mean $\pm$ SD	Total	3.89 ± 0.845	1.22 ± 0.328	2.66 ± 0.718	1.94 ± 0.787	1.16 ± 0.572
	M	3.85 ± 0.845	1.14 ± 0.328	2.70 ± 0.685	2.00 ± 0.787	1.26 ± 0.572
	F	3.90 ± 0.855	1.26 ± 0.337	2.65 ± 0.731	1.92 ± 0.807	1.13 ± 0.586
t-test		-0.7808	-4.698	0.9666	1.2615	2.8779
p value		0.4354	3.56×10^{-6}	0.3344	0.2079	0.0042
F-test		0.9244	0.7162	0.8782	0.8309	0.7964
p value		0.5239	0.0068	0.2885	0.1304	0.0633

Note: n(M) = 198 –number of men. n(F) = 495 –number of women. TC – total cholesterol; LDL-C – LDL-cholesterol; HDL-C – HDL-cholesterol; non-HDL-C – non-HDL cholesterol; TG – triglycerides. Statistical significance was set at $p < 0.05$. The t-test was applied to assess differences between mean values; F-test was applied to assess differences in variance between datasets.

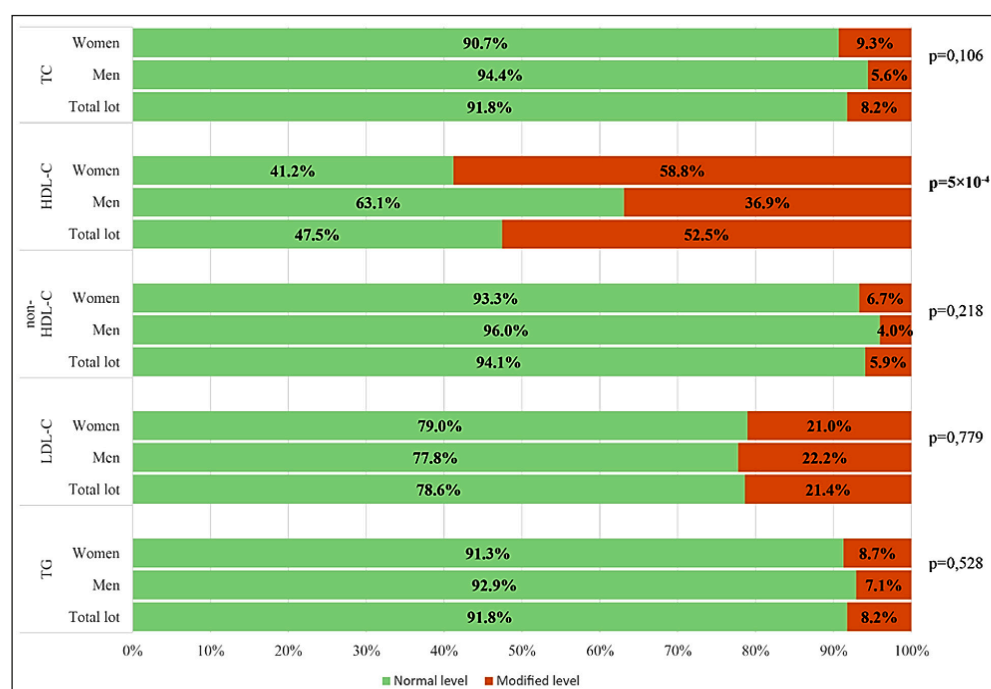
The majority of the evaluated young people (91.8%) had TC values within normal limits (less than 5.0 mmol/l), while 8.2% had levels above the threshold considered normal. Among women, the proportion of those with TC above the threshold value was 9.3%, and among men, 5.6% ($p = 0.106$). It is important to note that more than half of the participants (52.5%) had HDL-C values below the gender-specific thresholds. Thus, 58.8% of the women had HDL-C levels ≤ 1.29 mmol/l, and 36.9% of the men had levels ≤ 1.03 mmol/l. The association between HDL-C and gender was statistically significant ($(\chi^2 = 27.249, p = 5 \times 10^{-4})$). Non-HDL-C concentrations were within normal limits (≤ 3.8 mmol/l) in 94.1% of participants, and 5.9% were above the reference threshold. Analysis by gender revealed elevated non-HDL-C levels in 6.7% of women and 4.0% of men ($p = 0.218$). Also, LDL-C remained within normal limits (≤ 2.59 mmol/l) in 78.6% of participants, while 21.4% had values above the recommended threshold. According to gender, 22.2% of men and 21.0% of women had elevated LDL-C values, with no statistically significant difference between the two groups ($p = 0.779$). Regarding TG, 91.8% of participants had levels within normal limits (< 1.7 mmol/l), while 8.2% had values above the threshold. Elevated TG levels were observed in 8.7% of women and 7.1% of men ($p = 0.528$) (Fig. 1). Therefore, the comparative analysis of the lipid profile according to sex revealed a statistically significant difference only for HDL-C ($\chi^2 = 27.249, p = 5 \times 10^{-4}$). The proportion of women with pathological HDL-C levels (≤ 1.29 mmol/l) was significantly higher (58.8%) compared to men (36.9%). For the other parameters (TC, LDL-C, non-HDL-C, and TG), sex differences were not statistically significant (Fig. 1).

Discussions

The results of our study, using threshold values for lipid parameters [12, 13], revealed a relatively high prevalence, with more than half (52.5%) of the young assessed individuals having HDL-C levels below gender-specific thresholds. Low HDL-C levels among youth have also been documented in international research on this age group, with a prevalence ranging from 13% to 30% [9, 17, 18]. Our study recorded HDL-C levels below gender-specific threshold values in 58.8% of women and 36.9% of men, with a statistically significant difference ($p = 5 \times 10^{-4}$). Other research conducted in the same age group demonstrated the presence of this risk factor in 18.2% of men and 8.1% of women [17]. More comprehensive data are provided by a large-scale study from China involving 22,379 young students, which reported a high proportion (74%) of individuals with low HDL-C levels, particularly among men (23% vs. 7.2% in women). Elevated triglycerides (14.5%) were also noted, but as in our research, other risk factors such as diet, physical activity level, and age-specific hormonal characteristics were not analyzed [10]. A study conducted among medical students in Sri Lanka highlighted numerous deviations in the lipid profile among young people, including a prevalence of hypercholesterolemia of 25.4% and hypertriglyceridemia of 5.3%. The authors reported that these abnormalities were significantly more frequent among men (12.3%) compared to women (1.6%), with the difference being statistically significant ($p = 0.006$). Additionally, low HDL-C levels were observed in approximately 31.6% of participants, while 12.2% had elevated LDL-C values [19]. Several local studies among young medical students have likewise demonstrated changes in lipid profile parameters. Thus, a cross-sectional study conducted on a sample of 456

Fig. 1 Frequency of lipid parameter levels in relation to threshold values (mmol/l)

Note: TC – total cholesterol; LDL-C – LDL-cholesterol; HDL-C – HDL-cholesterol; non-HDL-C – non-HDL cholesterol; TG – triglycerides. Normal level – the percentage of subjects with the parameter within normal limits; Modified level – the percentage of subjects with values above the threshold (TC; LDL-C; non-HDL-C; TG) and below the sex-specific threshold (HDL-C). $p < 0.05$ was considered statistically significant.



students from the *Nicolae Testemițanu* State University of Medicine and Pharmacy revealed alterations in the lipid profile in 52.0% of participants, of whom 40.9% had HDL-C values below gender-specific reference thresholds, 11.8% had hypertriglyceridemia, and 7.3% had hypercholesterolemia [20]. Another study conducted among students at the same institution reported a prevalence of 53.0% for at least one altered lipid parameter among 302 women. Within this sample, 34.1% of participants had low HDL-C levels, 13.6% had hypertriglyceridemia, and 14.2% had hypercholesterolemia, while 7.0% exhibited elevated non-HDL-C values [21]. At the same time, among men, at least one altered lipid parameter was identified in 34.0% of 138 medical students, with low HDL-C being the most frequently observed abnormality [22]. These data confirm the trend observed in our own analysis, suggesting a significant frequency of dyslipidemia among the young population.

In comparison, data from the STEPS studies conducted in the Republic of Moldova indicate that, among the general population aged 18 to 29, 17.8% of young people had mean total cholesterol (TC) values above 5.0 mmol/l. The differences between sexes were statistically significant, with a higher prevalence in women (20.0%) compared to men (15.5%) [23, 24]. The changes observed in the lipid profile may potentially be influenced by genetic factors, considering the concept that genetic factors shape individuals' health status in youth, while behavioral and environmental factors become more significant with age – a point that should be taken into account when developing personalized preventive strategies.

Conclusions

The study demonstrated that more than half of the young individuals (52.5%) had HDL-C levels below gender-specific thresholds. These changes in the lipid profile increase the atherogenic potential of plasma, highlighting

the importance of implementing early preventive measures in this age group. In this context, it is essential to expand the use of cardiovascular risk assessment tools among the young population.

Competing interests

None declared.

Authors' contributions

All authors contributed equally to the conduct of the study and the drafting of the manuscript. All authors reviewed the work critically and approved the final version of the manuscript.

Informed consent for publication

Obtained.

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Ethics approval

The study protocol was approved by the Research Ethics Committee of the *Nicolae Testemițanu* State University of Medicine and Pharmacy (Minutes no. 9, dated November 20, 2012).

Provenance and peer review

Not commissioned, externally peer-reviewed.

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