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Risk Factors for Heart Disease in Working Railwaymen

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Abstract
Heart diseases are the most common non-communicable diseases worldwide. We examined the prevalence of risk factors for heart disease among a sub-population of working men. In total, 11,059 railway crew workers of the Russian Railways Company were included in the study. We also asked participants to answer several questions based on the WHO STEPwise approach to surveillance (STEPS) translated into Russian. Only 30% of drivers had normal body mass index (BMI), whereas 70% were overweight or obese. In 12% of subjects, total cholesterol was higher than 5 mmol/L. In 15% of participants, glucose level was higher than 5.5 mmol/L. 38% of drivers reported smoking. Physical inactivity was registered in 54% of persons. Only 29% ate according to the key principles of good diet quality. 24% of respondents had a family history of heart disease. MANOVA demonstrated that BMI was determined by age, profession, smoking, physical inactivity, and diet quality. As age increased, the number of people with normal cholesterol levels decreased. It was demonstrated that a correlation existed between glucose levels and BMI. In the total group, the correlation was 0.46 ($p < .05$). The correlation between those parameters increased due to age, from 0.33 in the <30 years of age group up to 0.52 in the >50 years of age group. This study demonstrated that there is a high prevalence of risk factors for heart disease in train drivers in the Russian Federation.

Keywords
non-communicable disease, health promotion and disease prevention, health care issues, railway, work disorders, occupational health

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Keypoints

- There is a high burden of heart disease among professional train drivers;
- Our results demonstrated a high prevalence of overweight and obesity among railway train drivers;
- We demonstrated an increasing correlation between BMI and glucose level due to age in railway drivers;
- We observed an apparent paradox: Medical examination for the profession is intended to select the healthiest people from the population, but in reality, the long-term health outcome is less than optimal.

Introduction

Heart diseases are the most common non-communicable disease worldwide. Every year the number of registered cases of heart disease increases. Heart disease is registered in low-, middle-, and high-income countries. The number of people with heart disease increases every year. Mortality from non-communicable disease has steadily increased from 50% in 1990 to 82% in 2017 (Afshari et al., 2020). In the literature, the problem of stigmatization of people with non-communicable diseases has been discussed (Rai et al., 2020). Decreasing the mortality from non-communicable diseases is one of the main goals of sustainable development (Afshari et al., 2020; Rai et al., 2020).

Obesity and overweight are well-known risk factors for the development of heart disease (Gill et al., 2021). Prevalence of obesity and overweight is consistently recorded worldwide. It is likely that there will be an increase in the number of people with obesity in the coming century. Note that body mass index (BMI) is the most utilized indicator of overweight and obesity prevalence in epidemiological studies (Oguntade et al., 2021). In Russia, overweight, including obesity, was detected in 66.1% of men and 63.0% of women. The incidence of obesity in men increases with age from 19 to 65 years. In women, the frequency of obesity increases slowly from 19 to 40 years of age, then there is a rapid increase up to 65 years (Martinchik et al., 2021).

Physical inactivity has been suggested to be one of the 'diseases of civilization' (Yuan et al., 2021). Physical inactivity is a risk factor for obesity and an independent risk factor for heart disease (Duijvestijn et al., 2020). It has been recorded that moderate physical activity is a preventive factor for heart diseases. The possibility of using increased physical activity to treat overweight and obesity has been discussed (Duijvestijn et al., 2020; Yuan et al., 2021).

Healthy diet has been proposed to prevent obesity and heart disease. The WHO recommended taking at least 400 g of vegetables or fruits per day for the prevention of heart disease (Strauss et al., 2021). High salt intake is a risk factor for arterial hypertension. Prevalence of fast-food restaurant (or pre-prepared food or high-processed food) feeding results in a decrease of vitamin, mineral, and food fibers and an increase in caloric intake. All these factors are frequently reported for obesity and heart diseases (Riccardi et al., 2021). Also, food intake between main meals is proposed to be a risk factor for obesity development (Strauss et al., 2021).

Another risk factor for heart disease is smoking. Both active and passive smoking have been suggested to be risk factors for heart disease. Moreover, electronic cigarette smoking and vaping are also risk factors. Smoking cessation may reduce the subsequent risk of heart disease development (Lovasi et al., 2021).

Age is another risk factor for obesity and heart disease development. The number of people with obesity and heart disease increases with age. Genetics is one of the known risk factors for heart disease development; for obesity, the role of genetics has been discussed. Male gender is one of the well-known genetic risk factors for heart disease (Seo et al., 2021). Consistent with the presence of genetic risk factors, the risk of heart disease is increased among people who have relatives with heart disease (Shinji et al., 2018). In Russia, arterial hypertension was diagnosed in 41% of all working people (predominantly I degree), more frequently observed in the obese (62.5%) and in males (45%) (Belyakova et al., 2021).

At the molecular level, glucose and cholesterol levels in blood are both markers of heart disease development and risk factors for fatal events. An association has been demonstrated between obesity and glucose levels. Correction of glucose levels in blood may prevent development of several heart diseases. Cholesterol levels, are used for the prognosis of development of heart disease, as one component of the systematic coronary risk estimation (SCORE) scale—the most used in general medicine for the prediction of fatal cardiac events (Whayne & Saha, 2019).

Investigation of risk factors for heart diseases is the first step toward the development of prevention programs (Graham et al., 2021). Such programs may reduce the burden of non-communicable diseases (Afshari et al., 2020). It is most relevant for working-age people (Blangiardo et al., 2020; Li et al., 2020).

The aim of the present study was to investigate the prevalence of risk factors for heart disease among a population of working men.

Materials and Methods

The investigation complies with the Declaration of Helsinki and was approved by the inter-university ethical committee, Moscow (Protocol number: 07-19) on July 18, 2019.

In total, 11,059 railway crew workers (drivers and their assistants) of the Russian Railways Company were included in the study (8.5% of total railway crew workers of Russian railways). Investigation was organized on Oktyabr'skaya railway (https://ozd.rzd.ru/). It traverses from Moscow to the North-West European part of the Russian Federation (RF), with a length of 10,378.4 km in 2021. We included all train drivers from Oktyabr'skay railway. Due to Russian Federal regulations, until 2021 only men were permitted to drive the trains.

Medical examination of railways crew workers is undertaken once per year as required by Russian legal regulation. Without these medical examinations, the person is not allowed to drive. As a minimum, the medical examination includes:

- Obtaining of weight and height;
- Determination of blood cholesterol and glucose.

Medical examination was undertaken in the morning, participants did not eat and drink after night sleeping. Smoking is allowed up to 2 hr before medical examination. Weight was measured in participants wearing only underwear.

Blood was taken in the amount of 5 mL from the cubital vein into Vacuette tubes with the Clot Activator. Total blood cholesterol and glucose were determined by colorimetry using a HumaStar 600 analyzer (HUMAN, Germany). HUMAN (Germany) reagent kits were used.

The results of medical examinations were entered into a common database with personal information of railways crew workers removed. Thereby written informed consent of train drivers was not required.

We also asked participants to answer several questions based on WHO's STEPwise approach to surveillance (STEPS—https://www.who.int/teams/noncommunicable-diseases/surveillance/systems-tools/steps/instrument) translated into Russian (Bojcov, 2016).

Participants were distributed into several groups, which were used as categorical variables for statistical analysis:

1. BMI
1.1. With normal: BMI 18 to 25 kg/m^2;
1.2. With overweight: BMI 25to 30;
1.3. With obesity: BMI 30 and more.
2. Cholesterol level: normal–5 mmol/L or 200 mg/dL and lower; high.
3. Glucose level: normal–5.5 mmol/L or 100 mg/dL and lower; high.
4. Results of questionnaire.
4.1. Smokers (who wrote: "I smoke"); non-smokers.
4.2. Physical activity.
4.2.1. Normal—at least 60 min/day walking 6 to 7 days or/and at least 30 to 40 min of additional physical activity at least 3 to 4 times a week.
4.2.2. Physical inactivity.
4.3. Diet status.
4.3.1. Healthy: at least 400 g of vegetables and fruits per day, every day of the week with at least four of five sub-criteria from those:
   - as rule, did not add additional salt with food,
   - as rule, did not visit fast-food restaurants,
   - as rule, did not eat prepared (shop purchased) food,
   - ate 3 to 4 times a day,
   - did not eat additional food between main food intakes.
4.3.2. Unhealthy.
4.4. Genetic status.
4.4.1. Problem genetics—if some relatives (mother, father, brother, sister, son, daughter) have cardiovascular diseases.
4.4.2. Non-problem genetics.

Statistics were calculated in programs Excel for Windows 2013 and Statistica for Windows 13.5. Mean, percentage of cases, and standard deviations from the mean were calculated. ANOVA and MANOVA were used. Means were compared by *t*-statistics (because the normal distribution of parameters was determinate). Also, the χ^2-statistic was used to examine the differences between categorical variables in the groups. Linear and multiple correlations were calculated. The $p < .05$ was adopted as a significance criterion.

Results

About 35.5% of the studied group were driver's assistants (Table 1). Mean age of the group was 38 years. Mean BMI was 26.4 kg/m^2. 30% of train workers had normal BMI, 70% were overweight or obese. Only 0.027% of persons had BMI <18.5 kg/m^2. The minimum observed BMI was 16.9 kg/m^2. Mean cholesterol level in blood was 4.2 mmol/L. In 12% of subjects, the total cholesterol was higher than 5 mmol/L. Mean blood glucose level in the morning, before a meal, was 5.2 mmol/L. In 15% of persons, glucose level was higher than 5.5 mmol/L. 38% of drivers reported smoking. Physical inactivity was found in 54% of persons. Only 29% ate according to the main principles of healthy diet. Genetic risk factors were reported by 24% of respondents.

MANOVA demonstrated that BMI corresponded with age, profession, smoking, physical inactivity, and dietary status (Table 2). BMI slowly increased due to age (r=0.21, p<.05). Drivers' assistance has lower BMI than drivers

Table 1. General Description of Group.

Criteria	Significance
Profession	
• Driver	7,138 (64.5%)
• Driver's assistant	3,921 (35.5%)
Age, years	38.3 ± 10.2
BMI, kg/m^2	26.4 ± 3.0
BMI-group	
• Normal	3,289 (29.8%)
• Overweight and obesity	7,767 (70.2%)
Cholesterol, mmol/L	4.2 ± 0.8
Cholesterol group	
• Normal	9,703 (87.7%)
• High	1,356 (12.3%)
Glucose, mmol/L	5.2 ± 0.8
Glucose group	
• Normal	9,415 (85.1%)
• High	1,644 (14.9%)
Smoking	
• No	6,830 (61.8%)
• Yes	4,229 (38.2%)
Physical inactivity	
• No	5,109 (46.2%)
• Yes	5,950 (53.8%)
Unhealthy diet	
• No	3,114 (28.2%)
• Yes	7,945 (71.8%)
Genetics	
• No	8,431 (76.2%)
• Yes	2,628 (23.8%)

Note. BMI = body mass index.

(p < .05). Participants with physical inactivity and unhealthy diet have higher BMI than those without physical inactivity and healthy diet ($p < 0.05$).

Cholesterol levels were dependent upon age and genetics. Glucose levels depended on age, smoking, diet, and genetics. Age dependence of glucose and cholesterol levels will be demonstrated below. Participants with genetic factors had higher blood cholesterol and glucose levels (p < .05). Participants with unhealthy diet had higher glucose levels than those with healthy diet (p < .05).

The largest proportion of drivers was aged >30 years (Table 3). For example, the <30 years group consisted of only 38% drivers. In contrast the group of >50 years consisted of 80% drivers. BMI was lower in the group <30 years of age than in >40 years of age. The percentage of people with normal BMI was higher in the group <30 years of age. Cholesterol level was lower in <30 years of age group than in >40 years of age groups. As a function of age the number of people with normal cholesterol levels decreased. Glucose level was lower in the group <30 years of age than in the group >50 years of age. The percentage of people with high glucose level was greater in the over 40 years of age group. There was no demonstrated age dependence in smoking prevalence, diet status, or physical activity. Genetic factors were reported much more often in the group <40 years of age than in the > 40 years of age group (see below for caveats on this statistic).

Table 2. Multiple Factor Analysis (MANOVA) for the Risk Factors.

Factor	BMI	Cholesterol	Glucose
Age group	***F* = 126.8**	***F* = 128.27**	***F* = 19.65**
Profession	***F* = 41.1**	*F* = 0.92	*F* = 0.28
Smoking	***F* = 53.3**	*F* = 1.53	***F* = 7.13**
Physical inactivity	***F* = 37.8**	*F* = 2.21	*F* = 0.10
Diet	***F* = 2399**	*F* = 2.95	***F* = 345.39**
Genetics	*F* = 0	***F* = 4.96**	***F* = 10669**

Note. P < .05 marked by bold. BMI = body mass index.

It was demonstrated that a correlation existed between glucose levels and BMI (Table 4). In the total group, correlation was 0.46. The correlation between those parameters increased due to age from 0.33 in <30 years age group up to 0.52 in the > 50 years age group. There were no significant correlations between cholesterol level and BMI. Multiple regression of glucose and cholesterol between BMI was 0.49 (F = 1,194, p = .00001).

Discussion

Train drivers appear (on the basis of local legal regulation of their health status) to be an unique working group (Gu et al., 2018). Due to local Russian legal regulation, there are medical restrictions on entering and remaining in the profession, so one might expect train drivers to be more healthy than the general population. From our data, this does not appear to be the case.

The prevalence of heart disease among train drivers in RF (Orlova et al., 2020) and other countries has been reported previously (Röösli et al., 2008). For example, arterial hypertension in train drivers in RF is twice as high as that in the general male population of the same age (78% in comparison with 40%; Orlova et al., 2020). High levels of heart disease were reported in metro drivers (Onninen et al., 2020), bus drivers (Cheung et al., 2020), truck drivers (Guest et al., 2021), and other drivers (Guest et al., 2021). So, it is evident that there is a high burden of heart disease among professional drivers. This is an apparent paradox: Medical examination for the profession is intended to select the healthiest people from the population, but in reality, the long-term health outcome is less than optimal. This paradox is the reason why the literature

Table 3. Age Difference Between Parameters.

Age, group	<30		30. . .40		40. . .50		>50	
Code of group	1	$p < .05$ from groups	2	$p < .05$ from groups	3	$p < .05$ from groups	4	$p < .05$ from groups
Number of persons	2,568		3,975		2,641		1,875	
Profession								
• Driver assistance	1,600 (61.6%)		1,330 (33.4%)		636 (24.1%)		373 (19.9%)	
• Driver	986 (38.4%)	2,3,4	2,645 (66.5%)	1	2,005 (75.9%)	1	1,502 (80.1%)	1
BMI, kg/m^2	25.5 ± 2.3	3,4	26.1 ± 2.8		27.1 ± 3.3	1	27.2 ± 3.4	1
BMI group								
• Normal	783 (36.1%)		1,276 (32.1%)		705 (26.7%)		525 (28.0%)	
• Overweight	1,683 (65.5%)		2,355 (59.2%)		1,509 (57.1%)		1,035 (55.2%)	
• Obesity	99 (3.9%)	2,3,4	344 (8.7%)	1,3,4	427 (16.2%)	1,2	315 (16.8%)	1,2
Cholesterol	3.8 ± 0.81	3,4	4.1 ± 0.78		4.3 ± 0.84	1	4.4 ± 0.85	1
Cholesterol group								
• Normal	2,419 (94.2%)		3,560 (89.6%)		2,214 (83.8%)		1,510 (80.5%)	
• High	149 (5.8%)	2,3,4	415(10.4%)	1,4	427 (16.2%)	2	365 (19.5%)	1,2
Glucose	5.1 ± 0.71	4	5.2 ± 0.78		5.3 ± 0.86		5.4 ± 0.89	1
Glucose group								
• Normal	2,340 (91.1%)		3,454 (86.9%)		2,130 (80.7%)		1,491 (79.5%)	
• High	228 (8.9%)	3,4	521 (13.1%)		511 (19.3%)	1	384 (20.5%)	1
Smoking								
• No	1,550 (60.4%)		2,548 (64.1%)		1,611 (61.0%)		1,121 (59.8%)	
• Yes	1,018 (39.6%)		1,427 (35.9%)		1,030 (39.0%)		754 (40.2%)	
Physical inactivity								
• No	1,128 (44.0%)		1,907 (48.0%)		1,238 (46.9%)		836 (44.6%)	
• Yes	1,440 (56.0%)		2,068 (52.0%)		1,403 (53.1%)		1,039 (55.4%)	
Unhealthy diet								
• No	759 (29.6%)		1,218 (30.6%)		668 (25.3%)		469 (25.0%)	
• Yes	1,809 (70.4%)		2,757 (69.4%)		1,973 (74.7%)		1,406 (75.0%)	
Genetics								
• No	1,709 (66.5%)		2,305 (58.0%)		2,582 (97.8%)		1,835 (97.9%)	
• Yes	859 (33.5%)	3,4	1,670 (42.0%)	3,4	59 (2.2%)	1,2	40 (2.1%)	1,2

Note. BMI = body mass index.

Table 4. Linear Correlation Matrix for BMI.

	Cholesterol	Glucose
All group	.045121	**.464306**
<30 years	.098538	**.334243**
30. . .40 years	.069009	**.423579**
40. . .50 years	.062175	**.509375**
>50 years	.025285	**.528836**

Note. Linear correlations with $p < .05$ marked in bold. BMI = body mass index.

discusses the role of environmental and occupational risk factors in development of heart disease in drivers (Guest et al., 2020) and pilots (Sutton et al., 2021). The first risk factor is shift work in combination with possible overworking time (Chapman et al., 2019). For example, systematic review demonstrated an increased frequency of stroke and cancer development in people engaged in shift work (Rivera et al., 2020). However, there seems to be no evidence of an influence of shift work on obesity development (Tiwari & Balasundaram, 2021). The role of shift work as an arterial hypertension risk factor has been discussed (Hannemann et al., 2021), however, it should be noted that not only professional drivers undertake shift work. Police officers, firefighters, and others also have shift work, but we did not find any reports of obesity or heart disease prevalence in those groups: male firefighters (Gurevich et al., 2017) and male officers (Heinrich et al., 2020). However, in a systematic review, a high prevalence of obesity was demonstrated in professional drivers in Australia (Chapman et al., 2019).

Other occupational risk factors for train drivers have been discussed as risk predictors for heart diseases.: noise, electrical and magnetic, vibration, chemical factors, and seat position (Loginova et al., 2021). Also, the stress factor has been discussed (Baek et al., 2017).

A WHO systematic report demonstrated the role of noise exposure in development of ischemic heart diseases, stroke, and arterial hypertension (Teixeira et al., 2021).

Table 1 of our results demonstrates a high prevalence of overweight and obesity among railway train drivers (70%). It is evidently a higher level of obesity in train drivers than in the general Russian population (44%; Shal'nova et al., 2020). Train drivers have higher levels of obesity than Russian male police officers (30%), firefighters (54%) (Gurevich et al., 2017) as we demonstrated previously. Our results correspond to literature data describing a high level of obesity in train drivers in Australia (up to 60%; Chapman et al., 2019; Clarke et al., 2022) France (50.1%; Garcia et al., 2018), and some other countries (Kimura et al., 2019; Spicer & Miller, 2016). It was unexpected to find a high prevalence of obesity in train drivers, because, due to Russian legal regulation, men with BMI >40 kg/m^2 are not allowed to be at work.

Results from Table 2 provide that age is the main independent risk factor of changes in BMI, cholesterol, and glucose levels. This result is consistent with other studies (Drozek et al., 2019).

Table 3 is a detailed breakdown of the results of Table 2. As it can be seen from the table, the number of people with obesity and overweight, high levels of glucose and cholesterol increases due to age. This result is consistent with others published in literature (Lin et al., 2014). In contrast, smoking, physical activity, and diet status were not observed to change with age. It should be noted that local Russian legal regulation did not restrict smoking in the locomotive cabin.

We demonstrated that, in the older age group, there was a lower prevalence of reported genetic factors than in the younger group. This result appears anomalous. We suggest that it is possible that this discrepancy has a psychological origin and is a function of self-reporting for genetic factors. The question was: "Do your near relatives have heart diseases?" We assumed that the older age group respondents understood this question as related to *living* relatives.

Table 4 demonstrates a positive correlation between BMI and glucose level. Similar association was demonstrated in a systematic review for low- and middle incoming countries (Afshari et al., 2020; Gill et al., 2021; Rai et al., 2020). Based on literature, an association between BMI and diabetes development can be assumed. It has to be noted that, in the literature, age is also described as an independent risk factor for diabetes (Alwash et al., 2021).

Study Limitations

As for all survey-related research, this work has limitations. We do not know the degree of reliability of respondents' answers to the questionnaire.

Conclusion

In conclusion, to our knowledge, this is the first study to demonstrate that there is a high prevalence of risk factors for heart disease in train drivers in RF. Our results contribute to a foundation for the development of prevention programs for heart disease in workers.

Declaration of Conflicting Interests

The author(s) declared the following potential conflicts of interest with respect to the research, authorship, and/or publication of this article: E.A.Z. is the head of Central Directorate of Healthcare-branch of JSC "Russian Railways"; all other authors' declaration of no potential conflict of interest.

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