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The importance of BMI in early prevention of cardiovascular risk in young adult Poles

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Abstract

Background: The natural course of atherosclerotic processes in young adults and the common occurrence of risk factors in the Polish population necessitate the search for simple methods of assessing cardiovascular risk in the early stage of its development.

Purpose: To determine the relationship between Body Mass Index (BMI) and the cardiovascular risk assessment in a group of young adults in the early stage of threat development.

Methods: Observational studies were conducted in a group of 1,593 participants – 1,012 females (63.5%) and 581 males (36.5%) between the ages of 19-35 years (average: 22.16; SD=2.81), studying at university colleges in Lublin. Data were collected between October 2008 – March 2009 and analyzed in 2009 and 2010. The studies included demographics, anthropometric and blood pressure measures, and laboratory tests of lipid levels in blood serum. Algorithm Framingham Risk Score (FRS) was used to assess the overall cardiovascular risk.

Results: The average BMI value among respondents was 22.4 kg/m^2 (SD=3.46). The results of BMI correlation indicate highly significant positive correlation in the variables range: waist circumference ($r=0.7850$, $p <0.01$); gender ($r=0.4783$, $p < 0.01$); triglyceride level ($r=0.3422$, $p< 0.01$), LDL level ($r=0.2432$, $p< 0.01$), age ($r=0.1321$, $p< 0.05$) and negative relation in the range of HDL level ($r=-0.2618$, < 0.01). BMI correlative value with FRS grading was statistically significant ($r=0.2757$, $p < 0.01$).

Conclusions: Significant correlations between BMI and variables, and FRS, confirm its importance as an early cardiovascular risk marker.

Key words

cardiovascular risk, BMI, young adults, primary preventive

INTRODUCTION

There are many factors influencing the risk development of cardiovascular diseases (CVD). Factors of lifestyle resulting from the behavioural sphere of an individual's functioning are among the most important. They include a high-fat and high-energy diet, low physical activity, and smoking habit [1]. Metabolic risk factors, depending largely on lifestyle, include lipid disorders, hypertension, glucometabolic disorders and obesity [2]. Along with others, they create a structure of 24 global risk factors responsible for 44% of deaths in the world, and 34% of potentially lost years of life (DALYs). Five major global risks in relation to mortality worldwide are constituted by high blood pressure, smoking, high glucose level in blood, lack of physical activity, overweight and obesity [3], and all are closely related to CVD risk.

Natural course of atherosclerotic processes in young adults, confirmed by numerous biopsical and ultrasonographic studies [4, 5, 6, 7, 8, 9, 10, 11, 12] and also common occurrence of risk factors of the ischemic heart disease at young adults in Polish population, which is determined in Pol-MONICA bis 2002, NATPOL PLUS 2002, WOBASZ 2005 programmes [13, 14, 15, 16, 17], incline to seek for simple and effective methods of assessing cardiovascular risk in the early stage of its development.

Risk assessment is a key element in the quest to determine the prognosis of CVD development through estimation of significant risk markers in circulatory system diseases. The aim is to identify and assess the potential directions of therapy, implement therapy effectively, both in primary and secondary prevention, as well as to reduce treatment costs [18].

The recommended general risk assessment system – the algorithm SCORE (*European Systematic Coronary Risk Evaluation)*, used to assess 10-year risk of cardiac death – estimates the risk by use of the following factors: gender, age, total cholesterol level, systolic blood pressure and smoking [19], and is intended for the population aged over 40. In the population aged from 20, the algorithm *Framingham Risk Score* [20] can be used according to the recommendations of Expert Panel on Detection, Evaluation, and Treatment of

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High Blood Cholesterol in Adults and National Cholesterol Education Program [21]. In assessing 10-year risk of ischemic heart disease development, the following factors are used in accordance with the *Framingham Risk Score:* age, total HDL cholesterol, systolic blood pressure, hypertension treatment and smoking. Preliminary risk assessment, according to the rules set out in an ATP III report, uses the major risk factors to establish the total risk level. In comparing sensitivity and specificity of 3 different algorithms assessing the risk, namely, the *Framingham Risk Score*, the SCORE system and CVD risk, in a group of 25,059 respondents in the *FINRISK Study*, the risk assessment for different cardiovascular diseases in 10-year observation period showed that the peculiarity for different final scores was the highest in the *SCORE system* and the *Framingham Risk Score* by 20% of risk [22].

The presented study aimed to determine the relationship between BMI and the cardiovascular risk assessment in a group of young adults in the early stage of threat development of cardiovascular incidents.

METHODS

Procedure. Participants completed a demographic and clinical questionnaire after the objective and rules of partaking in the study were explained to them. Participation was anonymous and voluntary. Registered nurses conducted several health measurements as described below.

Data were collected between October 2008 – March 2009, and analyzed in 2009 and 2010.

Participants. Cross-sectional studies were conducted in a group of individuals studying at university colleges in the city of Lublin in southeast Poland. A convenience sample was recruited by a stratified-random group method. In the academic year 2008-2009 there were 11 university colleges with 85,911 students attending full-time and part-time undergraduate and postgraduate courses. This placed the city in 6th position as an academic centre in Poland with respect to the number of students. The total number of students in Lublin province at that time was 103,209; in Poland, the total number of students amounted to 1, 910, 979 [23].

Of the 85,911 students in Lublin, 50,217 were full-time (58.5%) and 35,694 were part-time students (41.6%). The research project was addressed only to full-time students due to the initial assumption of the programme, namely, assurance of comparable access conditions to free laboratorial examinations (offered free within the project) for tested students. A sample of 2,000 students was chosen from the total number of students, and 1,593 individuals (79.7%) voluntarily participated in the research. 426 students (26.7%) voluntarily accepted the invitation offered to the whole group (1,593 people) within the research programme, and undertook a free laboratory indication of lipids level in blood serum. The sampling procedure is presented in Figure 1.

Measurements. *Blood Pressure.* Blood pressure was measured in a seated position on upper right arm with the oscillometric method using the Omron M1 Classic model. Three readings 2 minutes apart were taken after a participant had been seated for 10 minutes. Depending on the arm's circumference, the appropriate cuff was chosen (small, medium or large). The average pressure value was based

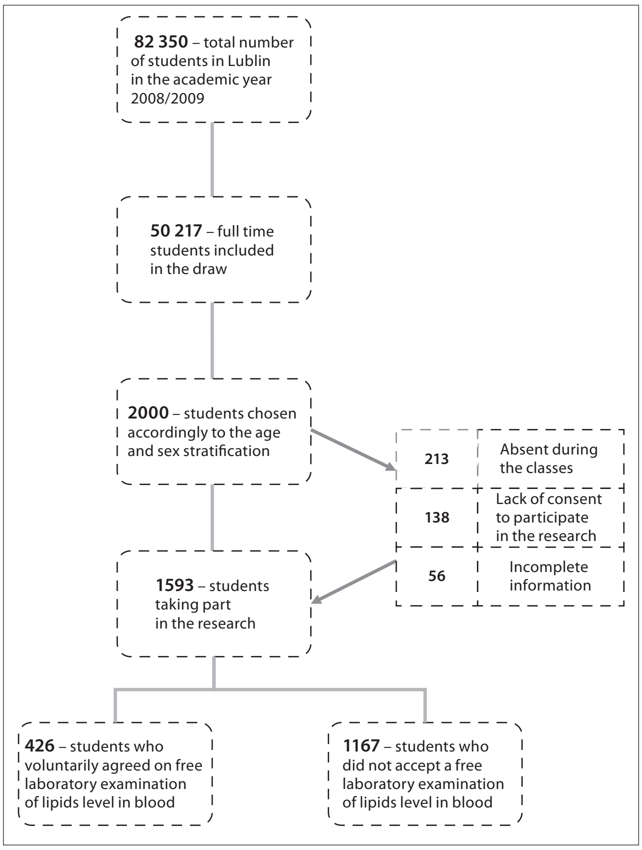

Figure 1. Plan and group selection diagram for cross-sectional survey

on the second and third readings. Data regarding current hypertension treatment was obtained from the questionnaire answers. The reading result was classified according to the standing classification [24], and differentiated in following manner: systolic blood pressure (SBP) SBP < 140 mmHg, diastolic blood pressure (DBP) DBP < 90 mmHg), including optimal (SBP < 120 mmHg, DBP < 80 mmHg), normal (SBP ≤ 120-129 mmHg, DBP ≤ 80-84 mmHg), high normal (SBP ≤ 130-139 mmHg, DBP ≤ 85-89 mmHg) and hypertension (SBP ≥ 140 mmHg and/or DBP ≥ 90 mmHg, and also early recognition of hypertension and taking hypertension medications).

Anthropometric Measures. Body mass was assessed with a standardized medical scales or a portable scales, certified by the Bauer company to the nearest 0.1kg. Height was measured with an altimeter to the nearest 0.5cm. Body mass index was calculated using the formula: BMI = kg/m^2. Three categories were distinguished: BMI < 25.0 kg/m^2 – normal weight, BMI from ≥ 25 – < 30 kg/m^2 – overweight, BMI ≥ 30 kg/m^2 – obesity [25]. Adipose tissue of waist circumference (WC) was measured to the nearest 0.5cm in the horizontal plane around the participant's waste at the level of the umbilicus. The normal waist circumference values accepted were < 80 cm for females and < 94 cm for males; the boundary values were ≥ 80 – < 88 cm and ≥ 94 – < 102 cm; abdominal obesity values were ≥ 88 cm and ≥ 102 cm for females and males, respectively [25].

Biological Health Indicators (Total Cholesterol, HDL-C, LDL-C, TG). A fasting lipid panel was analyzed using a venous blood serum sample in clinical laboratory conditions. Total cholesterol (TC), HDL cholesterol (HDL-C) and triglycerides (TG) were determined with the direct enzymatic method. Cholesterol LDL (LDL-C) was calculated with the Friedwald formula. For dyslipidemia, the following indicators were accepted: *hipercholesterolemia* – TC ≥5 mmol/l (≥190 mg/dl) and/or LDL-C ≥ 3,0 mmol/l (≥115 mg/dl), *hipertriglicerydemia* – TG ≥1.7 mmol/l (≥150 mg/dl) and low cholesterol HDL-C: HDL-C <1mmol/l (40 mg/dl) for males and <1.2 mmol/l (<45 mg/dl) for females [26, 27].

Assessment of overall cardiovascular risk. In order to estimate overall cardiovascular risk during the next 10 years, the *Framingham Risk Score* (FRS) was used [20]. The FRS tool uses the latest data from the Framingham Heart Study to estimate 10-year risk for myocardial infarction and coronary death. The calculator is designed for adults aged 20 and over who do not have heart disease or diabetes, and is based on the guidelines of *Third Report of the National Cholesterol Education Programme* (NCEP) [28], *Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults* [21]. It assesses the risk based on the following criteria: gender, age, total cholesterol level (TC), HDL cholesterol level, smoking, systolic blood pressure and taking hypertension medications.

Range of survey questions. The studies also included survey questions which concerned, inter alia, age, gender, place of residence, smoking, and anamnesis (treatment due to ischemic heart disease, hypertension, diabetes, medications, hypertension and coronary heart disease in first-degree relatives before the age of 60).

Statistical analysis. The results obtained were subjected to statistical analysis. Values of measurable parameters analysed were presented by mean value and standard deviation, and non-measurable ones by amount and percentage. Significance of variables correlation was examined by Pearson's correlation significance test (when both variables had normal distribution) and the Spearman's test (when one of the variables did not have normal distribution). Statistically significant correlation was p=0.05. The statistical analyses were conducted on the basis of STATISTICA 8.0 programme.

Opinion of Commission of Bioethics. The studies were conducted within own research financed by Medical University of Lublin. Research Grant No. PW 676/07-10 and the research procedure undertaken received the positive opinion of the Commission of Bioethics.

RESULTS

Demographics. Of the total number of participants – 1,593, the number of females amounted to 1,012 (63.5%) and males – 581 (36.5%). The age range was 19-35 years, the mean age – 22.2 (SD=2.8). 947 (59.5%) students were brought up in a city and 646 (40.5%) in the countryside. There were 415 (26.1%) students who smoked while the rest 1178 (79.0%) did not smoke. Anamnesis conducted showed that 80 (5.0%) students had been treated due to various diseases, namely, 9 people had hypertension, 5 – diabetes, 2 – supraventricular arrhythmia, 1 – heart valve regurgitation. Other common reasons for treatment were: bronchial asthma, allergy, discopathy, duodenal ulcer, hypothyroidism, anemia, kidney stones, epilepsy, chronic glomerulonephritis, hernia, gastro-oesophageal reflux disease, Lesniowski-Crohn's disease, visual impairments, malocclusion, and postural problems, among others.

Descriptive characteristics of variables. The average variable values, together with the basic descriptive characteristics in the group of respondents, are shown in Table 1. The mean values of systolic blood pressure were SBP – 118.72 mmHg (SD=13.11) and mean values of diastolic blood pressure were DBP – 71.5 mmHg (SD=9.35). The mean value for BMI was 22.4 m/kg^2 (SD=3.46). The range of mean values for lipids in blood serum was as follows: TC – 141.7 mg/dl (SD=60.86), HDL-C – 59.1 mg/dl (SD=22.06), LDL-C – 73.3 mg/dl (SD=34.62) and TG – 65,8 mg/dl (SD=35.13). The mean value for FRS indicator expressed in scores was 3.0 scores (SD=4.63).

Table 1. Descriptive statistics of variables

Variables	Mean	Standard deviation	Minimum	Lower quartile	Median	Upper quartile	Maximum
SBP I	118.72	13.11	60.00	110.00	120.00	125.00	180.00
DBP I	71.50	9.35	0.00	65.00	70.00	80.00	100.00
SBP II	116.35	13.66	0.00	110.00	117.00	125.00	180.00
DBP II	70.70	9.74	0.00	65.00	70.00	80.00	120.00
BMI	22.41	3.46	5.71	20.00	21.81	24.07	53.63
WHR	0.78	0.07	0.53	0.73	0.78	0.83	1.22
TC	141.69	60.86	13.00	132.00	157.00	177.00	276.00
HDL-C	59.12	22.06	1.00	53.00	63.00	74.00	111.00
LDL-C	73.32	34.62	1.00	59.00	77.00	91.00	173.00
TG	65.80	35.13	1.00	47.00	65.00	85.00	188.00
FRS/score	-3.03	4.63	-9.00	-7.00	-4.00	1.00	11.00
WC	78.24	10.65	52.00	70.00	77.00	85.00	135.00

In the detailed analysis, the distribution of particular variables was as follows: optimal values for systolic blood pressure (SBP < 120 mmHg) were observed at 43.6% respondents in reading I, and at 69.2% of respondents at reading II. The optimal values of diastolic blood pressure (DBP < 80 mmHg) were observed at 69.2% respondents in reading I and at 74.3% respondents at reading II. In the group of individuals with normal blood pressure (SBP ≤ 120-129 mmHg, DBP ≤ 80-84 mmHg – group II) there were 31.8% respondents in reading I, and 33.9% respondents in reading II with systolic blood pressure. With regards to diastolic blood pressure, there were 18.6% and 22.3% of respondents in readings I and II, respectively. High normal blood pressure (SBP ≤ 130-139 mmHg, DBP ≤ 85-89 mmHg – group III) was observed in 8.6% of respondents (reading I) and in 6.0% of respondents (reading II) with regards to systolic blood pressure, and at 5.4% of respondents (reading I) and 4.4% of respondents (reading II) with regards to diastolic blood pressure. The normal body weight with regards to BMI was identified in 77.2% of respondents. Overweight was observed in 15.2% students and obesity in 3.2% of respondents. The normal waist circumference (< 80 cm for females and < 94 cm

Table 2. Detailed results in the range of values for particular variables

Variables	Value range	n	%
SBP I	< 120	695	43.6
	≤ 120-129	540	33.9
	≤ 130-139	219	13.8
	≥ 140	139	8.7
Total		**1,593**	**100%**
DBP I	< 80 g	1,103	69.2
	≤ 80-84	355	22.3
	≤ 85-89	49	3.1
	≥ 90	86	5.4
Total		**1,593**	**100%**
SBP II	< 120	817	51.3
	≤ 120-129	506	31.8
	≤ 130-139	175	11.0
	≥ 140	95	6.0
Total		**1,593**	**100%**
DBP II	< 80 g	1,184	74.3
	≤ 80-84	296	18.6
	≤ 85-89	43	2.7
	≥ 90	70	4.4
Total		**1,593**	**100%**
WC	K< 80	794	78.5
	K≥ 80 to < 88	151	14.9
	K≥ 88	67	6.6
Total		**1,012**	**100%**
WC	M< 94	466	80.2
	M≥ 94 to < 102	81	14.0
	M≥ 102	34	5.9
Total		**581**	**100%**
WHR	K≤ 0.8	800	79.0
	K> 0.8	212	21.0
Total		**1,012**	**100%**
WHR	M≤ 0.95	544	93.6
	M> 0.95	37	6.4
Total		**581**	**100%**
TC	<190 mg/dl	345	81.0
	≥190 mg/dl	81	19.0
Total		**426**	**100%**
LDL	<115 mg/dl	378	88.7
	≥115 mg/dl	48	11.3
Total		**426**	**100%**
TG	<150 mg/dl	418	98.1
	≥150 mg/dl	8	1.9
Total		**426**	**100%**
HDL	K≥ 45 mg/dl	46	14.0
	K<45 mg/dl	281	85.9
Total		**327**	**100%**
HDL	M≥ 40mg/dl	35	35.4
	M<40 mg/dl	64	64.7
Total		**99**	**100%**
BMI	≥30kg/m²	51	3.2
	25-29,9kg/m²	242	15.2
	18.5-24.9kg/m	1,230	77.2
	<18.5 kg/m²	70	4.4
TOTAL		**1,593**	**100%**

for males) was observed in 78.5% of females and 80.2% of males. Waist circumference indicating abdominal obesity (≥ 88 cm for females and ≥ 102 cm for males) was found in 6.6% of females and 5.9% of males. In the group of people (n=426) undertaking the laboratory test to determine the level of blood lipids, a level of total cholesterol TC < 190 mg% was observed in 81.0% of respondents, and TC< 190≥ mg% in 19.0% of students. The value range of remaining lipids indicators in particular group is presented in Table 2.

In the group of people who reported to the laboratory and performed marking of lipids in blood serum, the cardiovascular risk indicator was determined according to *Framingham Risk Score (FRS)* scale n=426. Results are shown in Table 3.

Table 3. Distribution of individual cardiovascular risk in the *Framingham Risk Score (FRS)* scale n=426

FRS risk	Amount	%
<1	345	80.9
1	43	10.1
2	35	8.2
3	1	0.3
4	1	0.3
5	1	0.3

In the statistical analysis the correlation between variables was determined, and established that with regards to BMI there was a relationship between the following variables: age, gender, smoking, blood pressure, waist-to-hip ratio (WHR), waist circumference (WC), level of lipids in blood serum, and total cardiovascular risk on the *FRS* scale (Tab. 4).

Table 4. Correlation matrix between BMI indicator and the chosen variables (Spearman test and Pearson's correlations)

Variable	r (correlation coefficient)	p (significance level)
Age	0.1321	< 0.05
Gender	0.4783	<0.01
Smoking	0.3147	<0.01
SBP I	0.2721	< 0.01
DBP I	0.2183	< 0.01
SBP II	0.2948	< 0.01
DBP II	0.2390	< 0.01
WHR	0.783	< 0.01
TC	0.1792	< 0.01
HDL-C	-0.2618	< 0.01
LDL-C	0.232	< 0.01
TG	0.3422	< 0.01
WC	0.7850	< 0.01
FRS	0.2757	< 0.01

The results of analysis indicate that the correlation between age and BMI value was low, $r = 0.1321$, although it was statistically significant ($p<0.05$). The significant ($p<0.01$) correlation was found between BMI values and respondents' gender. There were 89% of females and 68% of males belonging to the group with <25 kg/m². In the group with 25-30 kg/m² there were 9% of females and 26% of males.

In the group with > 30 kg/m², females constituted 2% and males 5%. It was therefore observed that there is higher obesity level in males than in females.

All correlations between BMI and other medical variables proved to be statistically significant ($p<0.01$), except for the correlation with waist circumference ($r = 0.7850$). Of the other correlations, the relationship of BMI with WHR ($r = 0.4783$) and BMI with triglycerides level ($r = 0.3422$) was considerably high. BMI value was positively correlated with LDL ($r = 0.2432$), and at the same time, negatively correlated with HDL ($r = -0.2618$).

The correlation between FRS and BMI was low and was equal to 0.2752. It was statistically highly significant ($p<0.01$) (Fig. 2).

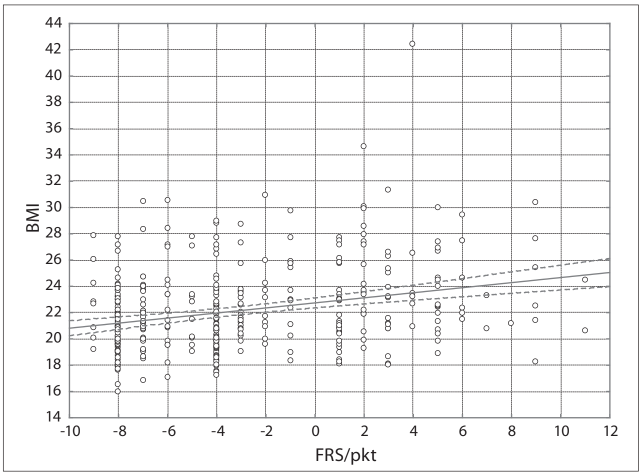

Figure 2. Correlation graph between BMI indicator and FRS cardiovascular risk increase in an examined group ($p < 0.01$)

DISCUSSION

Cardiovascular risk assessment is the basic element in seeking to identify the intensity of CVD risk factors and in assessing potential therapy aims, both in primary and secondary prevention of cardiovascular system diseases, and in order to raise public awareness. The value of identified risk indicator becomes the transmission of knowledge about existing danger of developing CVD in the strategy of individual and group activities, and also motivates people to follow the recommended lifestyle changes or treatment. In clinical practice, algorithms of risk forecast are used in the most direct way to identify people at high risk of circulatory system diseases in the short term [18]. On the other hand, in long-term preventive action, the early identification of developing CVD risk is important, as well as the early undertaking of effective interventions.

The indirect way of cardiovascular risk assessment has become an increasingly popular activity in the area of preventive cardiology. However, there are ongoing research and verification arrangements about the differences in sensitivity and specificity of various scales assessing CVD risk, and their ability to detect people with high risk in daily practice [22, 29].

The most popular proposals of simplified ways to assess cardiovascular risk are BMI indicators [30, 31, 32] and resting heart rate [33]. Although there are reports regarding controversies in relations between BMI in the range of overweight and obesity and total death risk [34, 35], most agree that obesity is related to many adverse changes in the risk factors of atherosclerosis development [36, 37, 38]. A number of studies have documented the association between obesity and cardiovascular disease (CVD) risk factors [39, 40], and some, but not all, with markers of subclinical CVD [41, 42, 43]. The obesity epidemic has the potential to reduce further gains in the US life expectancy [44], largely through an effect on CVD mortality [45, 46].

The results of own studies indicate the significance of correlations of the BMI indicator with important determinants in a group of young adults, as the risk factors of CVD. Hence, it is particularly important in the primary prevention of the development of cardiovascular changes.

Data in published studies indicate that overweight is related to a significant increase in the frequency increase of CVD risk factors, including type 2 diabetes, hypertension [47, 48, 49, 50, 51], and dyslipidemia [48]. Many reports also show that the risk of diabetes is significantly increased with overweight and obesity in different age groups [47, 48, 49, 52]. Overweight is related to hypertension; some studies confirmed an increase in relative risk of 1.4-1.7 [48, 50]. In a group of Caucasian women, aged 30-55, it was claimed that the relative risk of hypertension increased to 2.6 for BMI 25.0-25.9 kg/m² (95% CI 2.3-2.8), and to 4.2 for BMI 28.0-30.9 kg/m² (95% CI 3.9-3.6) during 16 years of observation in comparison to BMI <20,0 kg/m² [53]. According to Polish population data in the LIPIDOGRAM 2004 research, hypertension concerns 50.9% of examined Poles between the ages of 30-98. Moreover, a mutual relationship was found between the level of hypertension and BMI value, except in the subgroups with underweight and normal body weight where the risk of hypertension was similar [54].

Overweight is related to increased risk of other important undesirable effects, besides overall mortality, and frequently it is a preview of developing obesity and its negative consequences. Therefore, it is important to pay attention to the overweight and obesity factor, especially in their relationship with other CVD risk factors, such as type 2 diabetes or hypertension, and to intervene in body mass loss as a part of primary therapeutic procedure [55, 56].

Both healthy eating habits and physical activity play important role in managing the control of body mass and the potential CVD risk. This should be intentionally used as a vital tool for cardiovascular health promotion, consistent with the 'definition of Ideal Cardiovascular Health' [57] in its early development phase. It is particularly significant with regards to the group of young adults who begin to create their own lifestyle, which is the basis for the development of further health threats. In the domain of public health, increasing awareness and the change of habits require effective communication allowing the reduction of individual CVD risk with regards to the broader population [58, 59].

Study limitations. The study has several limitations. As mentioned above, our data cannot constitute an indicator of assessment of studied variables, FRS risk profile and diagnostic trends in a total population of young adults in Poland, because the data concerned only the subpopulation of one academic centre. Moreover, the information collected about subclinical assessment of atherosclerosis processes in young adults had quantitative and qualitative values, but were not verified with an ultrasound examination of vessels, taking into account the structure and intima-media complex thickness. The studies still need to focus on improving our understating of these phenomena which promote the development of cardiovascular risk in early stage of their formation, along with psychosocial factors. The strengths of this study include creation of common ground in building the investment in health strategy in a group of young adults, and also the detailed presentation of variables for assessing CVD risk in that group.

Implications for preventive cardiology practice. The findings of the study confirm the necessity to assess the risk since early adolescence as a practical category in preventive cardiology, and in the theoretical preparation of youth to raise their collective awareness. This should include awareness of CVD risk and creation of the attitude of investment in maintaining health in the context of active counteraction to developing health risks during life changes. The results obtained indicate that it is necessary to maximize efforts in order to assist in increasing healthy behaviours, and removing barriers for the maintenance and protection of a normal healthy body mass.

CONCLUSION

The significant correlations between Body Mass Index (BMI) indicator and factors such as gender, smoking, blood pressure, waist circumference, WHR indicator, biological health indicators (Total cholesterol (TC), HDL cholesterol (HDL-C), triglycerides (TG)), and algorithm Framingham Risk Score (FRS) indicator, confirms its significance in primary prevention of heart diseases in a group of young adults as important cardiovascular risk marker in the early phase of its development.

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