METABOLIC SYNDROME IN A MONGOLIAN WORKING POPULATION

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Aim. In this study we evaluated the metabolic syndrome (MetS) prevalence and its structure in Mongolian urban employed population.
Material and methods. The prevalence of MetS, defined by IDF (2005), JIS (2009) and modified NCEP ATP III (2004) criteria, was estimated in 1277 Mongolian railway workers (737 men and 540 women) aged 18 years or older.
Results. The MetS prevalence by IDF (2005) definition was found to be 36,1% in men and 39,6% in women, by JIS (2009) — in 38,9% and 40,9% and by NCEP ATP III (2004) — in 25,1% and 35,0% respectively. Abdominal obesity was the most common component (58,5% in men and 76,1% in women) as well as a constellation of abdominal obesity, elevated blood pressure and high serum triglycerides was the most common variant in MetS structure (51,9% in men and 30,4% in women).
Conclusion. Mongolian railway employees were characterized by high rate of MetS, which can be accounted for professional stress and changes in the lifestyle due to urbanization. The highest common components of MetS were found to be abdominal obesity, hypertension and hypertriglyceridemia.

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Key words: metabolic syndrome, central obesity, dyslipidemia, hypertension.

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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, DM2 — type 2 diabetes mellitus, FG — fasting plasma glucose, HDL-C — high-density lipoprotein cholesterol, HTN — arterial hypertension, LDL-C — low-density lipoprotein cholesterol, M — mean, MetS — metabolic syndrome, SD — standard deviation, TG — triglycerides, WC — waist circumference.

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МЕТАБОЛИЧЕСКИЙ СИНДРОМ СРЕДИ МОНГОЛЬСКОГО РАБОТАЮЩЕГО НАСЕЛЕНИЯ

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Цель. В данном исследовании мы оценивали метаболического синдрома (МС) распространенность и структура монгольского городского занятого населения.
Материал и методы. Распространенность МС, определяемая критериями IDF (2005), JIS (2009) and modified NCEP ATP III (2004), оценивалась у 1277 монгольских железнодорожников (737 мужчин и 540 женщин) в возрасте от 18 лет и старше.
Результаты. Распространенность МС по IDF (2005) была признана у 36,1% у мужчин и 39,6% женщин, по стандарту JIS (2009) — в 38,9% и 40,9%, и по modified NCEP ATP III (2004), соответственно. Абдоминальное ожирение является наиболее распространенным компонентом (58,5% у мужчин и 76,1% женщин), а также сочетание абдоминального ожирения, повышенного артериального давления и высокого уровня триглицеридов сыворотки было самым распространенным вариантом при МС (51,9% мужчин и 30,4% у женщин).
Заключение. Для монгольских железнодорожников характерен более высокий темп развития МС, который может быть следствием профессионального стресса и изменения образа жизни в связи с урбанизацией. Самыми распространенными компонентами МС оказались абдоминальное ожирение, артериальная гипертензия и гипертриглицеридемия.

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Ключевые слова: метаболический синдром, центральное ожирение, дислипидемия, артериальная гипертензия.

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Metabolic syndrome (MetS) is a clustering of abdominal obesity (AO), arterial hypertension (HTN), dyslipidemia and impaired carbohydrate metabolism. Clinical and prognostic significance of MetS as it is the expediency of its scientific consideration have lately become the subject of considerable discussion. Still it is common knowledge that on the one hand, the combination of risk factors mentioned above is not incidental, and on the other — it significantly increases the risk for type 2 diabetes mellitus (DM2) and cardiovascular diseases.

The MetS prevalence varies considerably in different populations and depends for the most part on the diagnostic criteria employed. In some ethnic groups, Mongolians in particular, the syndrome prevalence is scantily known, whereas among the urban employed population it remains obscure. Professional activity of the railway workers is characterized by a high psycho-emotional tension. Furthermore, most of them living in cities acquire "western" lifestyle. It is still unclear whether these factors affect the frequency of cardiometabolic risk factors resulting in MetS in Mongolians. Lastly, there are no studies on variants and ethnic character of correlations between different MetS components in Mongolians compared to other populations. In connection with the above the aim of our work was to study the MetS prevalence and its structure in Mongolian urban employed population.

Materials and methods

The study subjects were the Ulaanbaatar Railway employees, both male and female, residents of seven cities of Mongolia working at six Transmongolian Railway stations (Sükhbaatar, Darkhan, Dzüünharaa, Ulaanbaatar,

Table 1

Anthropometric and clinical characteristics of the study group

Parameter	Whole group n=1277		Men n=737		Women n=540		P-value*
	Mean (SD)		Mean (SD)		Mean (SD)		
Age, years	41,0	(9,2)	39,6	(9,4)	42,9	(8,6)	<0,01
WC, cm	91,0	(12,8)	92,2	(12,4)	89,3	(13,3)	<0,01
BMI, kg/m^2	27,6	(4,9)	27,5	(4,6)	27,9	(5,2)	0,42
Pack/years index	1,6	(4,6)	2,6	(5,7)	0,3	(1,4)	<0,01
TC, mmol/l	4,7	(0,8)	4,7	(0,7)	4,7	(0,8)	0,16
LDL-C, mmol/l	2,4	(0,6)	2,4	(0,6)	2,4	(0,7)	0,77
HDL-C, mmol/l	1,5	(0,3)	1,5	(0,3)	1,5	(0,3)	0,06
TG, mmol/l	1,7	(0,6)	1,7	(0,6)	1,6	(0,6)	<0,01
FG, mmol/l	5,2	(1,9)	5,3	(2,0)	5,1	(1,9)	<0,01
SBP, mmHg	127,4	(20,2)	129,7	(19,0)	124,3	(21,4)	<0,01
DBP, mmHg	81,4	(11,5)	82,5	(10,2)	80,0	(13,0)	<0,01

* — for the differences between male and female groups

Abbreviations: WC — waist circumference, BMI — body mass index, TC — total cholesterol,LDL-C — low-density lipoprotein cholesterol, HDL-C — high-density lipoprotein cholesterol, TG — triglycerides, FG — fasting glucose, SBP and DBP — systolic and diastolic BP.

Choir, Sainshand and Zamyn-Üüd). Altogether 1500 questionnaires were sent. The response rate totaled 85,1% (1277 persons, 737 male and 540 female). The dominant ethnicity reported was Mongolians (96,1%). All patients 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.

Weight and height were measured with calibrated digital weighing scales and a height bar. The waist circumference (WC) was measured with measurement tape horizontally after a number of successive breaths at the point midway between the iliac crest and the costal margin (lower rib). Measurements were taken by trained nurses. AO was diagnosed by two criteria: AO_{80-90} — for Asian residents with WC ≥80 cm in women and ≥90 cm in men [1], AO_{88-102} — with WC≥88 cm in women and ≥102cm in men by criteria NCEP ATP III [2]. BMI was derived following the formula: weight in kg/height^2 in meters.

Blood pressure (BP) was measured thrice with a two minute interval on the right hand of a sitting patient after a five minute rest. The mean of the three measurements was calculated. HTN as a criterion for MetS was diagnosed at systolic BP ≥130 mmHg and/or diastolic BP ≥85 mmHg. Subjects who claimed to have had previously diagnosed hypertension and taking antihypertensive drugs were referred to as HTN patients.

The lipid and fasting plasma glucose (FG) concentration was measured at the laboratory of the Ulaanbaatar railway company hospital. Total cholesterol, triglycerides (TG) and high-density lipoprotein cholesterol (HDL-C) were measured by colorimetric method with a Humalyser 3000 autoanalyzer system ("Human", Germany). Venous blood was collected from the antecubital vein after a 12-h overnight fast. Low-density lipoprotein cholesterol (LDL-C) was calculated by the following formula: LDL-C (mmol/L) = total cholesterol (mmol/L) — TG (mmol/L) / 2,2 — HDL-C (mmol/L). History of DM2 was taken into account. The data were collected from September 2011 till June 2012.

MetS was diagnosed according to the IDF (2005), JIS (2009) and modified NCEP ATP III criteria, as we have previously reported [3]. The IDF criteria included AO_{80-90} in combination with at least two of the following indicators — TG≥1,7 mmol/L, HDL-C<1,0 mmol/L in men and <1,3 mmol/L in women or lipid lowering therapy, BP ≥130/85 mmHg or antihypertensive medication, FG ≥5,6 mmol/L or DM2 [4]. According to the Joint Interim Statement criteria (JIS, 2009) any three or more of the following five components were taken into account: AO_{80-90}, TG≥1,7 mmol/L, HDL-C<1,0 mmol/L in men and <1,3 mmol/L in women, BP ≥130/85 mmHg or antihypertensive medication, FG ≥5.6 mmol/L or glucose-lowering therapy [5]. MetS diagnosis by NCEP ATP III (2004) was carried out in the same way as by JIS (2009), though instead of AO_{80-90} criterion we used AO_{88-102} [1, 2].

Data analysis was done by Statistica 8.0 analysis software («Statsoft», USA). The character of distribution was determined by Kolmogorov-Smirnov and Lilliefors normality tests. Mean values are expressed as mean (M) and standard deviation (SD).The sign prevalence in 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 and crosstabulation tables for evaluating the relative values differences. P-value of less than 0.05 was used to assess the significance.

Table 2

Prevalence of MetS criteria

MetS criterion	Whole group n=1277		Men n=737		Women n=540		*P*-value*
	%	95% CI	%	95% CI	%	95% CI	
AO_{80-90}	65,9	(63,3-68,6)	58,5	(54,8-62,2)	76,1	(72,3-79,9)	<0,01
AO_{102-88}	35,9	(33,2-38,7)	23,7	(20,5-27,0)	52,6	(48,2-7,0)	<0,01
LDL-C ≥3.0 mmol/L	15,7	(13,6-17,7)	14,8	(12,1-17,5)	16,9	(13,5-20,2)	0,32
↓HDL-C	11,5	(9,7-13,3)	1,1	(0,2-2,0)	25,7	(21,9-29,6)	<0,01
TG ≥1.7 mmol/L	50,8	(48,0-53,6)	53,6	(49,9-57,3)	47,0	(42,6-51,4)	0,02
$\uparrow FG_{5.6}$	24,6	(22,1-27,0)	27,8	(24,4-31,2)	20,2	(16,6-23,8)	<0,01
DM2 or FG≥7.0 mmol/L	8,1	(6,5-9,6)	9,6	(7,4-11,9)	5,9	(3,7-8,1)	0,02
BP ≥130/85 mmHg or HTN therapy	57,2	(54,4-60,0)	61,2	(57,5-64,9)	51,9	(47,4-56,3)	<0,01

* — for the differences between male and female groups

Abbreviations: AO, abdominal obesity; TC, total cholesterol; LDL-C, low-density lipoprotein cholesterol; HDL-C, and high-density lipoprotein cholesterol; ↓HDL-C, HDL-C<1.0mmol/L in men and <1.3mmol/L in women; TG, triglycerides; $\uparrow FG_{5.6}$, plasma fasting glucose ≥5.6 mmol/L; DM2, diabetes mellitus type 2; BP, blood pressure; HTN, hypertension.

Table 3

MetS prevalence among working urbanized population of Mongolia

MetS definition	Whole group n=1277		Men n=737		Women n=540	
IDF,% [95% CI]	37,6	[34,9-40,3]	36,1	[32,5-39,7]	39,6	[35,3-43,9]
JIS,% [95% CI]	39,8	[37,0-42,5]	38,9	[35,3-42,6]	40,9	[36,6-45,3]
NCEP ATP III,% [95% CI]	29,3	[26,7-31,9]†§	25,1	[21,8-28,4]†§	35,0	[30,8-39,2]*
Mean number of MetS criteria by IDF or JIS (SD)	2,1	(1,2)	2,0	(1,2)	2,2	(1,2)*
Mean number of MetS criteria by NCEP ATP III (SD)	1,8	(1,2)	1,7	(1,2)	2,0	(1,2)*

* — p<0,05 for the differences between male and female groups, † — p<0,05 for the differences between MetS prevalence by IDF and NCEP ATP III, § — p<0,05 for the differences between MetS prevalence by JIS and NCEP ATP III.

Abbreviation: MetS — metabolic syndrome.

Results

Table 1 presents anthropometric and clinical characteristics of patients under study. Men were younger than women. They smoked more and have higher WC, TG and BP values.

As it follows from Table 2 the most frequently defined criteria of MetS were AO, HTN and high TG. Men differed from women by elevated TG and FG, DM2 and HTN prevalence values. AO and low HDL-C were found more frequently in women. AO by IDF criteria for Asian residents occurred more regularly than by NCEP ATP III criteria.

The MetS prevalence by the IDF (2005), JIS (2009) and NCEP ATP III (2004) criteria is given in Table 3.

As can be seen from Table 3, the MetS prevalence by IDF (2005) and JIS (2009) with the use of AO criteria for Asian population did not differ and was the same in men and women. The MetS prevalence by NCEP ATP III (2004) with the use of "mild" definitions was found to be less regular for the group on the whole and for men and women as well. At the same time the average number of MetS criteria was regularly higher in women than in men.

The MetS prevalence increased with age both in men and women (Table 4).

The presence of three diagnostic criteria in the structure of MetS prevailed, whereas the combination of all five components was found extremely rare and mostly in women (Figure 1).

The most regular combination of the MetS components was found to be the combination of AO, HTN and high TG both in men and women (prevailing in men; *P*<0,001). The second most frequent variant was the combination of the three above symptoms with hyperglycemia (prevailing in men; *P*<0,001). The third leading MetS variant was proved to be the combination of AO, HTN and hyperglycemia in men and AO, HTN and low HDL-C in women. Different MetS variants including low HDL-C were found mostly in women (Figure 2).

Discussion

Asian population is known to be characterized by insulin resistance when having less body mass and waist circumference values and genetic predisposition to diabetes [6]. So, the study of the regional specific features of MetS and its timely diagnosing is considerably important for preventing DM2 and cardiovascular complications. The results of our study showed that the MetS prevalence among the Mongolian railway workers of both genders was

Table 4

MetS prevalence according to gender and age

MetS definition	18-29 years	30-39 years	40-49 years	≥50 years
	% [95% CI]	% [95% CI]	% [95% CI]	% (95% CI]
Men	n=135	n=216	n=272	n=114
IDF	14.8 [8.1-21.5]	36.6 [29.7-43.5]*	43.0 [36.8-49.3]	43.9 [33.9-53.8]*
JIS	14.8 [8.1-21.5]	40.7 [33.7-47.8]*	45.6 [39.3-51.9]	48.3 [38.2-58.3]*
NCEP ATP III	6.7 [1.7-11.6]*	27.3 [29.7-43.5]	29.4 [23.6-35.2]	32.4[23.0-41.9]*
Women	n=47	n=114	n=260	n=119
IDF	17.0 [4.2-29.9]	23.7 [15.0-32.4]	40.0 [33.7-46.3]	63.0 [53.5-72.5]
JIS	17.0 [4.2-29.9]	24.6 [15.8-33.3]	41.1 [34.8-47.5]	65.6 [56.2-74.9]
NCEP ATP III	17.0 [4.2-29.9]	21.0 [12.7-29.4]	35.8 [29.6-42.0]	53.8 [44.0-63.6]

* — p<0,05 for the differences between male and female groups.

high and by IDF (2005) amounted to 37,6%, and by JIS (2009) — to 39,8%. Minimal MetS occurrence (29,3%) was determined when using milder AO thresholds — 102 and 88 cm by NCEP ATP III (2004). There were reported only a few studies on the MetS prevalence in Mongolia. For instance, in a sample of 456 Mongolians MetS was diagnosed in 8-12% cases [7]. The given study included nomads and farmers living in rural regions of Inner Mongolia, People Republic of China. A similar result (12%) was obtained from the survey of 596 Japanese and Mongolians by NCEP ATP III criteria [8].

In our investigation the values for the MetS prevalence among Mongolians appear to be considerably higher than those presented above. This can be connected with the specificity of the study sample, which included urban employed residents. Urbanized lifestyle is liable to modify dietary patterns and reduce physical activity thus increasing the risk of abdominal obesity and MetS. Some of the supporting evidence for this comes from the data on the MetS frequency among urbanized Mongolian population. In a sample of 2536 adults after 20 years of age of Tongliao city, Inner Mongolia, the MetS prevalence amounted up to 17,1% and 19,6% by the IDF и NCEP ATP III criteria respectively [9]. A similar MetS frequency range — from 13,5% in women to 18,6% in men — was revealed among 257 industrial workers in Ulaanbaatar [10]. There is also evidence of higher MetS frequency among urban population in other regions of Asia. Besides, the effect of psycho-emotional stress the railway workers suffer in their professional activity on the development of MetS components must not be ruled out. Extremely high levels of obesity, dyslipidemia and hypertension among the engine railway drivers were reported by some authors [11].

The most close to our data values were reported by U. Shuumarjav (2011) according to which the MetS prevalence obtained from the sample of 285 Mongolian volunteers was 39,6% [12]. According to some authors the MetS frequency is higher in Mongolian than in Japanese (39,6% vs 31,1%), Chinese rural (37,6% vs 33,9%) and Korean (15,7% vs 7,8%) populations [9, 12, 13]. This fact

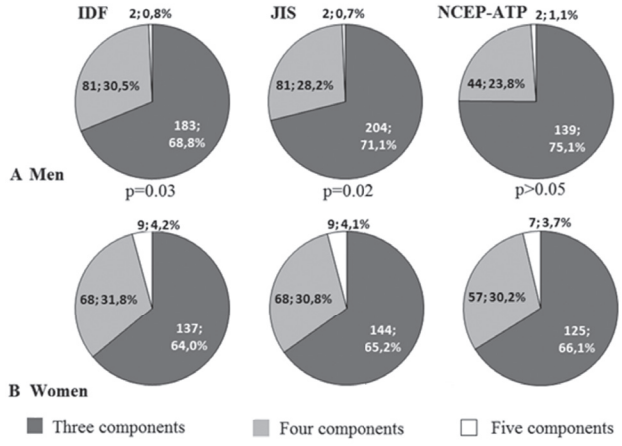

Figure 1. MetS variants related to the number of diagnostic criteria.

is explained by the higher prevalence of obesity and greater body fat percent in Mongolians due to urbanization and the attendant relatively unhealthy lifestyle [9]. In this connection it could be interesting to compare the MetS prevalence data on Mongolians with the records on Russian Siberia residents. The fullest MetS epidemiological data for Siberia were presented by G.I. Simonova (2011), according to which MetS frequency by the IDF criteria among 9190 residents of Novosibirsk city aged from 45 to 69 was 44,0% for both genders. This value was higher than we received (37,6%), however the above sample was population-based and differed by older age. Furthermore MetS significantly differed in structure and its components frequency. Hypertension, for instance, was more frequent in Russian Siberia Caucasians (75,0%) than in Mongolians (57,2%). Hyperglycemia frequency was also much higher in the Russians (54,8%) compared to that of the Mongolians (24,6%). Conversely, hypertriglyceridemia was found in a half of our study sample (50.8%), whereas among Russian Siberia residents it was only 28,8%. Besides, the MetS prevalence was higher in women of the Siberian population (52%) irrespective of diagnostic criteria, whereas in Mongolians it did not depend on gender when using AO definitions for Asia [14].

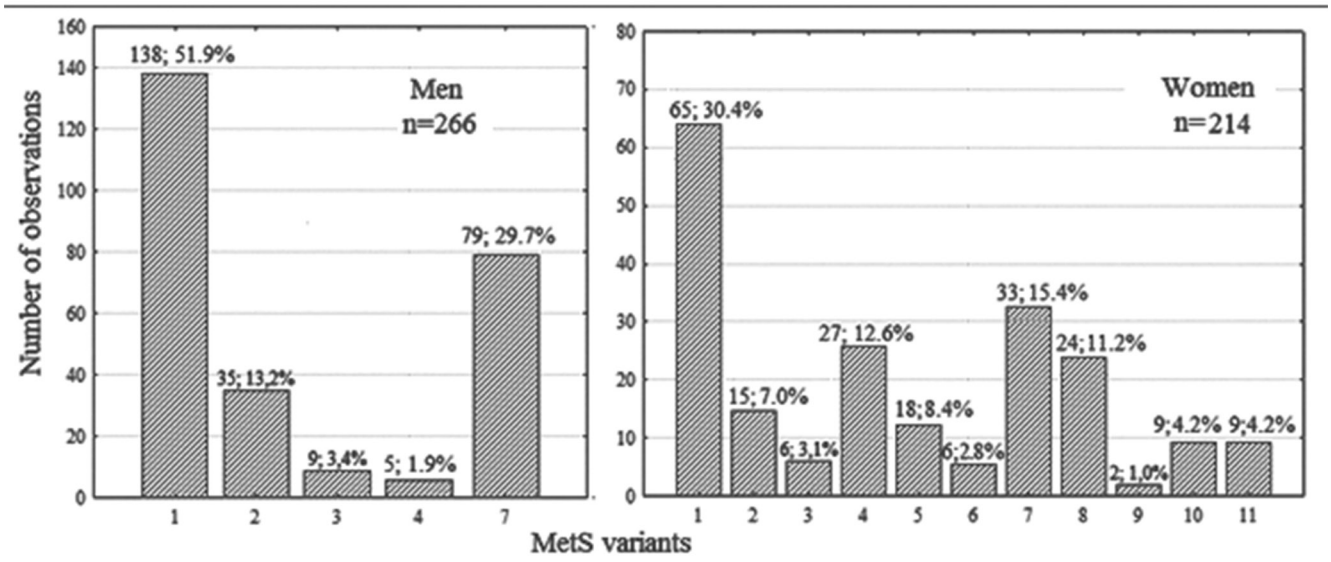

Figure 2. MetS variants by IDF criteria related to component combination.
The numbers on the horizontal axis denote the following variants of MetS: 1 — AO + HTN + high TG, 2 — AO + HTN + elevated FG, 3 — AO + high TG + elevated FG, 4 — AO + HTN + low HDL-C, 5 — AO + high TG + low HDL-C, 6 — AO + low HDL-C + elevated FG, 7 — AO + HTN + high TG + elevated FG, 8 — AO + HTN + high TG + low HDL-C, 9 — AO + high TG + low HDL-C + elevated FG, 10 — AO + HTN + low HDL-C + elevated FG, 11 — all five metabolic syndrome components.

For the residents of the European part of Russia (1561 employees of St. Petersburg) the most frequent combinations of the MetS structure were AO+HTN+low HDL-C and AO+HTN+elevated FG in contrast to our results in which these MetS variants ranked third and fifth in women and fifth and third in men [15]. In the West European population according to PAMELA study at total MetS prevalence by the NCEP ATP III criteria of 16,2% the most regular components were HTN (95,4%), high TG (77,1%) and low HDL-C (72,2%) [16], whereas in our study sample it was the combination of AO, HTN and high TG.

High prevalence of hypertriglyceridemia, which was revealed in a half of the studied subjects is seen to be another peculiarity of MetS. This fact may be explained by dietary habits of Mongolians who take large amounts of meat, milk, dairy products with high fat/total calorie ratio and saturated fatty acids proportion. And yet the main reason is likely to be a rapid growth of dietary carbohydrates consumption in Mongolian urban inhabitants leading to carbohydrate-induced hypertriglyceridemia.

Study strengths and limitations

It is the first report on the study of the MetS prevalence among Mongolian urbanized working population, railway workers in particular. We made an attempt to distinguish some important features of the MetS formation in Mongolian urban employees. Firstly, MetS prevalence was found to be considerably high, which can be connected to professional stress and changes in the lifestyles of city dwellers. Secondly, we proved hypertriglyceridemia along with AO and HTN to be the most regular components in the MetS structure, whereas low HDL-C and elevated FG are occasional.

The limitations of the study are as follows: (1) there was the cross-sectional design in which causality can't be determined; (2) the sample was not population-based and formed on the basis of directional selection although the study included the workers of all major railway stations in proportion to the staff number, and the study sample was formed with the account of the total number of employees, maximal expected MetS prevalence and admissible error.

Conclusion

The prevalence of MetS in Mongolian railway employees by the IDF (2005) criteria amounted to 36,1% in men and 39,6% in women, by JIS (2009) — 38,9% and 40,9%, by NCEP ATP III (2004) — 25,1% and 35,0%. The syndrome frequency increased with age reaching its maximal value at 50 years and after. No gender difference in the MetS prevalence by IDF and JIS criteria was observed despite the significant difference in the frequency of its separate components. The most frequent of the MetS criteria was abdominal obesity found in 58,5% of men and 76,1% of women, whereas the most frequent MetS variant was the combination of abdominal obesity, hypertension and hypertriglyceridemia observed in 51,9% of men and 30,4% of women.

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