PROGNOSTIC VALUE OF DIFFERENT OBESITY MARKERS FOR CARDIOVASCULAR RISK ASSESSMENT IN URBAN EMPLOYED MONGOLIANS

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We assessed the prevalence of obesity and identify obesity-related markers of elevated/high cardiovascular risk among urban employed Mongolians. 1277 railway workers aged 18-63 were investigated. Obesity parameters, blood pressure, lipids and fasting plasma glucose levels were measured. Body composition by bioelectrical impedance method was evaluated. 10-year risk for cardiovascular events was calculated. The results showed that the prevalence of general obesity was 65,4% in men and 68,5% in women. Abdominal obesity was found in 58,5% of men and 76.1% of women. By ROC-analysis we revealed the obesity-related markers with the best diagnostic accuracy for elevated/high cardiovascular risk assessed by the Systematic Coronary Risk Evaluation, Framingham Heart Study and Atherosclerotic Cardiovascular Disease risk algorithms. For men they were waist circumference waist-to-height ratio, for women — the body fat percentage. The optimal cut off values for these predictors and corresponding odds ratios for risk increase were determined.

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Key words: obesity, cardiovascular risk, Mongolians, bioelectrical impedance, waist-to-height ratio.

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AO — abdominal obesity, ASCVD — atherosclerotic cardiovascular disease, AUC — area under curve, BMI — body mass index, BP — blood pressure, CI — confidential interval, CV — cardiovascular, CVD — cardiovascular diseases, FRS — Framingham risk score, IR — interquartile range, Me — median, ROC — receiver operating characteristics, SCORE — Systematic Coronary Risk Evaluation, WC — waist circumference, WHp-R — waist-to-hip ratio, WHt-R — waist-to-height ratio.

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ПРОГНОСТИЧЕСКОЕ ЗНАЧЕНИЕ РАЗЛИЧНЫХ МАРКЕРОВ ОЖИРЕНИЯ ДЛЯ ОЦЕНКИ РИСКА СЕРДЕЧНО-СОСУДИСТЫХ ЗАБОЛЕВАНИЙ У РАБОТАЮЩИХ МОНГОЛОВ В ГОРОДСКОЙ СРЕДЕ

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Мы оценили распространенность ожирения и выявили маркеры, связанные с ожирением и повышенным/высоким риском сердечно-сосудистых заболеваний среди работающих монголов в городской среде. 1277 железнодорожников в возрасте 18-63 были обследованы. Были измерены параметры ожирения, артериального давления, уровни липидов и глюкозы плазмы крови натощак. Оценивали строение тела методом биоэлектрического импеданса. 10-летний риск сердечно-сосудистых событий был рассчитана. Результаты показали, что распространенность ожирения была у 65,4% мужчин и у 68,5% женщин. Абдоминальное ожирение найдено у 58,5% мужчин и у 76,1% женщин. С помощью ROC-анализа мы выявили ожирение-связанные маркеры с лучшей диагностической точностью для повышенного/высокого сердечно-сосудистого риска, оцениваемого SCORE, Фремингемским исследованием и шкалой ASCVD. Для мужчин это было отношение окружности талии к росту, для женщин — процент жира в организме. Были определены оптимальные значения этих предикторов и соответствующий показатель отношения шансов для роста рисков.

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Ключевые слова: ожирение, сердечно-сосудистый риск, монголы, биоэлектрический импеданс, отношение окружности талии и роста.

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Obesity presents one of the most acute medical and social problems in most countries of the world. Obesity revealing and relationships of its forms vary in different populations, the main reasons for that being ethnicity, differences in dietary patterns, the volume of physical activity, urbanization degree and profession. Obesity contributes immensely into the total risk of cardiovascular (CV) morbidity and mortality. Various obesity forms are differently related to CV risk. Specifically, waist circumference (WC) is of greater prognostic significance than the body mass index (BMI) [1]. However, in various populations the character of relationships between obesity parameters and CV risk has essential variations. So, in Asia as compared to European countries, the CV morbidity growth is associated with lower BMI [2]. This fact points out the need for distinguishing in different ethnic groups obesity markers most informative in CV risk assessment. In Mongolians obesity and overweight prevalence is scantily known while among employed population and railway employees in particular, it remains obscure. Obesity relationships with the degree of CV risk have not been studied yet. All these dictated the objective of the research as to assess the prevalence of obesity and identify obesity-related markers of elevated CV risk among urban employed Mongolians.

Material and methods

1277 Ulaanbaatar Railway employees (737 male and 540 female) were investigated. All participants were informed about the aim, character, methods and possible

consequences of the research and gave the informed consent for the study. The study protocol was approved by the local ethic committee of Irkutsk State Medical Academy of Continuing Education. From all the subjects under study anthropometric and blood pressure (BP) measurements were taken; lipids and fasting plasma glucose levels were determined by conventional methods. BMI was derived by the formula: weight in kg/height^2 in meters. Obesity was diagnosed by Western Pacific Region (WPRO) criteria for Asians. At BMI from 23,0 to 24,9 kg/м^2 the body mass was considered overweight. Obesity I was diagnosed for BMI between 25-29,9 kg/m^2 and obesity II at BMI ≥30 kg/m^2. Abdominal obesity (AO) was diagnosed for WC ≥90 cm in men and ≥80 cm in women. Waist-to-hip (WHp-R) and waist-to-height (WHt-R) ratios were calculated. The body and visceral fat percentage were evaluated by bioelectrical impedance analysis with the use of the body composition monitor Omron KaradaScan HBF-361 ("Omron", Japan). Histories of smoking, diabetes and established CV diseases (CVD) were taken into account. The prevalence of obesity and overweight were determined in the study sample.

We calculated the risk of CVD events by three scales. A 10-year risk for fatal CVD events by the SCORE (Systematic Coronary Risk Evaluation) algorithm for high risk regions was assessed in 668 persons (326 men and 342 women) after having excluded patients with diabetes (n=40), fasting glucose level ≥7,0 mmol/l (n=63), previous myocardial infarction (n=11), angina pectoris (n=62), systolic BP >180 mmHg (n=37) as well as persons younger 40 (n=396). By SCORE<1% the CV risk was considered low, in the range from 1 to 4% — moderate, and at ≥5% — high/very high. A 10-year CVD events risk according to Framingham risk score (FRS) was calculated in 1095 persons, 602 males and 493 females, aged 30 and older without established CVD. By FHS<10% the CV risk was considered low, at the values from10 to 19% — moderate, and at ≥20% -high. A 10-year risk for a first hard atherosclerotic CV disease (ASCVD) event was also assessed by means of 2013 ACC/AHA risk calculator in 763 persons (385 men and 378 women) aged 40 and over without previous myocardial infarction and angina pectoris. The risk was stated as elevated at the value of ≥7,5%.

The diagnostic accuracy of each obesity marker for increased CV risk was evaluated through receiver operating characteristics (ROC) analysis. The areas under curve (AUC ± standard error) were used to identify the obesity index with the best classification properties. The optimal cut-off values were detected as the point at which the value of "sensitivity + specificity — 1" was maximum [3]. The odds ratios (OR) of the CV risk increase were calculated by univariate logistic regression analysis. Data analysis was done by Statistica 8.0 analysis software ("Statsoft", USA) and SPSS Statistics 19.0 ("IBM", USA). Mean values are expressed as median (Me) and interquartile range (IR). The sign prevalence in the sample was displayed by% and 95% confidential interval (CI). As distribution of variables was different from normal the Mann-Whitney *U* test was used to assess the differences. We applied *Chi*-square test for evaluating the relative values differences. *P*-value of less than 0.05 was used to assess the significance.

Results

A total of 1277 people (737 men and 540 women aged from 18 to 63) were enrolled in the study. The mean age was 42,0 (34-48) years, 40,0 (32-46) in men and 44,0 (38-49) in women (p<0,001). The prevalence of obesity and overweight is given in Table 1.

As can be seen from Table 1 the obesity prevalence by BMI according to WPRO criteria in Mongolian railway employees was rather high and amounted to 65,4% in men and 68,5% in women.

We determined the 10-year CVD events risk by three scales — SCORE, FRS and ASCVD among Mongolian urbanized employed population (Table 2).

The ROC-analysis results are presented in Table 3. Because the number of women at high CV risk was not

Table 1

The obesity prevalence and severity

Obesity marker	Men		Women	
BMI, kg/m^2, Me (IR)	27,3	(23,9-30,7)	27,2	(24,1-30,8)
BMI 23,0 to 24,9 kg/м^2,% (CI)	16,0	(13,2-18,8)	13,7	(10,6-16,8)
BMI 25,0 to 29,9 kg/м^2,% (CI)	36,0	(32,4-39,6)	38,1	(33,9-42,4)
BMI ≥30,0 kg/м^2,% (CI)	29,4	(26,0-32,9)	30,4	(26,3-34,4)
Waist circumference, cm, Me (IR)	92,0	(83,0-101,0)	89,0	(80,0-98,0)*
Abdominal obesity,% (CI)	58,5	(54,8-62,2)	76,1	(72,3-79,9)#
Waist-to-hip ratio, Me (IR)	1,0	(0,9-1,0)	0,9	(0,9-1,0)*
Waist-to-height ratio, Me (IR)	0,58	(0,54-0,61)	0,62	(0,57-0,65)*
Body fat,%, Me (IR)	27,0	(22,4-31,6)	35,5	(31,4-39,4)*
Visceral fat,%, Me (IR)	12,5	(8,5-18,0)	9,5	(6,0-14,5)*

* — p Mann-Whitney<0,001; † — pχ^2 <0,001.

Abbreviation: BMI — body mass index.

Table 2

The estimated CV risk in employed urbanized Mongolians

Risk scale	Men		Women	
SCORE,%, Me (IR)	3,0	(2,0-4,0)	0,0	(0,0-1,0)*
SCORE 0-1%,% (CI)	3,4	(1,1-5,6)	52,1	(46,5-57,6)#
SCORE 1-4%,% (CI)	71,5	(66,3-76,7)	46,8	(41,2-52,4)#
SCORE ≥5%,% (CI)	25,2	(20,1-30,2)	1,2	(0,0-2,6)#
FHS,%, Me (IR)	6,0	(3,4-10,9)	2,9	(1,7-5,5)*
FHS <10%,% (CI)	71,6	(68,8-75,4)	90,5	(87,7-93,3)#
FHS 10-19%,% (CI)	19,4	(16,1-22,8)	7,3	(4,8-9,8)#
FHS ≥20%,% (CI)	9,0	(6,5-11,4)	2,2	(0,7-3,7)#
ASCVD,%, Me (IR)	3,3	(1,7-6,4)	1,0	(0,5-1,9)*
ASCVD≥7,5%,% (CI)	19,0	(14,8-23,1)	1,6	(0,1-3,1)#

* — p Mann-Whitney<0,001; † — pχ^2 <0,001.

Abbreviations: SCORE — Systematic Coronary Risk Evaluation, FRS — Framingham risk score, ASCVD — risk for a first hard atherosclerotic CV disease.

Table 3

Diagnostic accuracy of obesity parameters for elevated/high CV risk (areas under curves)

Obesity marker	Risk scale				
	SCORE ≥1% women	SCORE≥5% men	FHS ≥10% women	FHS ≥20% men	ASCVD≥7.5% men
BMI, kg/m^2	0,592±0,03	0,606±0,04	0,651±0,04	0,558±0,04	0,554±0,04*
WC, cm	0,579±0,03*	0,593±0,04	0,686±0,04	0,646±0,04	0,655±0,04
WHp-R	0,502±0,03*	0,542±0,04*	0,637±0,05*	0,615±0,04	0,623±0,04
WHt-R	0,606±0,03	0,630±0,04	0,643±0,05*	0,608±0,04	0,601±0,04
Body fat,%	0,658±0,03	0,58±0,04	0,745±0,04	0,601±0,04	0,579±0,04
Visceral fat,%	0,632±0,03	0,607±0,04	0,703±0,04	0,591±0,04	0,581±0,04

* — p<0,05 for differences between the largest and given AUC.

Abbreviations: BMI — body mass index, WC — waist circumference, WHp-R — waist-to-hip ratio, WHt-R — waist-to-height ratio.

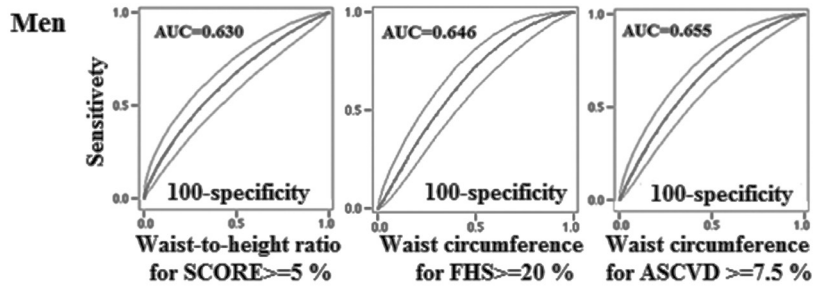
enough for correct estimation, calculations were performed in men at high risk by SCORE≥5%, FRS≥20% and ASCVD≥7,5%, and in women at moderate risk by SCORE≥1%, FRS≥20% и ASCVD≥7,5%.

For obesity markers with the largest AUC we determined cut-off values at which the optimal ratio of sensitivity and specificity is obtained. Odds ratios of CV risk increase in patients with obesity indices exceeding identified thresholds were calculated (Figure 1). Thus we defined the obesity markers of the highest accuracy for the increased CV risk prediction.

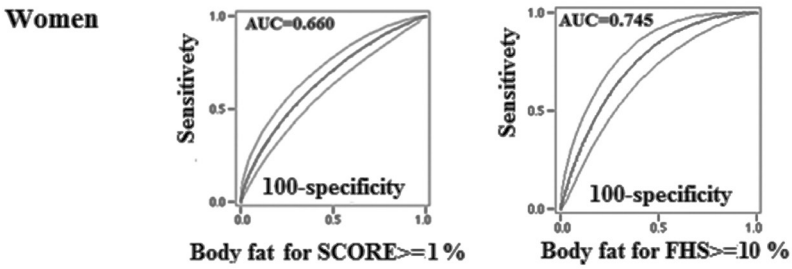
Discussion

We found a high prevalence of obesity in working urban Mongolians, as we have previously reported [4]. According to other authors overweight and obesity are more common in Mongols than in other Asian populations. Thus, among employed Japanese obesity by BMI ≥30 kg/m^2 was revealed only in 1,9% of men and 2,6% of women, and among Koreans — in 4,3% and 4,0%, respectively [5]. In the adult urban population of China the prevalence of AO was also rather small — in 42,6% of men and 45,7% of women [6]. These differences can be explained by traditional dietary habits of Mongolians, which differ in high amounts of high caloric meat products, saturated fats, oils, whole milk and sweets in daily diet. In addition, since the 1990s Mongolia has experienced a rapid urban population growth and significant changes in diet towards increased consumption of potatoes, refined grains, desserts, while sticking to the main part of meat and dairy products. Alcohol consumption has considerably increased along with the decline in physical activity. It is obviously these processes that can be related to the increased prevalence of obesity in Mongols in recent years.

However the above reasons do not account for the discrepancy between the data for obesity prevalence received from our research and those reported earlier in relation to the Mongolian population. So, in adult Mongolians BMI in the range of 25.0-29.9 kg/m^2 was reported in 31-36% of cases while BMI ≥30 kg/m^2 — in 7-24% [7], which is less common in comparison to the data received from our study sample. The revealed AO prevalence in our study was also found higher than that of the research by D. Otgontuya (2009), who reported it to be 46,1% in men and 65,1% in women of Mongolia. This discrepancy may be ascribed to the professional factor impact. The railway employees' professional activity is known to be characterized by psycho-



Cut-off value	0.59	93 cm	94 cm
Sensitivity/ specificity (%)	53.8/64.8	72.5/49.8	69.0/53.4
OR (95 % CI)	1.8 (1.1-3.0)	3.7 (1.9-7.4)	3.2 (1.8-5.6)



Cut-off value	37 %	37 %
Sensitivity/ specificity (%)	55.4/67.2	75.6/60.4
OR (95 % CI)	2.5 (1.6-3.8)	3.8 (1.9-7.4)

Figure 1. ROC-curves, areas under curve, cut-off values, odds ratios and sensitivity/specificity indices of the most informative obesity markers for elevated/high CV risk.

emotional overload, night shift work, increased levels of noise and vibration. These can result in chronic professional stress, which is, in its turn, an obesity risk factor [8, 9]. Overweight is also linked to the fact that railway employees usually live in cities taking up a "westernized" mode of life. This considerably changes a dietary pattern, widens the range of harmful habits, diminishes physical activity.

So, the combination of traditional food patterns, urbanization and professional factors is likely to result in such a high degree of obesity prevalence reported for our study sample. To answer the question whether this fact is associated with CV risk among the Mongols we pioneered in calculating 10-year CV event risk among the employed urbanized Mongolian population on three different scales — SCORE, FHS and ASCVD. It turned out that the risk mean value in men as well as the proportion of individuals with high risk was higher than in women for any of the scales. Noteworthy is the fact that most of men aged 40 years and older were found at high and very high CV risk. These data are confirmed by the work of other authors who stated the risk from SCORE≥5% and PROCAM≥20% in the locomotive crew to be 16% and 25% respectively, which is more frequent than that in individuals under low occupational stress [10]. According to the Framingham scale, the proportion of patients with high risk (≥20%) was relatively small which can be explained by younger average age of the given study sample — patients from 30 years old. It should be noted that the predictive accuracy of the scales we used for the Mongolian population was assessed earlier only for risk on the Framingham scale. According to the data received the current 10-year risk among residents of Inner Mongolia (China) amounted to 8,5% and was lower than the observed CC event frequency (13,4%) [11].

In this study we have determined which of the obesity parameters best predict the rise in CV risk. We emphasize that none of the markers for obesity was used at the stage of calculating the risk. The most informative indices for identifying high CV risk among the male population of Mongolia turned to be WHt-R (for SCORE≥5%) and WC (for FHS≥20% and ASCVD≥7,5%). Thus, the risk of CV events in men was associated with AO. The maximum area under the ROC curve is marked for a new system of risk prediction ASCVD, developed by the American College of Cardiology/American Heart Association (2013), which indirectly proves the applicability of this scale in male Mongols.

It is significant that calculated in our study the cut-off (threshold) values of WC as a factor of high CV risk were 93-94 cm, which are higher than the WPRO criteria for Asians (>90 cm) and almost the same as AO criterion for male Europeans (>94 cm) [12]. This, apparently, is not accidental: according to other studies the Mongols are more in line with the overweight criterion for WHO (BMI≥25,0 kg/m^2), than WPRO criterion for Asians (BMI≥23,0 kg/m^2) [13]. The WHt-R index in Mongol males was found to have the greatest prediction relevance by SCORE in comparison with the traditional BMI and WHp-R. Our data confirm the results of the recently published works, which reveal a better ability of WHt-R to predict the CC events [14].

Unlike men, among employed Mongolian women the total body fat index according to bioimpedance analysis was found to offer the most predictive efficiency. Clinical significance of body composition has in recent years actively investigated. However, rare studies are devoted to interrelation of body composition and CV risk [15]. According to our data the total fat content ≥37% increases by 2,5 to 3,8 times the development of elevated CV risk in women for European and Framingham scales, respectively. This fact justifies the possibility of easy and affordable bioimpedance method in assessing the CV risk in women.

Conclusion

We revealed a high prevalence of obesity among the Mongolian urbanized employed population. There was a significant proportion of men at a high cardiovascular risk, estimated by SCORE (25,2%), Framingham Risk Score (9,0%) and AHA/ACC 2013 Atherosclerotic Cardiovascular Disease risk (19,0%) algorithms. In men according to the ROC-analysis results the following abdominal obesity markers closely associated with high cardiovascular risk were: the waist-to-height ratio and the waist circumference. In women the whole body fat percentage evaluated by bioelectrical impedance analysis proved to be the best predictor for increased risk of cardiovascular events. In men the cardiovascular risk significantly rises with the waist circumference ≥93 cm and the waist-to-height ratio ≥0.59. In women it increases with the body fat volume ≥37%. Prognostic power of conventional obesity parameters such as body mass index and waist-to-hip ratio appeared to be insufficient for the effective cardiovascular risk screening in Mongolians.

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