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RESEARCH ARTICLE

Lipid metabolism and dyslipidemia incidence among urban residents

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The lipid metabolism indicators were analyzed: total cholesterol (TC), cholesterol of low density lipoprotein (LDL cholesterol), high density lipoprotein cholesterol (HDL cholesterol), triglycerides (TG) and atherogenic index (IA) in different age groups of men and females in Barnaul Altai region. It was shown that in the examined men and females the levels of total cholesterol and LDL cholesterol exceeded the norm; levels of HDL cholesterol and TG in both sex groups corresponded to the reference values. With age the level of TC and LDL cholesterol in the serum increases, respectively, and the AI. The TG content does not undergo significant changes, and the HDL cholesterol level tends to decrease. Data from biochemical blood tests were used to classify lipid spectrum disorders. Atherogenic dyslipidemia was found in 69.9±2.2% of cases, and in 17.2 ± 1.8% – combined dyslipidemia.
Keywords: lipid metabolism; dyslipidemia; atherogenic index; cardiovascular diseases

Introduction

Along with arterial hypertension, smoking and other risk factors, lipid metabolism disorders lead to the development of more than 95% of all cardiovascular diseases (CVD), and the contribution of dyslipidemia to the process of pathology progression is maximum (John, 2000; Grundy, Cleeman, Merz, 2004; Tabatabaei-Malazy et al., 2014; Helkin et al., 2016). In most developed countries, CVD occupies a leading place among causes of death (Oganov, Maslennikova, 2000; Molani et al., 2018). High mortality rates, as well as the early development of atherosclerotic CVD in Russia, make the study of lipid spectrum disorders among residents of the city of Barnaul relevant.

For the timely early diagnosis of lipid metabolism disorders, identification of lipid risk factors for atherosclerotic CVDs, the implementation of reasonable preventive measures, it is necessary to study the developmental features of the spectrum of blood lipids and lipoproteins, the prevalence of their disorders in people of different sex and age groups. In Diagnosis and correction of lipid metabolism disorders for the prevention and treatment of atherosclerosis (Russian recommendations, VI revision, 2017) it was stated that in 2016 mortality from CVD was 615 per 10,000 population. Absolute loss of 900,000 people (Ezhov et al., 2017).

In this regard, the study purpose was to study the lipid metabolism characteristics and the frequency of dyslipidemia occurrence in different men and females age groups in the city of Barnaul.

Materials and methods

To study the characteristics of the lipid spectrum and the frequency of dyslipidemia occurrence in Barnaul residents' data from the City Lipidological Center were used. The paper analyzes the results of a survey of 1050 patients (400 males and 650 females) aged from 20 to 89 years. The average age of the patients was 56.33±0.52 years.

The survey included a questioning, a clinical examination and a biochemical blood test. The questionnaire was used to find out the gender, age, diet, smoking status, physical activity, family cardiovascular history, etc. The clinical examination included blood pressure measurement.

Biochemical analysis of blood consisted in the determination of lipid metabolism: total cholesterol (TC), low-density lipoprotein cholesterol (LDL-C), high density lipoprotein (HDL-C) and triglycerides (TG), very low density lipoprotein cholesterol (VLDL-C). Laboratory studies were carried out using reagent kits and the semi-automatic analyzer. The work was carried out in compliance with all the rules of biomedical research.

The total atherogenic risk was assessed by the value of the calculated atherogenic index (AI): IA = (TC - HDL-C) / HDL-C. The type of dyslipidemia was assessed on the basis of lipid spectrum parameters (Fredrickson, Levil, Lee, 1967).
Statistical processing of the data was carried out using Microsoft Office Exel. It included the methods of descriptive statistics, correlation analysis, as well as analysis of the normality of the distribution of characters. The reliability of differences between the mean values of the groups was estimated using the Student's t-criterion. Differences were considered statistically significant at $p < 0.05$.

Results and discussion

Disruption of lipid metabolism is a recognized risk factor for the development of CVD, regardless of gender. However, today there is no doubt that some pathogenetic mechanisms in females and men are different. Probably, these differences require a differentiated approach to diagnosis depending on gender (Diagnosis and correction..., 2017).
The group surveyed included 400 males and 650 females aged from 20 to 89 years, who accounted for 38 and 62%, respectively. The analysis of laboratory studies showed that in men and females the levels of TC and LDL-C were higher than the recommended values: 5.80±0.11 and 3.60±0.11 mmol/l in males; 6.4±0.24 and 3.73±0.08 mmol/l – in females with an appropriate level of coronary risk. Moreover, the level of TC in men was significantly lower than in females ($p<0.05$) (Table 1).

Table 1. Lipid metabolism and atherogenic index in men and females, M±m

	The lipid metabolism parametres (mmol/l)				IA. relative units
	TG	TC	HDL-C	LDL-C	
Females	1.49±0.07	6.4±0.24*#	1.54±0.04*	3.73±0.08#	4.92±0.24*#
Men	1.46±0.06	5.8±0.11#	1.21±0.14	3.60±0.11#	4.49±0.05#
Norm	<1.7	≤5.00	>1.00	≤ 3.00	>3.8

Note: * – significant differences between men and females, $p < 0.05$; # - above normal

According to the results of the INTERHEART study, the main role in the development of atherosclerosis is played an increase of plasma levels cholesterol and LDL-C, which leads to a significant increase in the risk of coronary heart disease (CHD) and overall mortality (Yusuf et al., 2004).
The TG and HDL-C levels in both sex groups were normal, and the level in females was significantly higher than in men ($p<0.05$) (Table 1). A number of studies have shown an inverse relationship between the concentration of HDL-C and the risk of CHD developing. It has been established that a 1% decrease in the level of HDL-C is associated with an increase in the risk of CHD developing by 2-3% (Chazov, 2008), and an increase in the level of HDL-C by 1.0 mmol/l reduces the risk of ischemic stroke by 47% (Lindenstrom, 1994).
The average values of coefficient IA in groups of men and females are in the high values, i.e. relative serum atherogenicity blood from a significant number of surveyed increased. Moreover, in females, the serum concentration of atherogenic lipoprotein fractions was significantly higher ($p < 0.05$) than in men (Table 1).
There is a point of view that females, due to their gender characteristics, are relatively protected from CVD and this problem is less relevant for them than for males. The data obtained by us indicate an increased content of TC in females compared with males, which is apparently associated with age-related hypoestrogenism (Tuomikoski et al., 2014).
The biological process of aging begins at the moment of birth and continues irreversibly throughout life. With aging, there is a tendency to a decrease in basic metabolism and a decrease in the rate of metabolic processes. With age, lipid metabolism also undergoes significant changes. The serum concentration of lipids and lipoproteins reflects a predisposition to the atherosclerosis development and CVD; therefore, changes in lipid metabolism are one of the earliest markers of aging (Tot, Meki, 2010).
Among the surveyed were males and females aged 20 to 89 years. Most among them (36% of the total number of those examined) were people aged 50–59 years. 23% of patients entered the age group of 60–69 years. Least of all among those surveyed were young people (20–29 and 30–39 years old) and those over 70 – 6%, 10%, and 11%, respectively.
According to the data obtained, serum lipid spectrum in patients aged 20-29 years did not go beyond the physiological norm adopted in practical public health. From the age of 30–39 years, there was an increase in the level of TC and LDL-C relative to the norm and at the age of 50–59 years the highest values of these indicators were recorded – 6.30 ± 0.10 and 3.86 ± 0.10 mmol/l. In the older age groups (60–69 and 70 years and older), despite a slight decrease in mean values, TC and LDL-C remained significantly above the norm (Table 2).
According to a number of authors, the lowest risk of atherosclerosis is observed if the blood TC level does not exceed 5.0 mmol/l. According to our data, an increase in TC above 5.0 mmol/l was observed in patients older than 30 years. In addition, they also observed an excess of the norm in LDL-C levels (Diagnosis and correction..., 2017).
HDL cholesterol levels below 1.0 mmol/l in males and below 1.2 mmol/l in females, as well as the TG level above 1.7 mmol/l, are markers of increased cardiovascular risk and should be considered when choosing drug therapy (Diagnosis and correction of..., 2017). According to the data obtained, the content of HDL cholesterol in the serum of the examined patients

significantly decreased with age. So in the age group of 20–29 years, the content of HDL cholesterol was 1.73±0.11 mmol/l, while patients older than 70 years old the average value of this indicator is 1.22±0.06 mmol/l. However, the average indices of HDL cholesterol corresponded to the norm in all age groups (Table 2).

Table 2. Age dynamics of lipid metabolism and atherogenic index, M±m

Age groups (years)	The lipid metabolism parametres (mmol/l)				IA. relative units
	TG	TC	HDL-C	LDL-C	
20–29	1.07±0.16	4.54±0.34	1.73±0.05	2.48±0.28	2.93±0.10
30–39	1.55±0.04**	5.23±0.13*#	1.62±0.04*	3.46±0.30*#	3.69±0.28**
40–49	1.65±0.08	5.42±0.12#	1.51±0.02*	3.55±0.16#	4.39±0.16*#
50–59	1.58±0.03	6.30±0.10*#	1.25±0.04*	3.86±0.02*#	4.90±0.11*#
60–69	1.43±0.05**	6.20 ±0.03#	1.36±0.05*	3.77±0.05#	4.78±0.13#
More than 70	1.53±0.03*	5.90±0.16*#	1.22±0.06*	3.75±0.32#	4.77±0.16#
Norm	<1.7	≤5.00	>1.00	<3.00	<3.8

Note: # – above normal; the differences are significant relative to the previous group * – p<0.05; ** – p<0.01.

The average content of serum TG ranged by age groups from 1,07 to 1,65 mmol/l and did not go beyond the normal values (Table 2). The minimum value of the average was recorded in the group of patients aged 20-29 years and it was significantly lower than in the following age groups (p<0.01). The maximum TG level was noted in the group of persons 40–49 years old (1.65±0.08 mmol/l).

The average values of IA, as a consequence of elevated TC levels increase with age. In the group of 20–29 years the minimum values of AI were observed (2.93±0.10 relative units) and since the age of 40 years, the AI was above the norm. In the age group of 50–59 year the values of this indicator are maximum – 4.90±0.11 relative units.

Thus, lipid metabolism in a person undergoes significant changes with age, which should be taken into account when taking preventive measures to reduce the risk of CVD developing.

Numerous international studies: 4S (Scandinavian Simvastatin Study), Framingham Study, MRFIT (Multiple Risk Factor Intervention Trial), PROCAM (Prospective Cardiovascular Munster Study) convincingly proved that CVD mortality directly depends on dyslipidemia (DLP) (Iso, 1989). DLP includes a wide range of disorders (Erem, Hacihasanoglu, Deger et al., 2008; Joshi, Anjana, Deepa et al., 2014), some of which are of great importance in the development of CVD.

This factor, both independently and in combination with other risk factors, can lead to the development of atherosclerosis. In recent years, the focus has been on identifying and correcting elevated levels of TC and LDL-C. However, it has already been proven that other forms dyslipidemia (hypertriglyceridemia and others) can lead to premature development of CVD (Ross, Glomset, 2006; Okamura, 2010). Dyslipidemia may have a different pathological meaning in some subgroups of patients. Disorders of lipid metabolism can be manifestations of other diseases (secondary dyslipidemia) or the result of the interaction of genetic predisposition with environmental factors.

According to the data obtained, all the examined patients with lipid metabolic disturbances had type 2b DLP. This type is characterized by an increase in the serum of TC, LDL-C, TG, VLDL-C and is often found in patients with secondary disorders of lipid metabolism. Carriers of this type of DLP have a high risk of developing atherosclerosis and CHD.

The classification considered does not take into account the content of HDL-C, although its level significantly affects the likelihood of developing CHD in people with DLP. In this regard, we used the classification proposed by the All-Russian Scientific Society of Cardiology [8], according to which the following DLP are considered atherogenic:

– hypercholesterolemia or elevated levels of TC, mainly due to elevated levels of LDL-C;
– hypertriglyceridemia (and, accordingly, VLDL cholesterol);
– combined hyperlipidemia, i.e. the combination of hypercholesterolemia and hypertriglyceridemia.

At present, the role of hypo-α-cholesterolemia – a reduced level of HDL-C - in the development of atherosclerosis is widely discussed.

The assessment of the frequency of occurrence of lipid metabolic disturbances in the studied population indicates their high dyslipidemia (hypertriglyceridemia and others) can lead to premature development of CVD (Ross, Glomset, 2006; Okamura, 2010). Dyslipidemia may have a different pathological meaning in some subgroups of patients. Disorders of lipid metabolism can be manifestations of other diseases (secondary dyslipidemia) or the result of the interaction of genetic predisposition with environmental factors.

The level of TC, exceeding those recommended by the All-Russian Scientific Cardiological Society (Diagnosis and correction..., 2017), was found in 62.75% of patients. Of these, borderline hypercholesterolemia occurred in 32.41±2.24% of cases, and high levels of TC - in 30.34±2.20%. More than a third of individuals also had elevated levels of LDL-C (Table 3).

Abnormally high levels of TG were observed in 24.37±1.55% of all patients. Against the background of atherogenic changes in the form of increased TC, TG and LDL-C, there was a reduced level of HDL-C – a factor of anti-risk of atherogenic disorders (47.36±1.66% of the examined). This is important due to the fact that lowering HDL-C levels in combination with atherogenic DLP increases the risk of developing coronary artery disease in the future.

Table 3. Frequency of lipid spectrum disorders among residents

Indicator	Target (Diagnosis and correction.... 2017)	Content. mmol/l.	Frequency of the indicator. %
TC	Normal	≤ 5.00	37.24±1.77
	The borderline	5.20–6.20	32.41±2.24
	High	> 6.20	30.34±2.20
TG	Normal	< 1.70	75.63±2.06
	The borderline	1. 70–2.30	12.64±1.6
	High	> 2.3	11.73±1.54
LDL-C	Normal	< 3.00	44.14±2.38
	The borderline	3.4–4.1	22.76±2.01
	High	> 4.1	33.10±2.26
HDL-C	Low	< 1.00	8.74±1.09
	The borderline	1.00–1.2	38.62±2.33
IA. relative units	High	> 3.8	67.36±2.25

The high incidence of elevated values of atherogenic LDL-C and a reduced level of protective HDL-C explains the wide distribution of IA high values, found in 67.36±1.98% of surveyed city residents (Table 3).

Thus, according to the results of the study, 79% of the examined males and females had DLP, and only 21% of the examined individuals showed normal lipid metabolism.

Atherogenic DLP was found in 69.88±2.20% of the examined, in 17.24±1.81% of whom combined DLP were diagnosed – lipid spectrum disorders requiring dynamic monitoring and prevention measures.

In the course of the study, a correlation analysis of the data was carried out, which made it possible to identify a moderate positive association of total blood TC with the TG level ($r = 0.33$, $p<0.001$) and weak with HDL-C ($r = 0.28$, $p<0.001$). The connection of TC with TG indicates the possibility of development among urban residents combined DLP. The strong and moderate association of TC levels with the calculated parameters of LDL-C ($r = 0.94$, $p<0.001$) and IA ($r = 0.45$, $p<0.001$) indicate an increase in a significant proportion of the TC due to atherogenic LDL-C.

Analysis of medical records, survey results and interviews with the surveyed showed that 72.10 ± 2.94% of the Barnaul residents had an unfavorable cardiovascular family history and a high prevalence of risk factors for atherogenic disorders. Excessive consumption of rich cholesterol and animal fats foods was indicated by 17.94±2.51% of males and females; 28.70±3.03% of the city residents noted the effects of severe psychological and mental overload; 38.57±3.25% had a significant intensification of the working day and the presence of additional loads. A reduced level of physical activity was revealed in 50.44±2.10% of cases.

Conclusion

Thus, in urban residents revealed a high incidence of combined DLP with a predominance of type 2b (atherogenic). This fact can be considered as the main predisposing risk factor for the CVD development against the background of the wide spread of the examined burdened heredity and behavioral factors (irrational nutrition, hypodynamia, etc.). The obtained data indicate the need for an active study of lipid metabolism disorders in the population with subsequent preventive interventions.

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