NUTRITIONAL STATUS AND RISK OF OBESITY IN WORKING-AGE MEN

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The aim of this study was to estimate the energy content, macronutrient intake and their impact on the somatometric parameters in older working-age men. A total of 284 men included in the study were asked to fill out the questionnaire and underwent a physical examination. Dietary patterns were studied using a 24h recall method. The following measurements were taken: body height and weight, waist and hip circumference. BMI was calculated. The participants were divided into 3 groups by the level of their physical activity (PA): low PA (energy expenditure 2300≤PA<2700 kcal/day), moderate PA (2700≤PA<3100), high PA (3100≤PA<4000). Of all study participants, 22.3% had normal BMI, 31.7% were generally obese, and 27.1% had abdominal obesity. Individuals with abdominal obesity made up 93.3±3.7% of the general obesity group. On average, energy intake was within the reference range for 60.3±2.9% of the participants, was higher than recommended in 21.7±2.4% of cases and below the recommended level in 17.9±2.3% of cases. The risk of obesity for individuals whose dietary energy intake exceeded the recommended levels was OR=1.9 [1.05–3.67], χ^2=2.7; *p*=0.05. The diet of subjects with BMI ≥ 30 had higher protein, cholesterol and starch content than in other groups. The high PA group was at risk of abdominal and general obesity (OR=3.6 [1.5–7.7], *p*=0.005 and OR=3.6 [1.5–7.7], *p*=0.005, respectively). In the low PA group, increased BMI was observed in 47.4±3.4% of the subjects, and 12.3±5.8% had abdominal obesity. Our findings may be useful for developing nutritional guidelines for the working-age population.

Keywords: diet, energy value, macronutrients, total obesity, abdominal obesity, risk, men of working age

Author contribution: Efimova NV — collection of material, statistical processing, writing an article, analysis of literature.

Compliance with ethical standards: Voluntary informed consent was obtained for each participant. The study was biomedical ethical and did not endanger the participants.

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ИЗУЧЕНИЕ ПИЩЕВОГО СТАТУСА И РИСК РАЗВИТИЯ ОЖИРЕНИЯ У МУЖЧИН ТРУДОСПОСОБНОГО ВОЗРАСТА

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Цель исследования: изучить энергетическую ценность рациона, потребление макронутриентов и их влияние на соматометрические параметры у мужчин старшей группы трудоспособного возраста. Проведено анкетирование и физикальное обследование 284 мужчин. Фактическое питание изучали с использованием метода 24-часового воспроизведения питания в компьютерной программе. Все респонденты прошли соматометрическое обследование, включающее длину и массу тела, обхват талии, обхват бедер, расчет индекса массы тела (ИМТ). Деление на группы по уровню физической активности (ФА) представлено следующим образом: низкая ФА (расход энергии 2300 ≤ ФА < 2700 ккал/сут), средняя (2700 ≤ ФА < 3100), повышенная (3100 ≤ ФА < 4000). Нормальный уровень ИМТ имели 22,3% обследованных, общее ожирение 31,7%, а абдоминальное — 27,1%. В группе лиц с общим ожирением доля лиц с абдоминальной формой составила — 93,3 ± 3,7%. По средним величинам энергетическая ценность рациона соответствовала норме в 60,3 ± 2,9%, выше потребностей — 21,7 ± 2,4%, ниже — 17,9 ± 2,3%. Риск ожирения у лиц, рацион которых превышает физиологическую норму — OR=1,9 [1,05-3,67], χ^2 = 2,7; *p* = 0,05. У обследованных с ИМТ ≥ 30 выше, чем в других группах поступление белков, холестерина, крахмала. В группе с повышенной физической активностью отмечен риск как абдоминального OR = 3,6 [1,5–7,7], *p* = 0,005, так и общего ожирения OR = 3,6 [1,5–7,7], *p* = 0,005. У обследованных с низкой физической активностью повышенный ИМТ выявлен в 47,4 ± 3,4% случаев, абдоминальное ожирение — 12,3 ± 5,8%. Полученные результаты могут быть полезны для обоснования рекомендаций по питанию организованного трудоспособного населения.

Ключевые слова: пищевой рацион, энергетическая ценность, макронутриенты, общее ожирение, абдоминальное ожирение, риск, мужчины трудоспособного возраста

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Соблюдение этических стандартов: Добровольное информированное согласие было получено для каждого участника. Исследование соответствовало требованиям биомедицинской этики и не подвергало опасности участников.

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Obesity and other non-communicable nutrition-related diseases are a sign of serious public health challenges facing the world population [1, 2]. In Russia, profound social and economic changes of the past decades have engendered changes in lifestyle and diet [3, 4]. Some of them were potentially positive, including better access to varied foods, which actually resulted in energy and nutrient surfeit, and improvements in food safety [4-7]. However, looking at the world's past experience, these changes may have repercussions, such as poor food choices and nonadherence to the principles of healthy eating by members of different age-, sex- and social groups [1, 8]. So far, there have been quite a few studies of food hygiene and dietary practices in Russia [4, 9–11]. Dietary assessment and diet optimization for the working-age population seek to preserve public health and improve employee productivity and thus are an important area of research [3, 10, 12]. Energy and macronutrient intake is an interesting subject for analysis due to the diversity of dietary preferences among different social groups and varying availability of some foods across Russia. The World Health Organization (WHO) and the Food and Agriculture Organization (FAO) have published nutritional recommendations, or population reference intakes (PRI), for major nutrients [13, 14], which allows assessing the diet of the Russian population against international standards. The aim of this study was to measure the energy content of the participants' diets, analyze the macronutrient consumption and assess their impact on somatometric parameters in the older working-age male population.

METHODS

The study complied with the Declaration of Helsinki and recruited men residing in the south of Irkutsk region. Informed consent was obtained from every participant. The initial sample size was 364 men; of them, 284 men were included in the final sample (72 men aged 40–49 years and 212 men aged 50–59 years). The following inclusion criteria were applied: age between 40 and 59 years, Irkutsk region residency, the absence of chronic diseases that required a special diet (gastrointestinal or urinary tract disorders, diabetes mellitus), answers to all questions in the questionnaire and during the interview. Besides, the following additional exclusion criteria were applied after conducting a physical examination: energy consumption falling within the reference range for males engaging in moderate and low physical activity (800–4,000 kcal/day), body mass index (BMI) > 18.4 [1].

The questionnaire contained questions about age, chronic conditions, job, residency, education, smoking, diet patterns, physical activity during the week and at the weekend. Consumption of foods, beverages and nutrients was assessed by means of a 24-hour dietary recall using the software developed by the Federal Research Centre of Nutrition and Biotechnology and a quantitative food frequency assessment method. This study presents data on dietary energy value (E), protein intake (PI), total fat (TF) intake, intake of saturated fatty acids (SFA), intake of polyunsaturated fatty acids (PUFA), intake of n-3 and n-6 fatty acids, total carbohydrate (TC) intake, intake of monosaccharides, disaccharides, and added sugar.

All respondent underwent a somatometric examination; the following measurements were taken: body height and weight (BW), waist circumference (WC), and hip circumference (HC). BMI was calculated as described in [13] and expressed in kg/m2. All study participants were divided in 3 groups: normal BW (BMI ≤ 24.9), overweight (25 ≤ BMI≤ 29.9) and obesity (BMI ≥ 30). WC > 102 cm was interpreted as abdominal obesity; participants with WC > 102 cm formed a separate group.

The level of physical activity (PA) was calculated considering energy costs of physical labor in the workplace, energy costs of activities off work and the basal metabolic rate. The following PA groups (groups II-IV) were formed according to the guidelines in [15]: low PA (energy expenditures 2170 ≤ PA < 2618 kcal/day), moderate PA (2618 ≤ PA < 2992 kcal/day), high PA (2992 ≤ PA < 3553 kcal/day). The adequacy of macronutrient intake was assessed using international [13, 14] and Russian guidelines [15].

Statistical analysis was performed in Statistica.V.10. Normality of data distribution was tested using the Kolmogorov-Smirnov test. For quantitative variables, results are presented below as mean values with 95% confidence interval (M CI) and standard deviations (Std). For qualitative variables, results are presented as frequencies per 100 participants. Intergroup comparisons were done using Student's *t*-test with the Bonferroni correction for independent samples. Proportions were compared using the chi-squared test (χ^2) with the Yates correction. Associations were assessed using Pearson's correlation coefficient. Odds ratios with 95% CI (OR CI) were calculated to confirm the discovered associations. Statistical significance was assumed to be at $p<0.05$.

RESULTS

Table 1 shows anthropometric data of study participants grouped by age. Statistical significance is shown for parameters that reflect the level of nutrition. In the group of subjects aged 50–59 years, WC was larger than in those aged 40–49 years (108.4 (106.1–110.7) cm vs. 102.6 (97.7–107.5) cm), and BMI was also higher (28.5 (27.9–29.1) vs.27.3 (26.6–28.1)).

Only 22.3% of the participants had normal BMI; 31.7% of the participants were generally obese, 27.1% of the participants had abdominal obesity (Table 2).

No significant correlations were detected when studying the effect of age on the frequency of increased BMI in the groups (pairwise comparison: BMI ≤ 24.9 $\chi^2 = 0.01$, $p = 0.915$; BMI ≥ 30 $\chi^2 = 0.96$, $p = 0.327$; comparison by 3 BMI ranges: $\chi^2 = 1.99$, $p = 0.369$). The prevalence of abdominal obesity did not differ between the groups ($\chi^2 = 1.52$, $p = 0.218$). Because age was not a significant factor, further analysis made no distinction by age. It should be noted that abdominal obesity accounted for 93.3±3.7% of all obesity cases in the general obesity group. The chi-squared test demonstrated that the distribution of the participants by waist circumference differed between the groups with different BMI (p=0.000). The risk of abdominal obesity in men with 25 ≤ BMI ≤ 29.9, compared to the group with normal BMI, was 4.4 (95% CI (1.7–11.5)). For the group with BMI ≥ 30, OR was 7.9 CI (3.1-19.9) relative to the subjects with BMI ≤ 24.9 and OR was 1.8 CI (1.4–2.3) relative to the individuals with increased BMI.

Nutritional value and metabolizable energy contents in the consumed diet are grouped by BMI values in Table 3.

On average, energy intake was within the reference range for 60.3±2.9% of the participants; excess energy intake was observed in 21.7±2.4% of cases, whereas low energy intake, in 17.9±2.3 % of cases. The risk of obesity was statistically higher for individuals whose diet exceeded the physiological norm for daily energy intake (OR=1.9 [1.05–3.67], χ^2=2.7; p=0.05). The analysis of nutrient intake revealed a few significant differences

Table 1. Average anthropometric parameters of male study participants aged 40–59

Age groups		Age	Waist circumference	Hip circumference	Body height	Body weight	BMI
40–49 years (n = 72)	M	45.3	102.6	95.4	176.8	85.5	27.3
	Std	3	14.1	7.1	5.5	10. 6	3.3
	CI	44.6–46.0	97.7–107.5	92.9–97.9	175.5–178.1	83.1–87.9	26.5–28.1
50–59 years (n = 212)	M	55.8	108.4	97.2	175.4	87.8	28.5
	Std	3	13.2	10	6.3	14.1	4.3
	CI	55.3–56.3	106.0–110.8	95.4–99.0	174.5–176.3	85.8–89.8	27.9–29.1
t-test (*p*)		24.6 (0.00)	2.0 (0.037)	1.1 (0.223)	1.7 (0.071)	1.4 (0.149)	2.4 (0.017)

Table 2. BMI and waist circumference in different age groups (%)

Parameter	40–49 years		50–59 years		Total	
	Abs.	%	Abs.	%	Abs.	%
Normal BMI	18	25	46	21.7	64	22.3
Increased BMI	36	50	94	44.3	130	45.8
General obesity	18	20.5	72	33.9	90	31.7
Abdominal obesity	15	20.8	62	29.2	77	27.1

between the studied groups. The highest protein intake was observed for study participants with BMI ≥ 30 and equaled 90.7 (87.8-93.5) g/day vs. 86.2 (82.6-89.7) g/day for individuals with normal BMI (p = 0.050) and 85.1 (82.9-87.3) g/day for those with increased BMI (p = 0.003). Besides, cholesterol intake was higher among study participants with BMI ≥ 30: 380.9 (348.3-413.5) mg/day vs. 331.0 (299.0–362.9) for individuals with BMI ≤ 24.9 (p=0.033) and 338.2 (312.9–363.5) for those with 25 ≤ BMI ≤ 29.9 (p = 0.043). The groups with increased BMI and obesity tended to differ in terms of SFA intake: 40.1 (38.4–41.7) g/day vs. 37.9 (36.3–39.0) g/day, respectively (p = 0.06). Although TC intake did not differ between the groups, individuals with BMI ≥ 30 had significantly more starch in their diet than individuals with BMI ≤ 24.9 (p = 0.05), and the amount of added sugars in their diet was lower than in the diet of those with 25 ≤ BMI ≤ 29.9 (p = 0.029).

Regardless of their PA levels, the majority of the participants exceeded the recommended level of macronutrient intake [15] (Table 4). In the group with high PA, the diet was low in proteins in 60.2 % cases, low in fats in 44.6% of cases, and low in carbohydrates in 92.6% of cases. At the same time, in this group the diet was characterized by excess energy content in 11.5±2.5% of cases and excess fat intake in 33.7±5.2% of cases. Regarding the low PA group, protein intake exceeded the norm in 39.4±5.5 cases per 100 participants, which was at least twice as frequent as among moderately and highly active individuals. Dietary fat surplus occurred at the same frequency in all studied groups. In the moderate PA group, macronutrient intake was within the recommended reference range in 68.7%, 68.1% and 60.0% of cases for proteins, fats, and carbohydrates, respectively, i.e. met the nutrient needs of 86±3.6% of the participants in terms of dietary energy content.

DISCUSSION

Our study focused primarily on the consumption of macronutrients by older working-age men, aiming to identify the impact of diet on the risk of obesity. The study is particularly interesting from this standpoint because obesity, along with other non-communicable nutrition-related diseases poses a serious threat to public health. As diets are becoming more energy-dense, it is becoming increasingly important to analyze the dietary intake of macronutrients and its impact on the risk of obesity. For 16.2±2.1% of the participants included in our study, dietary E exceeded the recommended level by 7.8–30.1% in the low PA group, by 0-19.5% in the moderate PA group and by 11.7–34.8% in the high PA groups. A similar situation was reported by other authors studying the working-age population in other Russian regions [6, 16, 17]. According to studies conducted by Frolova OA and Bocharov EP, male Tatarstan residents aged 40–59 years with type I PA consumed 2510.6 kcal with their daily meals, which exceeds the recommended

Table 3. Nutritional value and metabolizable energy contents in the diet of men aged 40–59 years

Parameter	BMI ≤ 24,9		25 ≤ BMI ≤ 29,9		BMI ≥ 30	
	M (CI)	Std	M(CI)	Std	M(CI)	Std
Energy	2768.3 (2668.6–2768.1)	406.8	2751.2 (2687.1–2815.3)	371.3	2799.9 (2716.5–2883.3)	404.2
Protein, g/day	86.2 (82.6–89.5)	14.6	85.1 (82.9–87.3)	12.7	90.7 (87.8–93.5)	13.8
Total fat, g/day	114.8 (109.5–121.2)	21.9	112.1 (107.7–116.6)	25.8	115.6 (111.0–120.2)	22.1
SFA,%	39.4 (37.3–41.4)	8.5	37.9 (36.3–39.5)	9.3	40.1 (38.4–41.7)	8.2
PUFA,%	24.8 (23.4–25.2)	5.7	24.9 (23.8–26.0)	6.5	25.0 (23.8–26.3)	6
n-6 PUFA,%	22.4 (21.2–23.6)	5.2	22.5 (21.5–23.5)	5.8	22.6 (21.5–23.7)	5.5
n-3 PUFA,%	3.0 (2.8–4.1)	0.8	2.9 (2.8–3.1)	0.8	3.0 (2.8–3.1)	0.7
Cholesterol	331.0 (299.0–362.9)	130.6	338.2 (312.9–363.5)	146.3	380.9 (348.3–413.5)	158
Monosaccharides, disaccharides, g/day	127.5 (118.7–138.7)	35.8	127.7 (121.0–134.0)	36.4	122.1 (113.6–130.7)	41.2
Added sugar, g/day	57.7 (50.4–65.0)	30	60.6 (54.8–66.4)	33.4	50.6 (43.7–57.5)	33.4
Starch, g/day	193.1 (182.6–204.5)	42.9	195.9 (188.7–203.1)	41.8	206.3 (197.8–214.8)	41.2
Total carbohydrates g/day	320.6 (305.9–335.8)	59.8	323.6 (314.4–223.8)	53.3	328.5 (316.3–340.7)	59

Note: BMI — body mass index; SFA — saturated fatty acids; PUFA — polyunsaturated fatty acids; n-3 PUFA — omega-3 polyunsaturated fatty acids; n-6 PUFA — omega-6 polyunsaturated fatty acids; M (CI) — mean value with 95% confidence interval; Std — standard deviation.

Table 4. Intake of macronutrients by groups with different levels of physical activity (per 100 participants)

Relation to the norm	Physical activity	Proteins	Fats	Carbohydrates
Below	low (1)	2.8 ± 2.7	2.8 ± 2.7	30.3 ± 8.0
	moderate (2)	15.6 ± 2.9	6.2 ± 1.9	38.7 ± 3.8
	high (3)	60.2 ± 5.4	44.6 ± 5.5	92.6 ± 1.7
Significance of differences		$^{1-2}$p = 0.001 $^{1-3}$p = 0.000 $^{2-3}$p = 0.000	$^{1-2}$p = 0.305 $^{1-3}$p = 0.000 $^{2-3}$p = 0.000	$^{1-2}$p = 0.344 $^{1-3}$p = 0.000 $^{2-3}$p = 0.000
Meets	low (1)	42.2 ± 8.0	76.8 ± 7.5	60.1 ± 8.5
	moderate (2)	68.7 ± 3.7	68.1 ± 3.7	60.0 ± 3.9
	high (3)	19.3 ± 4.3	21.7 ± 4.5	2.4 ± 1.7
Significance of differences		$^{1-2}$p = 0.003 $^{1-3}$p = 0.013 $^{2-3}$p = 0.000	$^{1-2}$p = 0.299 $^{1-3}$p = 0.000 $^{2-3}$p = 0.000	$^{1-2}$p = 0.991 $^{1-3}$p = 0.000 $^{2-3}$p = 0.000
Above	low (1)	39.4 ± 5.5	30.3 ± 8.0	9.5 ± 5.0
	moderate (2)	15.6 ± 2.9	25.6 ± 3.4	1.2 ± 0.9
	high (3)	20.5 ± 4.4	33.7 ± 5.2	2.4 ± 1.7
Significance of differences		$^{1-2}$p = 0.000 $^{1-3}$p = 0.008 $^{2-3}$p = 0.353	$^{1-2}$p = 0.550 $^{1-3}$p = 0.761 $^{2-3}$p = 0.194	$^{1-2}$p = 0.103 $^{1-3}$p = 0.181 $^{2-3}$p = 0.531

dietary energy intake by 19.6%; for 57.1% of the participants, E was increased. The average EC in the diet of our subjects with type 2 PA was 2286.7 kcal, which is within the reference range, but in 38.8% of cases the amount of consumed calories exceeded the recommended level [6].

In our cohort, protein intake was higher than recommended for individuals with types I–III PA [15] (88 CI (86-90) g/day on average), regardless of the participants' age or physical activity. Protein intake relative to the total energy content (13.3% E) was above the upper limit of the reference range recommended by WHO (0.83 g/kg body weight for adults, which is about 12% of energy intake) [13]. In our study, 21.3±2.5% of the participants had excess protein in their diet, 48.4±3.1% consumed the recommended amount of protein, and 29.8±2.8% had too little protein in their diet. However, considering that dietary energy content was excessive in the studied cohort, their protein intake can be described as increased. Our findings differ from the results of another study that investigated macronutrient consumption across Russia and found that protein intake amounted to 9.3–11.5% E [18]. Surveys show that average protein consumption across European populations is the same or higher than the reference intake, reaching 15% E [19, 20]. Clinical studies have found that protein intake which exceeds the recommended norm no more than twofold can be considered safe for adults although it does not meet the criteria for a healthy diet. Daily protein consumption over 45% E may lead to unfavorable outcomes [20]. Long-term excess protein intake is associated with impaired renal function. Other side effects of high-protein diets are associated with insulin resistance and glucose tolerance [21, 22]. On the other hand, it is postulated that high-protein diets promote weight loss [2].

At present, total fat intake recommended by WHO and FAO is 20%–35% E [23], which ensures the right amount of essential fatty acids and energy and facilitates digestion of fat-soluble vitamins. In our cohort of patients, total fat intake did not meet these recommendations (38.4 % E; the lowest total fat intake was 28.1% E, the highest total fat intake was 47.8% E). Of all study participants, 8.9±1.8% were above the upper limit of the recommended fat intake. Our findings are consistent with the data reported by Evstratova VS et al. [18], who found that across Russia, total fat intake was above the recommended level (33.2-38.8% E). According to another study, 30.6±2.9% of its participants consumed a high-fat diet [15]. It is well known that excess dietary fat promotes ischemic heart disease, atherosclerosis and thrombosis. Besides, high-fat diets can reduce or worsen insulin resistance and may be associated with increased risk for cardiovascular disorders [13, 24]. By contrast, high-PUFA diets are associated with reduced risk for cardiovascular disorders. The recommended PUFA intake is 6-10% EC. In our cohort, the average PUFA intake observed in 91.5±1.8% of the participants was 7.5% E, which meets the dietary requirements. According to WHO and FAO, daily SFA intake should amount to 10% E [23], similar to the recommendations of Russian authors [15]. For the overwhelming majority of our participants (95.5±1.3%), SFA intake was higher than recommended. This worrying trend was noticed by some other authors [6, 17, 19, 25]. According to the European Nutrition and Health Report [25], the average SFA dietary intake among adults varies from 9% to 26% E; the lowest SFA intake levels were reported in Southern Europe. In our study, n-3 PUFA intake was 0.9% E and met the dietary recommendations set by WHO/FAO [23] in only 32.0±2.9% of cases. Pronounced nutritional imbalances were also noted in the diet of the working-age residents of Samara region, including increased dietary fat content (45% E) due to saturated fatty acids and added sugar consumption (13% E) [17].

It is well known that carbohydrates have a number of important physical, chemical and physiological properties: they control body weight and the development of diabetes and cardiovascular disorders. To assess the quality of diet, one should distinguish between different types of carbohydrates and dietary sources, because the amount of naturally occurring and added sugars, as well as fibers, is currently the major dietary health concern. WHO and FAO [13] recommend that TCH amount to at least 50% E. In our study, average TCH amounted to 48.3% E, differing from the results obtained in other Russian regions, where TCH made up 50.3-56.4% E, compared to the recommended 50-60% E [18]. TCH intake was lower than recommended for the corresponding PA level in 59.3±3.1% of the participants.

The balance of macronutrients is one of the key criteria for dietary adequacy. In our study, total fat intake was higher than recommended in 30.6±2.9% of the participants and lower than recommended in 59.3±3.1% of the participants. Macronutrient imbalances were discovered in the diet of 15.9±2.3% of the participants; protein-fat imbalances were observed in 31.0±2.9% of cases, and protein-carbohydrate imbalances occurred in 10.5±1.9% of cases. Most often, dietary imbalances were observed in the high PA group and included high fat intake (59.0±5.4% of the participants), high carb intake (13.2±3.7%) and a combination of both (19.3±4.3%). In groups with low and moderate PA, the imbalances manifested as high fat intake in 21.2±7.1% and 15.9±2.7% of cases, respectively.

According to some reports, BMI changes with age, indicating excess body weight and obesity [2]. In Tatarstan, the lowest (18.2%) percentage of individuals with normal BMI was observed in the cohort of 50–59-year-old individuals [6]. In our study, 21.7% of the participants had BMI ≤ 24.9; no differences were detected between two age groups included in the study (40-49 and 50-59 years). The analysis of associations between somatometric parameters and consumption of major nutrients revealed that the number of statistically significant associations differed between the groups with different BMI. For individuals with BMI ≤ 24.9, the correlation coefficients were as follows: r_{xy}=0.43, p=0.032 for the association between WC and mono/disaccharide intake; r_{xy}=0.39, p=0.040 for the association between WC and total carbohydrates. For individuals with 25 ≤ BMI ≤ 29.9, WC was associated with dietary energy content (r_{xy}=0.24, p=0.044), protein intake (r_{xy}=0.36, p=0.002), TF intake (r_{xy}=0.26, p=0.033), and SFA intake (r_{xy}=0.30, p=0.011). For individuals with BMI ≥ 30, the were fewer associations between WC and diet: WC was associated with dietary energy content (r_{xy}=0.29, p =0.036), protein intake (r_{xy}=0.28, p=0.041) and TCH intake (r_{xy}=0.27, p=0.046). These findings may indicate the involvement of metabolic disorders in the development of obesity in the group with BMI ≥ 30. Besides, it should be born in mind that there are 3 contributors to overweight and obesity: environmental, genetic and epigenetic factors [26].

The association between general and abdominal obesity was confirmed by correlations between BMI and WC (r_{xy}=0.61, p=0.001), BMI and HC (r_{xy}=0.51, p=0.007). According to current estimates, chronic noninfectious diseases associated with nutrition account for 46% of morbidity cases and 60% of deaths; the risk of death from cardiovascular diseases is especially high [1, 27]. In our study, individuals with elevated blood pressure prevailed in the abdominal obesity group (RR=2.6 [1.4–5.1], p=0.003).

In the high PA group, there was a risk of abdominal (OR=3.6 [1.5–7.7], p=0.005) and general (OR=3.6 [1.5-7.7], p=0.005) obesity. Paradoxically, despite excess macronutrient intake and excess dietary energy content, there were no individuals with general obesity in the low PA group; in this group, increased BW was observed in 47.4±3.4% of cases and abdominal obesity in 12.3±5.8% of cases. Perhaps, this can be explained by the insufficient accuracy of the applied dietary assessment method, which was based on the data provided by the respondents. Similar uncertainty in estimates was indicated by Russian [7, 17] and foreign [8, 21, 27, 28] researchers. Ashton LM et al. conducted a meta-analysis and concluded that the results of research into associations between the quality of diet and obesity depend on a variety of factors, including study design, methods applied, the physical activity of the respondents, etc. [8].

Despite some uncertainty of the obtained data, information about the diet of working-age individuals residing in an industrial Russian region might be essential for developing dietary recommendations and public health strategies aimed at improving the quality of life of the Russian population.

CONCLUSION

The dietary patterns of older working-age male residents of Irkutsk region were significantly different from dietary guidelines of international and Russian authorities. Those patterns were characterized by energy surfeit, increased intake of proteins and fats. Our study found that only 22.3% of the participants had normal BMI, 31.7% were generally obese, and 27.1% had abdominal obesity. Macronutrient imbalances were observed in 15.9±2.3% of the participants, imbalances between protein and fat intake, in 31.0±2.9% of cases, and imbalances between carbohydrate and protein intake, in 10.5±1.9% of cases. Low intake of major macronutrients was common in the high PA group (60.2% of its members had protein deficiency, 44.6% had fat deficiency, and 92.6% had carbohydrate deficiency). However, due to such imbalances, dietary energy deficiency was detected in only 2.5% of the respondents. Total fat surfeit was observed in only 25.6-33.7% of the respondents. In the moderate PA group, macronutrient intake was within the recommended reference range in 68.7%, 68.1% and 60.0% of cases for proteins, fats, and carbohydrates, respectively, i.e. met the nutrient needs of 86±3.6% of the participants in terms of dietary energy content.

The study has detected associations between abdominal obesity and the energy value of the consumed diet, total carbohydrate, mono- and disaccharide, fat and protein intake. These associations were weaker in the group of subjects with general obesity. Our findings may be useful for updating the existing nutritional guidelines for the working-age population and setting new goals for public nutrition.

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