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Original article

FRAMINGHAM RISK SCORE IN DEFINED GROUPS OF WORKERS

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Abstract

The Framingham Risk Score (FRS) is a multivariable system for risk assessment of cardiovascular disease (CVD) in the next 10 years.

Aim. To determine and to compare the risk of CVD by calculating the FRS in four groups of workers classified according to the current International Labor Organization classification.

In a cross-sectional study, 356 workers classified into four groups according to skills, work tasks and workloads at their workplace, i.e., Group 1 including manual workers to Group 4 including workers with dominantly intellectual work, were included. The FRS was calculated by software application using data of risk factors for CVD development and categorized as low (risk of CVD lower than 10%), moderate (10-20%) and high (higher than 20%).

The mean FRS value for the whole study sample was 10.3 ± 9.3% indicating low to moderate CVD risk in the next 10 years. The highest value of FRS was registered among study subjects of Group 1 (14.3%) which was significantly higher compared to the mean values registered in Groups 2 (10.9%), 3 (10.8%) and 4 (6.7%).

The highest risk of CVD development was registered among manual workers, while the lowest one in the group of workers with dominantly intellectual work.

Keywords: cardiovascular disease, Framingham Risk Score, risk factors, working population, workload

Introduction

The exceptional public health importance of cardiovascular diseases (CVD) imposes the need to determine the risk of their occurrence[1]. Cardiovascular risk (CVR) is defined as "probability of occurrence of cardiovascular disease in a defined period of time, under the influence of several risk factors at the same time". Each of the risk factors, to a certain degree, increases the risk of cardiovascular diseases, but their combined effect significantly increases the risk and imposes the need for intervention[2,3].

The term "CVR assessment" refers to the procedure of identification of persons with the highest risk of CVD and assessment of the rate of occurrence and survival from CVD[4]. There are numerous scoring systems for CVR categorization and by using software applications it can be calculated and categorized[3].

One of the most commonly used score systems is the Framingham risk score (FRS) system; it is a multivariable algorithm for assessing the risk of CVD (coronary artery disease,

cerebrovascular disease, peripheral artery disease and heart failure) in the next 10 years for persons between 30 and 74 years of age not diagnosed with cardiovascular disease and/or diabetes. The factors, i.e., the elements according to which the risk of developing these diseases are categorized as low, medium and high are: sex, age, level of total and high-density lipoprotein (HDL) cholesterol, value of systolic blood pressure, regular therapy for hypertension, presence of diabetes and CVD and smoking status. A more aggressive approach to the modification of risk factors is needed in persons with a high risk of developing cardiovascular diseases. Apart from the value of the 10-year risk, the FRS also estimates the "vascular age", which determines the "age" of the arteries according to age, health status and risk factors present in the subject. The application of the FRS system for assessing the risk of cardiovascular diseases has been validated in the USA, and it has also been applied in the countries of Europe, the Mediterranean and Asia[3,5].

The extension of working life, changes in the type and flow of work, the automation of work processes and the increasing representation of the sedentary way of working have a direct impact on an increase in CVR among the working population. Hence, there is a great importance of identifying CVR in certain types of occupations or job categories according to their characteristics.

According to the International Standard Classification of Occupations of the International Labour Organization (ILO) from 2012, occupations are classified into four groups in terms of skills, work tasks and workloads[6].

The first group includes occupations characterized by performing simple and routine physical or manual tasks (cleaning, lifting loads, assembling or sorting machine parts), such as janitors, general workers, factory workers and warehouse workers.

The second group includes jobs in which devices, machines or electronic devices are used, driving vehicles, maintenance and repair of mechanical or electrical devices and equipment, etc., such as professional drivers, electricians, etc.

The third group includes the performance of complex technical and practical work tasks that require extensive technical and procedural knowledge in specialized areas, e.g., nurses and laboratory assistants.

The fourth group includes jobs where the performance of work tasks requires mental ability to solve complex problems, make decisions and creativity. Tasks usually include analysis and research in specific areas, diagnosis and treatment of diseases, transfer of knowledge to others, design of machines and processes in construction and in production processes, and require a high degree of education and excellent communication skills. These include: professors, engineers, economists and doctors.

The timely identification of asymptomatic persons with increased CVD, as well as the early detection of risk factors with the application of risk scoring systems among workers with different occupations/jobs, has a great importance and represents the basis for the primary prevention of CVD in the working population.

Aim of the paper

The aim of the paper was to determine and compare FRS among the four groups of workers classified according to the current recommendations of the ILO.

Material and methods

Study design and study population

This was a descriptive-analytical cross-sectional study involving 356 workers, aged 30 to 67 years, during their regular preventive medical examinations at the Institute of Occupational Health of the Republic of Macedonia, Skopje in the period of September 2020-September 2021. According to 2012 ILO Classification of Occupations, the participants were

divided into four groups each, with no statistically significant difference in size (18.8% in Group 1, 28.4% in Group 2, 22.2% in Group 3 and 30.6% in Group 4). The participation in the study was anonymous and on a voluntary basis. Respondents were informed about the objectives of the study and consent was obtained from each participant.

Study protocol

Data on demographic characteristics, workplace, work experience, and smoking status were obtained from the Demographic Characteristics, Workplace, and Work Activities Questionnaire designed for this study, and data on cardiovascular risk factors were identified as part of an occupational health specialist review and laboratory tests.

Categorization of cardiovascular risk was performed by applying the FRS system in a software application according to data on gender, age, level of total and HDL cholesterol, systolic blood pressure, smoking status of respondents, as well as regular therapy for hypertension, presence of diabetes and data on previous CVD[7].

Gender (male or female), use of regular hypertension therapy (yes/no), active smoking status (yes/no), presence of diabetes (yes/no) and data on previous CVD (yes/no) were determined as dichotomous variables.

Arterial blood pressure was measured with a mercury manometer in a sitting position on the participant's right arm on two occasions, after resting for at least 5 minutes before measurement, and the mean value was used for statistical analysis[8].

Laboratory tests, i.e., determining the levels of total cholesterol and HDL cholesterol, were carried out using the Cobas c 111 device (Rosche Diagnostics Ltd, Basel, Switzerland).

Each of the listed categories was automatically scored by the software application according to the individual classification of the elements, and according to the obtained FRS cardiovascular risk was categorized as low (lower than 10% risk of CVD), medium (10-20%) and high (risk higher than 20% for the occurrence of CVD)[4,9,10].

Statistical analysis

Data obtained were statistically analyzed using the statistical software SPSS 26.0 for Windows. Continuous variables are expressed as minimum, maximum and mean values with standard deviation, and nominal variables as absolute numbers and percentages. Statistical processing was performed using univariate statistical models, that is, $\chi 2$ test for testing differences in frequencies and Student t-test for testing differences in mean values. A statistically significant difference was determined by P values lower than 0.05.

Results

The distribution of workers according to gender was 193 men (54.2%) and 163 women (45.8%); the mean average age 46.5 ± 10 years, and 135 of them (37.9%) were active smokers. The average mean value of systolic blood pressure in all subjects was 126.59 ± 21.57 mmHg, and the average level of HDL cholesterol was 1.32 ± 0.39 mmol/l. 137 study subjects (38.5%) had a diagnosed chronic disease, 73 participants (20.5%) receive regular therapy for hypertension, and 12 participants (3.4%) have been diagnosed with diabetes. The mean value of FRS for the entire group of participants was 10.3 ± 9.3% (Figure 1).

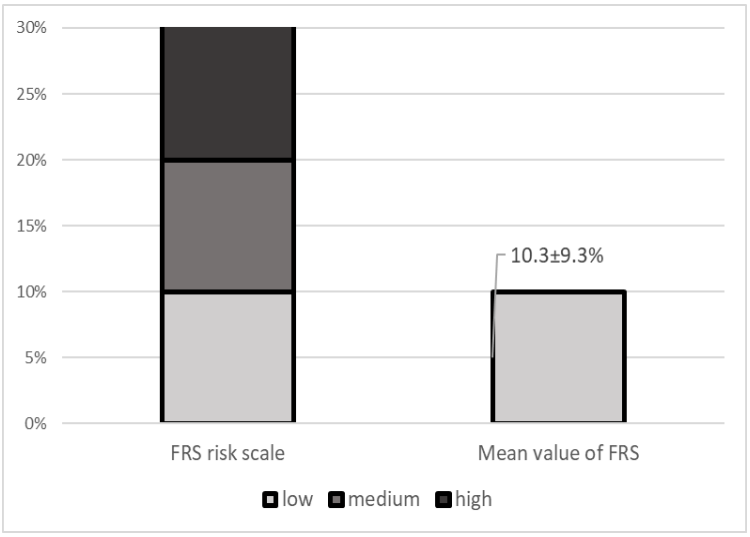

Fig. 1. Mean value of FRS for all participants compared to reference categories

Figure 2 shows the distribution of the four groups of participants according to gender. In Group 1, a statistically significantly higher preponderance of men than women was registered (P=0.000), while the difference in frequency between men and women in the other three groups was not statistically significant. Also, the preponderance of men in Group 1 was statistically significantly higher compared to their representation in Group 2 (P=0.000), Group 3 (P=0.000) and Group 4 (P=0.000), while the difference in the preponderance of men and women between the remaining three groups was not statistically significant.

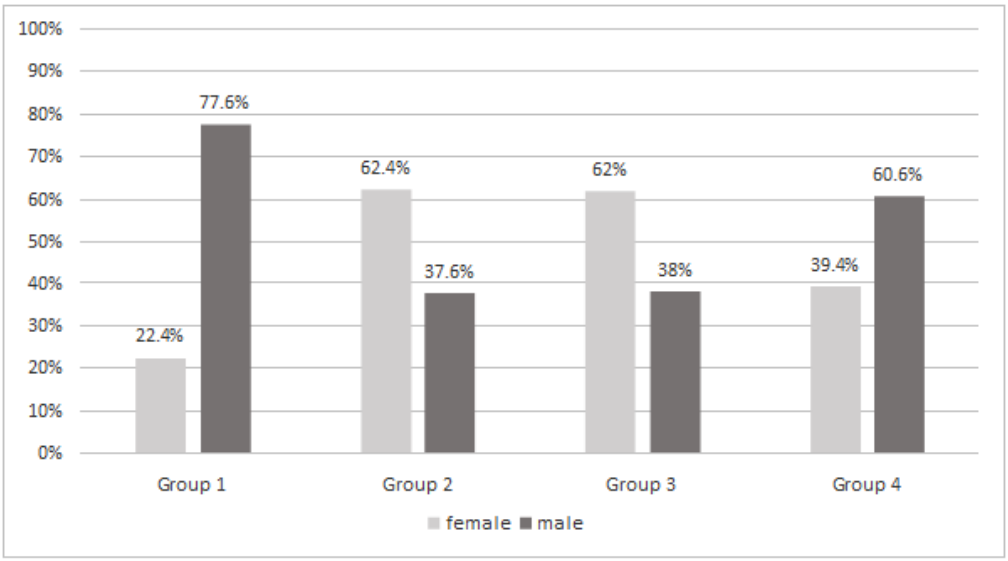

Fig. 2. Distribution of participants in groups according to their gender (%)

Figure 3 shows the average age of the study subjects from the four groups. A statistically significant difference was registered in terms of the average age of participants between Group 4 and Group 1 (P=0.000), Group 2 (P=0.000) and Group 3 (P=0.000), and the average age between the first three groups was similar.

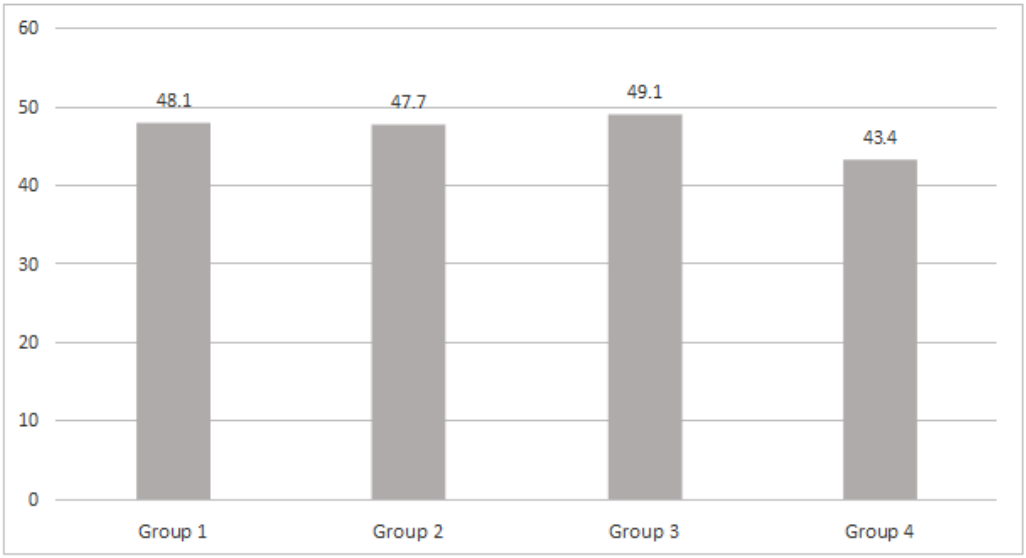

Fig. 3. Average age of participants in the groups (years)

The highest frequency of active smokers was registered in Group 1 and Group 2, and the lowest among participants from Group 4 (Figure 4). A statistically significant difference in the frequency of active smokers was registered between Group 2 and Group 3 (P=0.048), as well as between Group 2 and Group 4 (P=0.007).

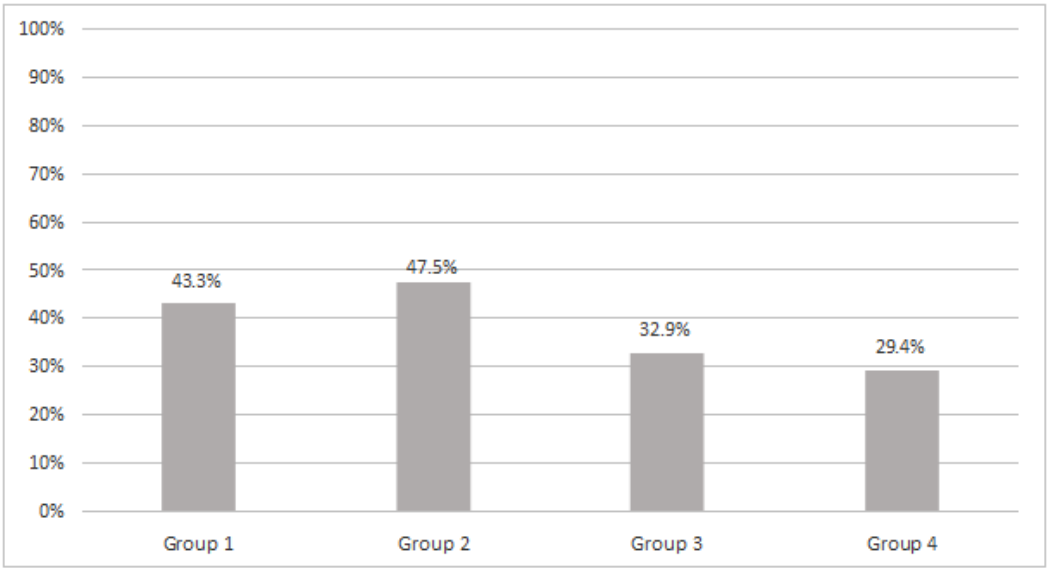

Fig. 4. Frequency of active smokers among participants from the four groups (%)

Figure 5 shows the average values of systolic blood pressure in the studied groups. The lowest average value of systolic blood pressure was registered among subjects from Group 4. The average value of systolic blood pressure among subjects from Group 1 was statistically significantly higher than its average value among subjects from Group 2 (P=0.028), Group 3 (P= 0.008) and Group 4 (P=0.000). Also, the average value of systolic blood pressure was statistically significantly higher in subjects from Group 2 compared to subjects from Group 3 (P=0.002), as well as in subjects from Group 3 compared to subjects from Group 4 (P=0.028).

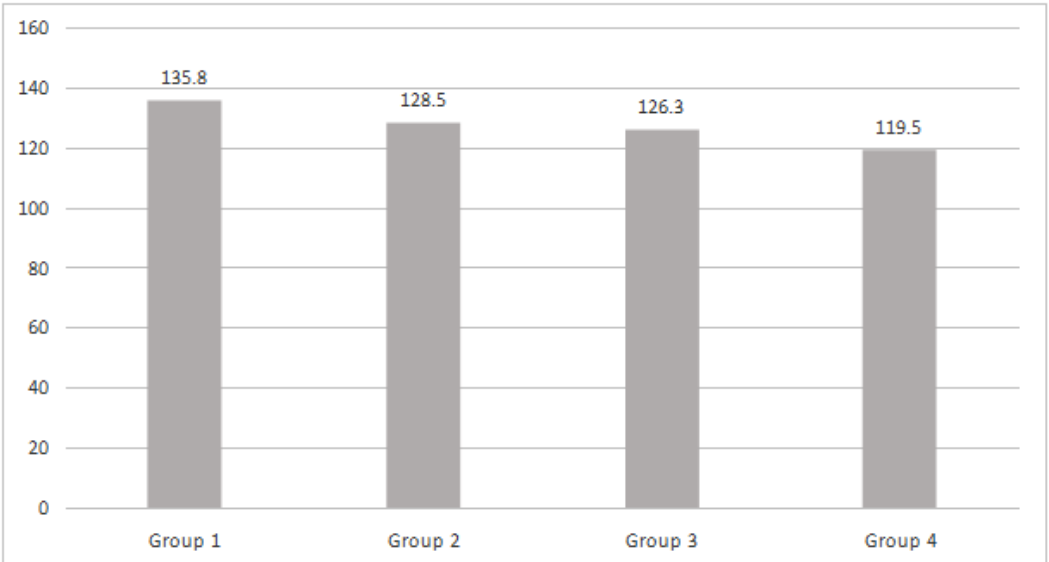

Fig. 5. Average values of systolic blood pressure in the four groups (mmHg)

Figure 6 shows the average level of total cholesterol in the four groups. The highest average level of total cholesterol was registered among participants from Group 3. A statistically significant difference in the average level of cholesterol was registered between Group 3 and Group 4 (P=0.026), while the differences in its level between the other groups were not statistically significant.

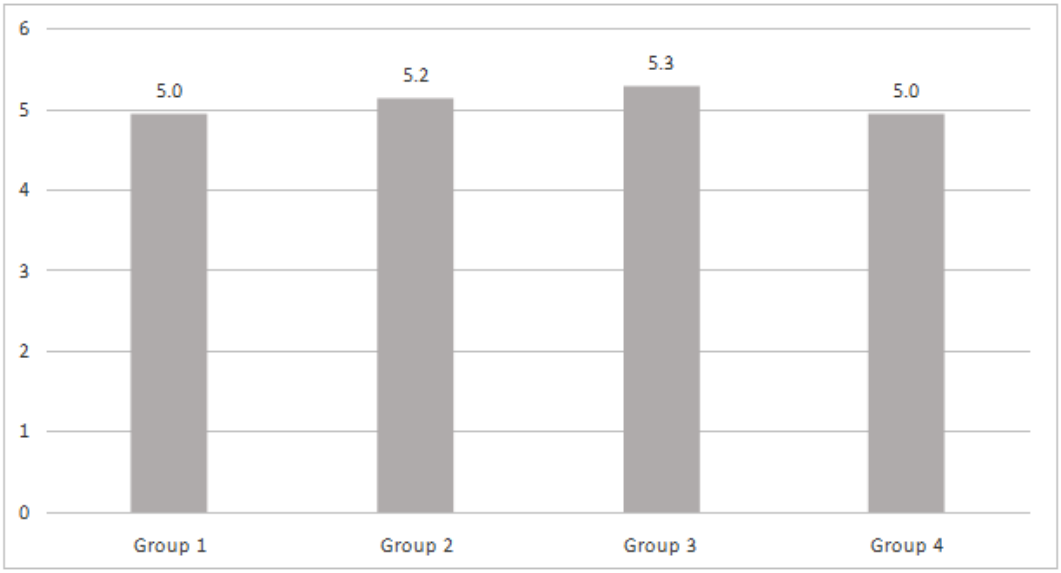

Fig. 6. Average level of total cholesterol in the four groups (mmol/l)

Figure 7 shows the average level of HDL cholesterol in the participants from the four groups. The average HDL cholesterol level in Group 1 participants was statistically significantly lower than its average level in Group 3 (P=0.001) and Group 4 (P=0.001). Also, the average level of HDL cholesterol among Group 2 participants was statistically significantly lower than its average level among Group 3 participants (P=0.045). The differences in the average levels of HDL cholesterol between subjects from other groups were not statistically significant.

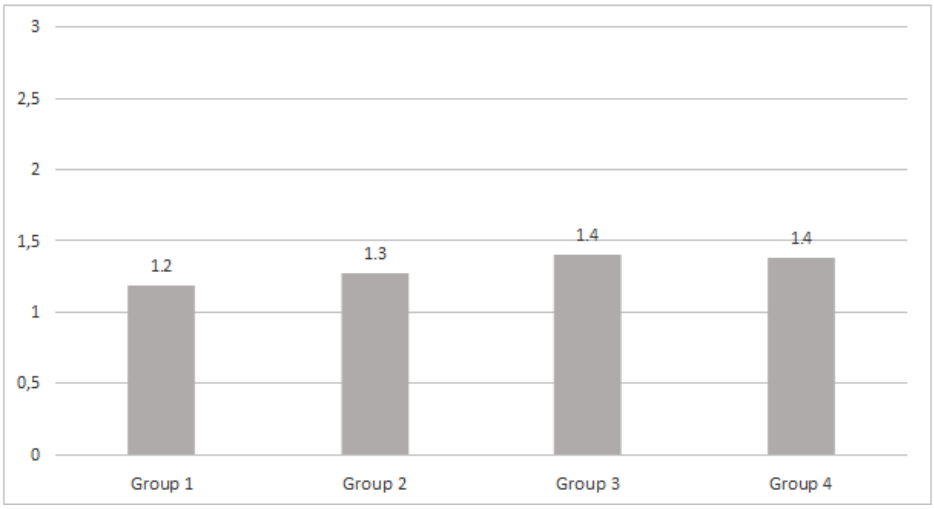

Fig. 7. Average level of HDL cholesterol in the four groups (mmol/l)

Figure 8 shows the frequency of participants from the four groups who receive regular therapy for hypertension. The lowest frequency was registered among participants from Group 4. A statistically significant difference was registered in the frequency of participants receiving regular therapy for hypertension between Group 1 and Group 4 (P=0.042), Group 2 and Group 3 (P=0.033) and Group 2 and Group 4 (P=0.000). The difference in the frequency of participants who receive regular therapy for hypertension between respondents from other studied groups was not statistically significant.

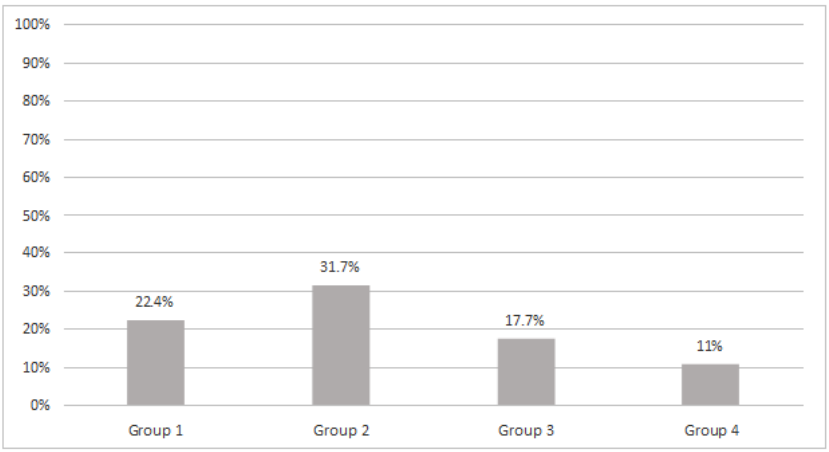

Fig. 8. Distribution of participants from the four groups receiving regular therapy for hypertension (%)

Regarding the frequency of participants with diabetes mellitus, no statistically significant difference was registered between participants from the four studied groups.

Figure 9 shows the mean FRS values of participants from the four groups. The mean value of FRS among participants from Group 1 was statistically significantly higher than its mean values among participants from Group 2 (P=0.000), Group 3 (P=0.000) and Group 4 (P=0.000). Also, the mean value of FRS among participants from Group 2 was statistically significantly higher than its mean value among participants from Group 4 (P=0.000), and the mean value of FRS among participants from Group 3 was statistically significantly higher than its mean value among participants from Group 4 (P=0.000).

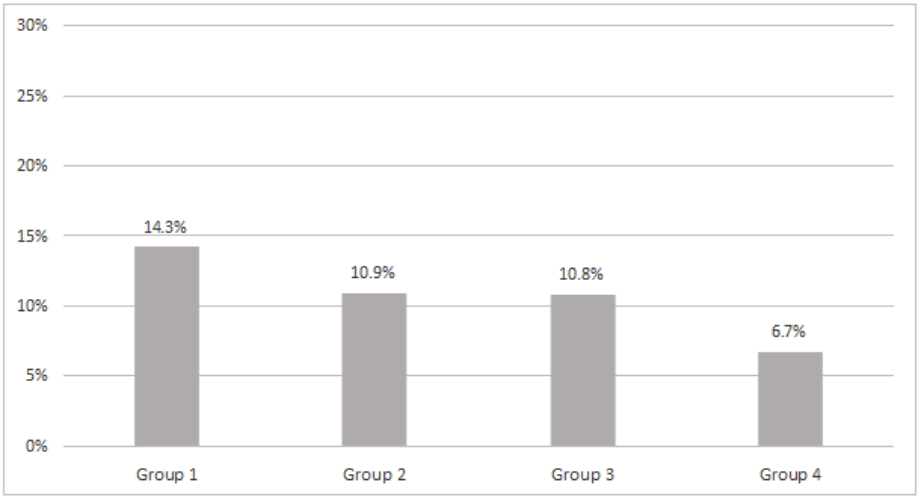

Fig. 9. Mean values of FRS among participants from the four groups (%)

The mean value of FRS among participants from Group 1 indicated an intermediate risk of developing cardiovascular disease, the mean values of Group 2 and Group 3 were on the borderline between low and medium risk of developing cardiovascular disease, while the mean value of FRS among participants from Group 4 indicated a low risk of developing cardiovascular disease.

Discussion

CVDs present a global public health problem being the leading cause of death according to the latest WHO data. An estimated 17.9 million people have died from CVD in 2019 accounting for 32% of all deaths globally, and more than three-quarters of deaths caused by these diseases were registered in developing countries Much of CVDs can be prevented by addressing their modifying risk factors, such as tobacco use, unhealthy diet and obesity, physical inactivity, and harmful alcohol use[1]. Regarding the working population, the results of several studies indicate that men between the ages of 20 and 64 in semi- and unskilled manual occupations have three times higher risk of premature death from CVDs compared to those in highly skilled, specialized and managerial positions. Also, the results of several studies indicate a higher frequency of certain CVD risk factors (e.g., hypertension and smoking) among workers in manufacturing sectors, especially in construction, compared to non-manual workers, e.g., workers in service activities[11,12].

Considering the high frequency and high mortality from CVDs, several algorithms have been created for the quantification of the risk of their occurrence in separate groups of the general population in recent decades, which enables adequate targeting of preventive activities towards the risk factors of these diseases. One such algorithm is the FRS, which, through a software application that includes the most important risk factors, determines the risk of developing CVDs (coronary artery disease, cerebrovascular disease, peripheral artery disease and heart failure) in the next 10 years for people aged between 30 and 74 years[5].

In the current cross-sectional study, the risk of CVDs was determined by the FRS in 356 respondents from the working population, 163 men and 193 women with an average age of 46.5 years. The study subjects were classified into four groups with similar numbers in line with the current ILO classification according to skills, work tasks and workloads at the workplace. Respondents from Group 1 were unskilled and semi-skilled workers whose work tasks consisted of heavy physical work; respondents from Group 2 were qualified and highly qualified workers whose work activities included physical work to a lesser extent than the

previous group; Group 3 consisted of workers from a specialized field whose work tasks included light physical work, while Group 4 included workers who were engaged in intellectual work.

The average value of FSR was 10.3% indicating a borderline between low and medium risk for the occurrence of CVD in the next 10 years. Given the differences in the values of the variables from which the FRS was calculated, its average values in the four groups were different.

The distribution of respondents by gender in Groups 2, 3 and 4 was even, which was not the case with their distribution in Group 1 where the representation of men was statistically significantly higher than that of women. Also, the frequency of men in this group was statistically significantly higher than their frequency in the other groups. In both cases, it was an expected finding considering the type of work activities of participants from Group 1. On the other hand, the mean age of Group 4 participants was statistically significantly lower than the mean age of participants from the other groups, which again represents an expected finding having in mind the nature of the work activities of the participants from the four groups. The results of several studies indicate a correlation of gender and age with separate risk factors for the occurrence of CVDs, but that "isolated" approach has been modified with the FRS, which implements an integral calculation of the risk by including nine factors[2].

There were about 38% active smokers of the total number of respondents that responded to their representation registered in our previous studies[13,14]. The frequency of active smokers in the individual groups ranged from about 30% in Group 4 to 47.5% in Group 2, with a statistically significant difference in their frequency between Group 2 and Group 4. The frequency of active smokers registered in other studies in workers from different occupations was different, that is, it ranged from 11% among office workers in Iran to 91% among construction workers in India[15,16]. Smoking is a risk factor for the occurrence of CVDs registered in numerous studies. The results of the mentioned study from Iran indicate a statistically significantly higher value of FRS in active smokers compared to its value in non-smoking respondents[15].

The mean value of systolic blood pressure in the total number of subjects was within the limits of its reference values, that is, 126.59 mmHg, which is similar to the value obtained in other studies[17]. The mean values of the systolic blood pressure among respondents from the four groups were also within the reference values, with its highest value being registered among respondents who did heavy physical work, and the lowest among respondents who were engaged in intellectual work.

The results of several studies indicate increased total cholesterol levels and decreased HDL cholesterol levels in different groups of workers. Thus, according to the results of a survey of construction workers from Senegal with a mean age of 44.9 years, increased total cholesterol level or decreased HDL cholesterol level were registered in more than 50% of respondents[18]. Increased total cholesterol levels were registered in 24.3% of workers in the oil and gas industry in Italy, that is, in 35% of workers working in the production of chemical materials for construction[17,19].

In the current study, the mean levels of total cholesterol and HDL cholesterol in all subjects were within their reference values. Similar results were obtained in a study conducted in Iran that included 8,138 subjects with a mean age similar to the mean age of subjects in our study[20]. The mean cholesterol levels among subjects from all four groups were within their reference values, with a statistically significant difference registered in subjects from Groups 3 and 4. Also, the mean levels of HDL cholesterol in subjects from all four groups were within their reference levels, but the average HDL cholesterol level in subjects from Group 1 was statistically significantly lower than its mean levels among subjects from other groups.

Regular therapy for hypertension was used by one fifth of the total number of participants. Regarding the frequency in the four groups, its statistically significantly higher frequency was registered among respondents from Group 1 and 2 compared to Group 4. The frequency of diabetes mellitus type 2 in the entire group of respondents was 3.4%. The results on the frequency of hypertension and diabetes obtained from surveys of workers from different sectors have shown wide variations depending on the number of respondents included in the study, their characteristics (gender, age, education, accessibility to health facilities, etc.), their jobs, etc. Similar results to those obtained in the current study, i.e., the frequency of hypertension of 19.6% and of diabetes mellitus type 2 of 1.3% were obtained in the Portuguese study in which 332 respondents employed in a university (teaching and administrative staff)[21]. Research results carried out in our country in recent years have indicated a higher prevalence of diabetes (7.1% among construction workers, 10.4% among textile workers and 4.7-6.9% among administrative workers), while the frequency of hypertension diagnosed by a doctor is 15.6% of construction workers and 44.3% of textile workers[19]. A higher prevalence of hypertension was registered in the previously mentioned Italian survey of workers in the oil and gas industry (35.5%), as well as in a survey of construction workers in India (31.9%)[16,17]. A lower prevalence of hypertension, on the other hand, was registered among construction workers in Senegal (17.8%) and among respondents from the 2018 Iranian study (12.8%)[18,22]. In the previously mentioned study of about 500 industrial workers from Nepal, the frequency of doctor-diagnosed hypertension and diabetes was 33.6% and 4.2%, respectively[23]. The prevalence of diabetes recorded in an Irish survey of construction workers was 1.2%[24], while a Spanish study involving workers from different sectors reported a higher risk of hypertension and diabetes in construction workers compared to the risk in workers from other sectors[12].

The value of FRS with the integral software calculation in which the previously mentioned variables were included for all respondents was 10.3%, that is, it is on the border between low and medium risk for the occurrence of CVD in the next 10 years. Viewed by groups, respondents from Group 1 (workers exposed to the greatest physical loads during work) had the highest average value of FRS (14.27%), which indicates an average risk for the occurrence of CVD in the next 10 years. The average value of FRS among respondents from Groups 2 and 3 was on the border between low and medium risk of CVD occurrence in the next 10 years, while this risk among respondents from Group 4 (workers engaged in intellectual work) according to the value of FRS was low (6.73%).

The results regarding representation of cardiovascular risk factors and categories of FRS among different groups of workers are different. Thus, in the Indian study with workers in the chemical industry, high blood pressure values and hypercholesterolemia were registered in about 40% of respondents[16]. In the Iranian study with office workers, a statistically significantly higher value of FRS was registered in subjects with increased values of systolic pressure and total cholesterol and low levels of HDL cholesterol compared to other subjects[15]. In a Brazilian study involving agricultural workers, a statistically significant association of the FRS value with gender, active smoking and systolic blood pressure value was registered[25].

In Group 1 participants who had the highest average value of FRS, a statistically significant difference was registered in relation to the average values of systolic blood pressure, the average HDL cholesterol levels and the frequency of subjects receiving regular therapy for hypertension compared to all other groups, especially in relation to respondents from Group 4, which included occupations with predominantly intellectual work. The results of the British and Finnish study on the cardiovascular risk in separate groups of workers also indicated the so-called paradox of physical activity at the workplace, i.e., an increased risk of CVDs among workers in jobs with a high intensity of physical activity compared to other

workers, which was due to a higher frequency of cardiovascular risk factors among these workers compared to other workers[26,27].

The results of this study should be interpreted in the context of its limitations. Regardless of the fact that they are characteristic of individual groups, their heterogeneity by gender and age may have an impact on the results obtained and their interpretation. Also, although it is not statistically significant, the difference in the number of separate groups can have an impact on the results obtained and their interpretation. On the other hand, this study is the first one on cardiovascular risk among workers from different groups according to skills, work tasks and workloads at the workplace, and the results obtained allow adequate targeting of preventive activities to the modifying risk factors for the occurrence of CVDs and health protection of the working population.

Conclusion

The results obtained have shown that the risk of CVDs in the four groups of workers is the highest among workers exposed to the greatest physical loads during work, and the lowest among workers engaged in intellectual work. Also, the results obtained indicate the need of implementation of preventive activities towards the risk factors for CVDs among all workers, and special attention should be paid to the implementation of these activities among manual workers.

Conflict of interest statement. None declared.

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