MEDICAL SCIENCES
PROCEEDINGS OF THE SHEVCHENKO SCIENTIFIC SOCIETY
Register Login
Open Access, Peer Reviewed
ISSN 2708-8634
ISSN 2708-8642
Founded in 1898
#2
2022

Proceedings of the Shevchenko Scientific Society. Medical Sciences **2022**, *2 (69)*. https://doi.org/10.25040/ntsh www. mspsss.org.ua
DOI: 10.25040/ntsh2022.02.13

For correspondence: 69 Pekarska str., Lviv, Ukraine, 79010
Twitter: @UlanaLot
E-mail: ulyanalot@gmail.com

Received: 13 Apr, 2022
Accepted: 12 Dec, 2022
Published: 30 Dec, 2022

ORCID IDs

Ulyana Lototska-Dudyk:
https://orcid.org/0000-0001-7587-8457

Borys Kuzminov:
https://orcid.org/0000-0002-8693-1046

Lyubov Gutor:
https://orcid.org/0000-0002-4685-594X

Oleksandra Breidak:
https://orcid.org/0000-0003-1051-0410

Oksana Kovalska:
https://orcid.org/0000-0001-5242-601X

Disclosures: The authors declared no conflict of interest.

Author Contributions:
Conceptualization: Ulyana Lototska-Dudyk, Borys Kuzminov;

Results of study: Ulyana Lototska-Dudyk, Oleksandra Breidak;

Writing: Ulyana Lototska-Dudyk, Lyubov Gutor;

Review & editing: Borys Kuzminov, Lyubov Gutor, Oksana Kovalska.

Ethical approval: June 22, 2019, protocol № 6 of Danylo Halytsky Lviv National Medical University.

Funding: The authors received no financial support for their study.

Original Research: Clinical Sciences

Biometric and biochemical indicators as factors of metabolic risk among footwear industry workers: the relationship with work conditions

Ulyana Lototska-Dudyk, Borys Kuzminov, Lyubov Gutor, Oleksandra Breidak, Oksana Kovalska

Danylo Halytsky Lviv National Medical University, Lviv, Ukraine

Introduction. The presence of a connection of metabolic syndrome (MetS) with working conditions in various professional groups dictates the necessity to use diagnostics of its presymptomatic phase in the practice of occupational medicine.

The aim was to analyze the indices of anthropometric screening and blood lipid spectre among footwear industry workers with the aim of detecting early metabolic disorders..

Methods. It was conducted a cross-sectional study of 200 footwear industry workers: 119 male (59.5%) and 81 female (40.5%) aged 25 to 62. All workers were divided into groups according to their professional working experience: under 5 years, 6-14 years, 15-21 years.Anthropometric profile indexes were determined: body height (BH), body weight (BW), waist circumference (WC) and hip circumference (HC), body mass index (BMI), waist-to-hip ratio (WHR). Biochemical indicators of the lipid body balance were assessed by total cholesterol (TCH), triglycerides (TG), high density lipoprotein cholesterol (HDL CH), low density lipoprotein cholesterol (LDL CH), atherogenic coefficient (AC).

Results: Visceral obesity was detected among 60.56% of female workers and 30.91% male workers. It has been found that the increasing tendency of WHR was associated with the increase of working experience. The share of workers with normal body weight according to BMI accounts for 39.7-41.18%.

Lipid metabolism indices among workers with working experience under 5 years do not differ from referent norm and are characterized as dyslipidemia in the experience group of 15-21 years. The signs of MetS development were detected in 5.0-5.26% (experience group under 5 years), 10.7-11.1% (6-14 years), and 23.5-31.8% (15-21 years) of footwear industry workers. It was higher in male workers (18.3%), than female (11.7%).

Conclusions. Professional factors in footwear industry increase the risk of developing MetS components. Inclusion of anthropometric and lipid statuses assessments into the monitoring of health state will help to detect individuals with early dysmetabolic disturbances and to develop preventive instruments directed at saving metabolic health of workers in the branch.

Keywords: Male; female; body mass index; waist circumference; waist-hip ratio; abdominal obesity; metabolic syndrome; lipid metabolism; occupational medicine.

Introduction

Health condition of workers provides the basis for both quantity and quality of a country's working potential, which contributes to prosperity of the population, economic development, defense capability, and independence of a state. However, nowadays, the health of working population demonstrates a clear tendency towards deterioration. In particular, it has been found that over 1/5 of adult workers suffer from metabolic syndrome (MetS) [1]. MetS increases the risk of cardiovascular diseases, type 2 diabetes mellitus, and causes death among working age population [2, 3, 4]. This is a serious economic burden and a public health problem in many countries.

Scientific evidence confirms the presence of MetS in 25.2-27.21% of male workers and 8.94-18.97% of female workers [5, 6] and grounds its relation with working conditions of various professional groups [7, 8, 9, 10]. This fact activates the problem of detecting individuals with early signs of metabolic disorders [11], selecting workers with metabolic problems by distinct professions [12], and dictates the necessity of practical implementation of diagnostics of MetS presymptomatic phase in occupational medicine with the aim of preventive measures implementation [13].

Since MetS is defined by the presence of at least three varied components, individuals with MetS can possess different combinations of these separate components. The researchers [14, 15] consider the increase of anthropometric parameters combined with atherogenic dyslipidemia a reliable risk factor of coronary events and MetS.

Thus, the research was aim at analyzing the indices of anthropometric screening and blood lipid spectre among footwear industry workers with the aim of detecting early metabolic disorders.

Materials and Methods

A cross-sectional study was conducted with the participation of 200 footwear industry workers, who are involved in different stages of footwear production: cutting – 64 workers (32.0%), preparation – 68 (34.0%) and closing – 68 (34.0%). The number of male workers was 119 (59.5%) aged 26 to 62, female workers - 81 (40.5%) aged 25 to 61.

All workers were divided into three groups according to their working experience. Cutting departments: up to 5 years – n=18 (28.13%), 6-14 years – n=29 (45.31%), 15-21 years – n=17 (26.56%). Preparation departments: up to 5 years – n=19 (27.94 %), 6-14 years – n=28 (41.18 %), 15-21 years – n=21 (30.88%). Closing departments: up to 5 years – n=19 (27.94 %), 6-14 years – n=27 (39.71%), 15-21 years – n=22 (32.35%).

The research was carried in out-patient clinics of Lviv, Lutsk and Khmelnytskyi, where periodic medical examinations of workers of shoe enterprises were performed. The study involved only those workers, whose state of health was determined to be satisfactory and the possibility of their admission to work at the enterprise was substantiated. Written informed consents were preliminary signed by all participants.

The study design included analysis of the following criteria for MetS (according to the International Diabetes Federation (IDF), 2005): presence of abdominal obesity, increased level of triglycerides, decreased level of high density lipoprotein cholesterol, or a specific therapy due to dyslipidemia.

Anthropometric profile indexes were determined: body height (BH, m), body weight (BW, kg), waist circumference (WC, cm) and hip circumference (HC, cm), body mass index (BMI = BW (kg) / BH (m2)), waist-to-hip ratio (WHR=WC / HC).

BMI assessment criteria were as follows: <18.0 – insufficient weight; 18.5-24.9 – adequate nutrition; 25.0-29.9 – overweight; 30.0-34.9 – class I obesity; 35.0-39.9 – class II obesity; >40.0 – class III obesity.

Referent meanings of WC were: <80 cm – in females, <94 cm – in males, WHR: ≤ 0.85 – in females, ≤ 0.9 – in males.

Biochemical indicators of blood which characterize the lipid body balance were assessed by total cholesterol (TCH), triglycerides (TG), high density lipoprotein cholesterol (HDL CH), low density lipoprotein cholesterol (LDL CH), atherogenic coefficient (AC).

Reference values of these indicators were: TCH <5.2 mmol/l; TG <1.7 mmol/l; HDL CH >1.0 mmol/l in males, >1.3 mmol/l in females; LDL CH <3.0 mmol/l; AC <4.0.

Level of TCH was determined by a colorimetery method by the set of reagents of «Cholesterol «SpL»», HDL CH – by reagents «Cholesterol liquicolor», TG – by the reagents «Triglycerides «SpL» in Vitro». The level LDL CH was calculated by the formula of Friedewald (LDL CH = TCH - (HDL CH + TG/2.2)). AC was calculated by the formula: AC = (TCH - HDL CH)/HDL CH.

For statistical processing of the obtained results the program SPSS 21.0 was used. Taking into account little amount of selected material, we applied methods of nonparametric statistics, namely, the description of quantitative data was performed as medians and quartiles (Me [Q1; Q3]). The comparison of statistical differences between groups involved the application of Mann-Whitney U – test. The determination of links between the indexes was carried out by Spearman's correlation. The probability of frequency difference was estimated by the Fisher's exact test. The hypothesis was controlled according to the significance level 0.05.

Results

Almost half of all workers had the signs of abdominal obesity by the deviation from referent meanings of WC (Figure 1). The gender distribution according to this criterion varied in different departments. It was lower or almost equal in female workers of cutting and preparation departments, where their involvement was the lowest. The highest percent of deviations was found in closing sections, where female workers constituted the main part of all workers. The converse situation was observed in male workers. Their maximal deviations were fixed in cutting and closing departments, while the minimal – in preparation ones.

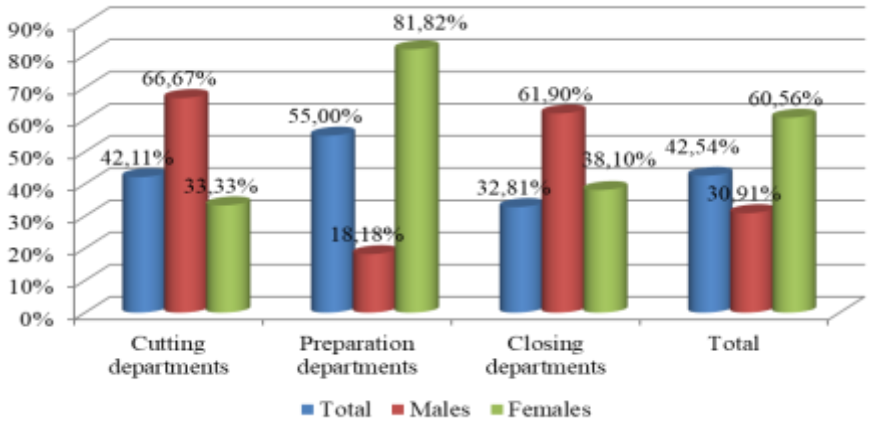

Figure 1. The frequency of the expanded WC among workers of different sections at footwear enterprises

WHR is an additional index characterizing the accumulation of fatty tissue in the visceral fat depot, i.e. abdominal one. A probable tendency towards its increase has been established with the increase of a working experience (6-14 years) in preparation and closing departments and maximal rates among the workers of all departments in case of a working experience of 15-21 years. According to the gender structure, no significant differences were found among male and female workers at all departments (Figure 2).

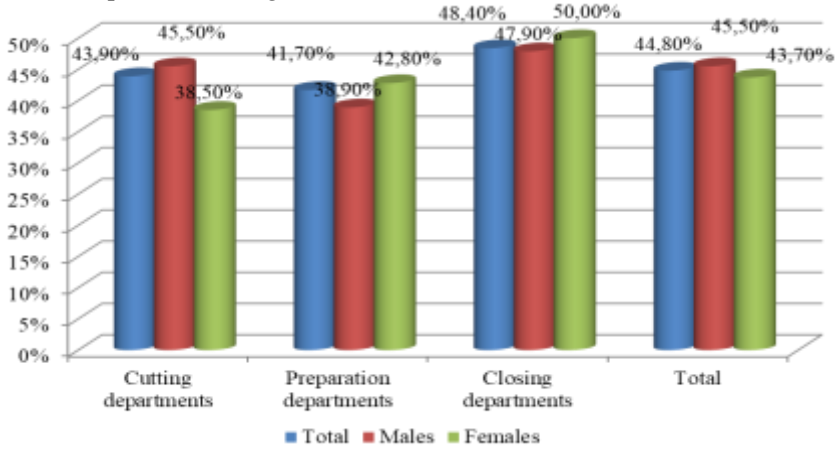

Figure 2. The frequency of increased WHR among workers of different sections of footwear enterprises

The value of BMI correlates directly with the obesity class. The WHO recommendations concerning the criteria of MetS define the referent meanings of BMI ≥30 kg/m2. The comparison of BMI rates among workers of different

departments (Figure 3) indicates that that the share of individuals with normal body weight was practically equal and was less than the half of examined workers (39.7-41.18%). Increased BW and obesity of different classes were found in all groups. The share of this category exceeds the number of individuals with normal meaning of BMI. This group can be considered a risk one concerning the development of a MetS and MetS-associated diseases: cardiovascular pathology, obesity, type 2 diabetes mellitus, etc.

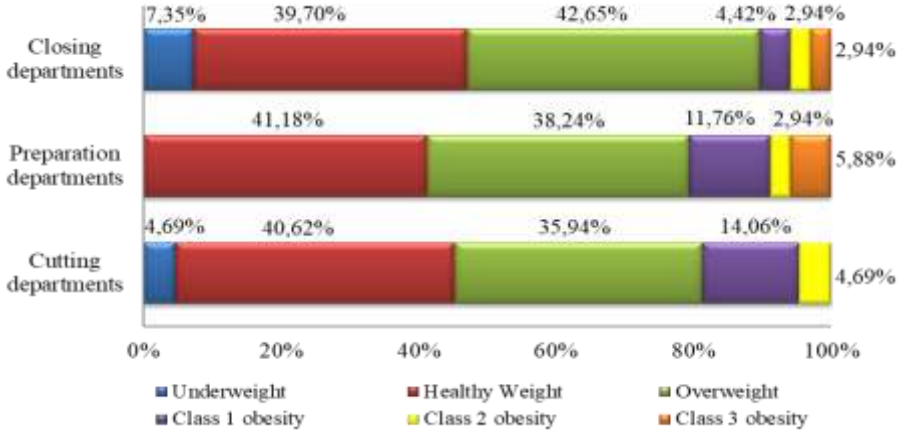

Figure 3. Assessment of BMI of workers in different departments

The analysis of anthropometric profile indexes (Table 1) of workers discloses the tendency to statistically significant increase of the WC value in the experience groups of 6-14 years (preparation departments - 88 [83; 93] cm, closing departments - 88 [82; 92] cm) and 15-21 years (cutting departments - 99 [94; 104] cm, preparation departments - 95 [85; 100] cm, closing departments - 96 [93; 100] cm) compared to workers belonging to the groups of workers with working experience under 5 years (84.5 [80; 90] cm, 80 [76; 87] cm, 80 [77; 84] cm respectively). The same tendency is observed for other anthropometric indexes (WHR, BMI), serving as additional risk parameters of obesity development, i. e. of central one.

Table 1. Anthropometric profile for footwear industry workers of different experience groups (Me [Q1; Q3])

Parameters, measuring units	Departments		
	Cutting	Preparation	Closing
under 5 years			
WC (cm)	84.5 [80; 90]	80 [76; 87]	80 [77; 84]
WHR	0.86 [0.83; 0.89]	0.84 [0.82; 0.87]	0.87 [0.85; 0.88]
BMI	23.16 [21.84; 25]	22.55 [22.04; 25.74]	21.73 [20.37; 22.96]
6-14 years			
WC (cm)	90 [84; 96]	88 [83; 93]	88 [82; 92]
	p_1=0.061	p_1=0.012	p_1=0.008
WHR	0.88 [0.85; 0.96]	0.86 [0.84; 0.9]	0.89 [0.88; 0.93]
	p_1=0.062	p_1= 0.13	p_1=0.01
BMI	25.24 [23.0; 28.09]	27.24 [23.77; 28.39]	25.62 [22.23; 27.59]
	p_1=0.045	p_1=0.013	p_1=0.006
15-21 years			
WC (cm)	99 [94; 104]	95 [85; 100]	96 [93; 100]
	p_2=0.0007	p_2=0.0003	p_2<0.0001
WHR	0.99 [0.92; 1.13]	0.89 [0.86; 0.93]	0.96 [0.9; 1.04]
	p_2=0.0003	p_2=0.005	p_2<0.0001
BMI	27.89 [26.24; 30]	27.73 [24.82; 31.95]	26.52 [25.28; 28.62]
	p_2=0.002	p_2=0.002	p_2<0.0001

p1 – difference probability between the experience groups of under 5 years and 6-14 years,
p2 - difference probability between the experience groups of under 5 years and 15-21 years.

The indexes of lipid metabolism among workers of all departments do not differ from referent norm (experience group under 5 years) and dyslipidemia in the experience group of 15-21 years is statistically significant (Table 2). No statistically significant differences were found in the lipid profile of workers in the experience groups of 6-14 years and 15-21 years.

Table 2. Lipid spectrum parameters among footwear industry workers of different experience groups (Me [Q1; Q3])

Parameters, measuring units	Departments		
	Cutting	Preparation	Closing
under 5 years			
TCH, mmol/l	4.91 [4.45; 5.15]	4.84 [4.64; 5]	4.83 [4.67; 5]
TG, mmol/l	1.64 [1.38; 1.95]	1.25 [1.12; 1.63]	1.25 [1.09; 1.47]
HDL CH, mmol/l	1.49 [1.3; 1.55]	1.43 [1.34; 1.52]	1.53 [1.43; 1.6]
LDL CH, mmol/l	2.56 [2.16; 3.06]	2.85 [2.53; 3.11]	2.67 [2.5; 2.87]
AC	2.2 [1.83; 2.83]	2.5 [1.99; 2.74]	2.06 [1.86; 2.49]
6-14 years			
TCH, mmol/l	5.25 [4.92; 5.92] p_1=0.024	5.2 [4.81; 6.25] p_1=0.067	5.34 [4.93; 6.03] p_1= 0.001
TG, mmol/l	1.95 [1.55; 2.02] p_1=0.12	1.34 [1.2; 1.68] p_1=0.42	1.46 [1.21; 1.9] p_1= 0.132
HDL CH, mmol/l	1.27 [1.2; 1.51] p_1=0.107	1.46 [1.2; 1.52] p_1=0.87	1.33 [1.19; 1.46] p_1= 0.002
LDL CH, mmol/l	3.05 [2.69; 3.74] p_1=0.01	3.12 [2.74; 3.98] p_1=0.068	3.15 [2.92; 3.94] p_1=0.0002
AC	3.1 [2.22; 3.84] p_1=0.018	2.48 [2.21; 3.35] p_1=0.28	3.1 [2.42; 3.94] p_1=0.0003
15-21 years			
TCH, mmol/l	5.79 [5.04; 6.3] p_2=0.003	5.8 [5.1; 6.6] p_2=0.0002	5.86 [5.47; 6.19] p_2<0.0001
TG, mmol/l	2.34 [1.97; 2.72] p_2=0.0002	1.65 [1.24; 2.32] p_2=0.021	2.21 [1.75; 2.69] p_2<0.0001
HDL CH, mmol/l	1.23 [1.1; 1.34] p_2=0.003	1.21 [1.1; 1.4] p_2<0.0001	1.22 [1.13; 1.3] p_2<0.0001
LDL CH, mmol/l	3.32 [2.89; 3.68] p_2=0.006	3.62 [3.15; 4.28] p_2=0.0002	3.59 [3.41; 3.84] p_2<0.0001
AC	3.56 [3.07; 4.57] p_2=0.0007	4.05 [2.98; 4.93] p_2=0.0005	3.85[3.41; 4.48] p_2<0.0001

p1 – difference probability between the experience groups of under 5 years and 6-14 years,
p2 - difference probability between the experience groups of under 5 years and 15-21 years.

Increased level of triglycerides was detected among workers of experience group of 15-21 years of cutting (2.34 [1.97; 2.72]) and closing departments (2.21 [1.75; 2.69]). Decreased HDL CH, increased TCH, increased LDL CH and AC in this group are characterized as marginally high.

In general, the analyzed data indicate a tendency towards the worsening of the metabolic profile of the organism among workers of all departments with increase of working experience at the enterprises (Table 3).

Table 3. The share of workers with the risk of metabolic syndrome development

Experience group	Departments								
	Cutting			Preparation			Closing		
Criteria of MetS	1	2	3	1	2	3	1	2	3
under 5 years	27.7%	11.1%	-	21.1%	9.5%	5.0%	26.3%	5.26%	5.26%
6-14 years	27.5%	20.7%	13.8%	28.5%	17.9%	10.7%	33.3%	14.8%	11.1%
15-21 years	23.5%	35.3%	23.5%	23.8%	19.0%	30.8%	27.3%	18.2%	31.8%

Thus, the risk of MetS development (the presence of three criteria) increases with working experience at the enterprises. The signs of MetS development were detected among workers of 15-21-year experience groups of all departments compared to workers of 5-year experience, namely at cutting departments - 23.5% of workers in case of their absence in a previous group (Fisher's exact test 0.04545); preparation departments –30.8% of workers vs 5.0% Fisher's exact test 0.03047); and closing departments – 31.8% of workers vs 5.26% on under 5-year experience group; (Fisher's exact test 0,04965).

Discussion

This research provides the analysis of MetS determinants, namely the anthropometric and lipid statuses, and grounds the requirement for the inclusion of these criteria into the monitoring of health state of working population involved in footwear industry.

The research confirms the positive relation of MetS with such professional aspects as physical and chemical factors, ergonomics, labour regimen, long working experience [16, 17, 18], which are common in footwear industry.

It has been found that the increase of working experience causes deterioration of a metabolic profile of biometrical and biochemical indices. The triad of MetS components was found in 5.0-5.26% (experience group under 5 years), 10.7-11.1% (experience group of 6-14 years), and 23.5-31.8% (experience group of 15-21 years) of footwear industry workers.

The frequency of these manifestations among workers of both genders in experience group of 6-14 years is practically similar. In experience group of 15-21 years this index is reliably higher in male workers (18.3%) compared to female (11.7%).

The research of MetS prevalence in German workers (≥ 3 risk factors) accounted for 12.7% (males) and 7.4% (females). The prevalence increased with the age and experience up to 20% [19].

It is evident that the increase of working experience at the enterprise is associated with the increase of workers' age, which in its turn increases the risks of MetS.

However, the authors [20] indicate, that MetS morbidity of aging workers (45-65 years) depends on their professional group and health behavior. Low-skilled office workers (OR: 1.24; 95% CI: 1.12, 1.37) and poorly qualified workers (OR: 1.37; 95% CI: 1.18, 1.59) were characterized with the significantly higher morbidity risk of MetS compared to highly qualified workers. Analogical professional differences were also detected on the level of MetS components.

The results obtained by Polish researchers [21] demonstrate that the highest cardiometabolic risk among all professions (60-65 years) is characteristic for workers.

It is interesting that MetS is registered in 4.8-7.0% of young people (younger than 30 years) [22]. Among the MetS components of this age group, the decrease of LDL CH (26.9-41.2%), and increase of TG (8.6-15.6%), abdominal obesity (6.8-23.6%) were the most widely spread.

It confirms the necessity of control of the metabolic health state among workers of all age categories.

The authors [23] indicate, that the combination of MetS components, namely: obesity + low LDL CH + increased level of TG, is encountered in average in 9.2-24.8% of professionally occupied population. This tendency is confirmed [1], when the prevalence of MetS components in working population accounted 39.1% for low level of HDL CH, 30.8% - for triglyteridemia, 29.2% - for central obesity. Another study indicates [19], that the increased level of TG is detected in 32.8% of male workers and 13.8% of female workers, abdominal obesity – 15.1% and 16.9% respectively.

Among the workers of footwear enterprises extra body weight by the criterion of body mass index was found in 35.94-42.65% of workers, first degree obesity – 4.42-14.06%, obesity of II-III degrees– 5.88-8.82%. Abdominal obesity is

detected in 42.54% of workers, while the share of female workers was twice higher (60.56%) than this of male workers (30.91%).

The highest deviations in lipidogram were detected in workers of cutting and closing departments (experience group of 15-21 years), where the above-normal levels of production noise are registered [24]. The authors [25] also indicate the prevalence of dyslipidemia in workers under the conditions of prolonged action of professional noise for 11-24.5 years (OR: 1.81; CI: 1.40; 2.35). The changes of lipid spectre in workers of closing departments are also explained by the presence of chemical contamination in production environment. The similar results are received by authors [8], proving the role of physical and chemical production factors in the development of MetS. However, the share of workers with low level of HDL CH and increased TG was significantly higher under conditions of chemical impact.

Modern footwear industry is characterized by the significant technological changes, mechanization and automatization of many laborious production processes causing the hypodynamic activity on the basis of above-normal duration of a working day and its irrational organization [26]. A prolonged working day restricts possibilities of healthy diet, physical activity and adequate sleep, causing the increase of a body mass and obesity development as the central criterion of MetS [7, 27, 28]. Our data correspond to the results of the research carried out in Mexican enterprises [29], which confirm the deterioration of anthropometric and biochemical indices among workers of this branch.

In conclusions, the above listed information determines the necessity of dynamic monitoring of health condition of this professional cohort.

Study limitations: In particular, pharmacological correction of workers' health is not taken into account. The comprehensive evaluation of developmental MetS risks in workers requires the evaluation of health-related behavioral factors.

References

1. Roomi M, Mohammadnezhad M. Prevalence of metabolic syndrome among apparently healthy workforce. J Ayub Med Coll Abbottabad. 2019; 31(2): 252-4. PMID: 31094127.
2. Chmyr N. Prediction of the development of chronic coronary heart disease in patients with metabolic syndrome at obesity considered age and gender features. Proc Shevchenko Sci Soc Med Sci. 2018; 52 (1): 96-107. DOI: 10.25040/ntsh2018.01.09.
3. Katsimardou A, Imprialos K, Stavropoulos K, Sachinidis A, Doumas M, Athyros V. Hypertension in metabolic syndrome: novel insights. Current Hypertens Rev. 2020; 16(1): 12-8. DOI: 10.2174/1573402115666190415161813.
4. Saklayen M. The global epidemic of the metabolic syndrome. Current Hypertension Rep. 2018; 20(2): 1-8. DOI: 10.1007/s11906-018-0812-z.
5. Strauß M, Foshag P, Przybylek B, Horlitz M, Alejandro L, et al. Occupation and metabolic syndrome: is there correlation? A cross sectional study in different work activity occupations of German firefighters and office workers. Diabetol Metab Syndr. 2016; 8(1): 57–72. DOI: 10.1186/s13098-016-0174-0.
6. Ibrahim M, Pang D, Randhawa G, Pappas Y. Development and validation of a simple risk model for predicting metabolic syndrome (MetS) in midlife: a cohort study. Diabetes Metab Syndr Obes. 2022; 15: 1051-75. DOI: 10.2147/DMSO.S336384.
7. Luckhaupt S, Cohen M, Li J, Calvert G. Prevalence of obesity among u.s. workers and associations with occupational factors. Am J Prev Med. 2014; 46(3): 237-48. DOI: http://dx.doi.org/10.1016/j.
8. Mehrdad R, Pouryaghoub G, Moradi M. Association between metabolic syndrome and job rank. Int J Occup Environ Med. 2018; 9(1): 45-51. DOI: 10.15171/ijoem.2018.1197.
9. Lee W, Yeom H, Yoon J, Won J, Jung P et al. Metabolic outcomes of workers according to the International Standard Classification of Occupations in Korea. Am J Ind Med. 2016; 59(8): 685-94. DOI: 10.1002/ajim.22596.
10. Jeong HS. The Relationship between workplace environment and metabolic syndrome. Int J Occup Environ Med. 2018; 9(4): 176-83. DOI: 10.15171/ijoem.2018.1346.
11. Abd El-Wahab E, Shatat H, Charl F. Adapti ng a prediction rule for metabolic syndrome risk assessment suitable for developing countries. J Prim Care Community Health. 2019; 10: 1-13. DOI: 10.1177/2150132719882760.
12. Hidaka T, Hayakawa T, Kakamu T, Kumagai T, Hiruta Y, Hata J, Tsuji M, Fukushima T. Prevalence of Metabolic Syndrome and Its Components among Japanese Workers by Clustered Business Category. PLoS One. 2016; 11(4): 0153368. DOI: 10.1371/journal.pone.0153368.
13. Sorensen G, McLellan D, Sabbath E, Dennerlein J, Nagler E, et al. Integrating worksite health protection and health promotion: A conceptual model for intervention and research. Prev Med. 2016; 91: 188-96. DOI: 10.1016/j.ypmed.2016.08.005.
14. Pouragha H, Amiri M, Saraei M. et al. Body impedance analyzer and anthropometric indicators; predictors of metabolic syndrome. J Diabetes Metab Disord. 2021; 20(2): 1169–78. doi.org/10.1007/s40200-021-00836-w.
15. Nekić V, Loga S, Sutkovic J. Anthropometric correlation with metabolic syndrome in Sarajevo population. Endocr Metab Immune Disord Drug Targets. 2016. 16 (2): 113-9. DOI: 10.2174/1871530316666160208150135.

16. Santana A, Merces M, Magalhães L, Costa A, D'Oliveira A. Association between metabolic syndrome and work: an integrative review of the literature. Rev Bras Med Trab. 2020; 18(2): 185-93. DOI: 10.47626/1679-4435-2020-511.
17. Watanabe K., Sakuraya A., Kawakami N., Imamura K., Ando E., Asai Y. Work- related psychosocial factors and metabolic syndrome onset among workers: A systematic review and meta-analysis. Obesity Reviews. 2018; 19(11): 1557–68. DOI: 10.1111/obr.12725.
18. Proper K, van de Langenberg D, Rodenburg W, Vermeulen R, van der Beek A et al. The relationship between shift work and metabolic risk factors: a systematic review of longitudinal studies. Am J Prev Med. 2016; 50(5): 147-57. DOI: 10.1016/j.amepre.2015.11.013.
19. Schaller N, Blume K, Hanssen H, Schuster T, Schmidt-Trucksäss A et al. Prevalence of the metabolic syndrome and its risk factors: results of a large work-site health assessment. Dtsch Med Wochenschr. 2014; 139(45): 2279-84. DOI: 10.1055/s-0034-1387352 [in German].
20. Runge K, van Zon SKR, Bültmann U, Henkens K. Metabolic syndrome incidence in an aging workforce: Occupational differences and the role of health behaviors. SSM Popul Health. 2021; 15: 100881. DOI: 10.1016/j.ssmph.2021.100881.
21. Sołtysik B, Kostka J, Karolczak K et al. What is the most important determinant of cardiometabolic risk in 60–65-year-old subjects: physical activity-related behaviours, overall energy expenditure or occupational status? A cross-sectional study in three populations with different employment status in Poland. BMJ Open 2019; 9:e025905. DOI:10.1136/ bmjopen-2018-025905.
22. Nolan P, Carrick-Ranson G, Stinear J et al. Prevalence of metabolic syndrome and metabolic syndrome components in young adults: A pooled analysis. Prev. Med. Rep. 2017; 7: 211-15. DOI: https://doi.org/10.1016/j.
23. Scuteri A, Laurent S, Cucca F, et al. The metabolic syndrome across Europe: Different clusters of risk factors. European J Preventive Cardiology. 2015; 22(4): 486–91. DOI: 10.1177/2047487314525529.
24. Lototska-Dudyk U. Profesiini shkidlyvosti pratsivnykiv vzuttievykh vyrobnytstv [Harmful occupational factors of shoe productions: noise and vibration]. Medicni perspektivi. 2019; 24(1): 87-93. doi.org/10.26641/2307-0404.2019.1.162315. [in Ukrainian].
25. Zhang K, Jiang F, Luo H, Liu F. Occupational noise exposure and the prevalence of dyslipidemia in a cross-sectional study. BMC Public Health. 2021; 21(1): 1258. DOI: 10.1186/s12889-021-11274-x.
26. Kuzminov B, Lototska-Dudyk U. Shkidlyvi vyrobnychi chynnyky vzuttievykh vyrobnytstv: shum ta vibratsiia [Occupational factors and their influence on the health of workers of shoe productions]. Ukrainian journal of occupational health. 2016; 1(46): 74-8. doi.org/10.33573/ujoh2016.01.074. [in Ukrainian].
27. Chen M, Chiu C, Chen S. Risk assessment of metabolic syndrome prevalence involving sedentary occupations and socioeconomic status. BMJ Open. 2021; 11(12): 1-9. DOI: 10.1136/bmjopen-2020-042802.
28. Yarborough C, Brethauer S, Burton W, et al. Obesity in the workplace: Impact, outcomes and recommendations. J Occup Environ Med. 2018; 60 (1): 97–107. DOI: 10.1097/JOM.0000000000001220.
29. González-Yebra A, Muñoz-López D, Preciado-Puga M et al. Metabolic Risk Factors in low Physical Activity Shoe Workers of Central Mexico. Int J Clinical Studies and Medical Case Reports. 2021; 13(2): 1-4. DOI: 10.46998/IJCMCR.2021.13.000309.