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# Features of working conditions and modifiable risk factors for cardiovascular diseases among employees of locomotive crews of the metro and railways in the city of Saint Petersburg

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**Abstract**

**Objective.** *To study the features of working conditions and modifiable risk factors among employees of locomotive crews depending on their place of work.*

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**Materials and methods.** *The survey included 599 employees of locomotive crews, all of them were male, machinists and their assistants: 313 worked in Russian Railways and 287 in Saint Petersburg Metro. All the participants answered the questionnaire on the features of working conditions and behavioral risk factors with the help of medical personnel.*

**Results.** *The studied groups differed with p<0.05 by working conditions. Russian Railways workers had 12-hour shift and metro employees 8-hour shift in 96 % and 81 % of cases, respectively. Machinists of Russian Railways were 4 times more likely to complain about overheating in summer and cooling in winter compared with metro workers. Moreover, machinists of Russian Railways were 7.5 times more likely to report that they were forced to repair the railways compared with metro workers. Employees of Russian Railways were 2.1 times more likely to smoke and consume excess salt, and 2.5 times more often ate irregularly (1–2 times a day) compared with metropolitan employees. Machinists of Saint Petersburg Metro had 2 times lower physical activity and 1.3 times more often ate in fast food restaurants. Workers of the Russian Railways had higher body mass index, diastolic blood pressure and fasting blood glucose level. At the same time metro workers showed higher values of waist and hip circumferences. Compared with metro workers, employees of Russian Railways over the past 12 months took a temporary disability certificate 4 times more often, visited the physician 9 times more often, and were admitted to the hospital 3 times more often. Metro employees were 8 times more likely to be suspended from driving than employees of Russian Railways.*

**Conclusion.** *This study showed the difference between working conditions and the presence of modifiable risk factors among workers of Russian Railways and Saint Petersburg Metro. The results may be useful for the development of preventive programs for the Russian Railways employees.*

**Keywords:** *locomotive crew employees, health, metropolitan, working conditions.*

**Conflict of interest:** None declared.

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## Introduction

Passenger rail transport plays a pivotal role in communication between megacities and smaller settlements. Rail transport is usually cheaper and more convenient for passengers compared with wheeled transport. For small distances between towns, rail transport can be more convenient than aviation. In addition, rail transport can be advantageous compared to aviation in the absence of an airport in a city or regular flights between cities [1].

Transport sector has a large impact on employment. One of the features of rail transport is that representatives of various professions work in this industry [2]. However, the most valuable are workers of locomotive crews (machinists and their assistants), who directly control the traffic [3].

The work of machinists is considered stressful and is associated with various psycho-emotional stress factors. In addition, there are working conditions-related risk factors, such as: noise, vibration, temperature changes, static posture [4]. Another negative factor for metro workers is the lack of sunlight [5].

Over the last years, many publications in the literature showed the presence of modifiable risk factors among workers of locomotive crews. Such studies claim that its combined effect leads to the development of chronic noncommunicable diseases (primarily cardiovascular) that are the main cause of temporary disability and early departure of drivers and their assistants from the profession [6].

The objective of this study is to investigate the features of working conditions and modifiable risk factors among employees of locomotive crews in megacity depending on their place of work — railways and metro.

## Materials and methods

The study was approved by the Intercollegiate Ethics Committee. The study was conducted in accordance with the Declaration of Helsinki Ethical Principles and Good Clinical Practices.

The study included 599 employees of locomotive crews, all of them were male, machinists and their assistants: 313 worked in Russian Railways and 287

Table 1. **Characteristics of study participants**

| Place of work | Number of machinists, % | Age, years | Work experience of machinists, years | Officially married, % | Live in separate apartment% | n | |
|---|---|---|---|---|---|---|---|
| Russian railway | 56.5% | 34.18±10.09 | 11.03±10.93 | 47.3% | 69.0% | 313 | 599 |
| Metro | 68.4% | 39.15±9.62 | 13.64±11.10 | 53.6% | 60.1% | 286 | |
| p | 0.79 | 0.071 | 0.18 | >0.89 | 0.85 | - | |

Table 2. **The comparison of groups by the organization of working process**

| Parameter | | Russian railway | Metro | p | |
|---|---|---|---|---|---|
| The length of shift | 8 hours | 4.2% | 81.1% | 0.0004 | 0.018 |
| | 12 hours | 95.8% | 6.6% | | |
| Schedule | Shifts | 51.8% | 91.3% | 0.016 | |
| | Rotating | 48.2% | 8.7% | | |
| The beginning of the shift before 6 a.m. | | 23.0% | 24.6% | 0.90 | |
| The end of the shift after 10 p.m. | | 21.7% | 14.0% | 0.75 | |
| Overworking | | 2.6% | 39.3% | 0.045 | |
| The way of getting to work | Public transport | 47.6% | 59.3% | 0.88 | |
| | Personal transport | 39.0% | 18.9% | | |
| | On foot | 13.4% | 21.8% | | |

in Saint Petersburg Metro. The groups were comparable by age, work experience and several other characteristics (table 1). 61.9% (n=372) were machinists, half of them were officially married, over 60% lived in separate apartments. The study included only citizens of Saint Peterburg by the year 2020. The written informed consent was waived from all the study participants.

All the participants answered the questionnaire on the features of working conditions and behavioral risk factors with the help of medical personnel. This questionnaire was developed by our team earlier using the STEPS tool [7].

Based on the results of the survey, the index of adherence to healthy lifestyle (HLS) was calculated for each participant [8]. High level of adherence to HLS identified in workers with no hypodynamia, salt-free or hypo-salt diet, adequate intake of vegetables and fruits, non-smokers, and those who drink less than 168 g of alcohol less than several times a week. A satisfactory level of adherence to HLS was determined in non-smokers with the absence of any other (no more than one) component of high level of adherence to HLS. Low level of adherence to HLS was determined in smokers or those with the absence of over two components of high level of adherence to HLS.

In addition, the machinists and their assistants answered the questions if they were suspended from driving, had unscheduled requests for medical help, took a temporary disability certificate and were admitted to the hospital over the last year. With the help of medical personnel, blood cholesterol and blood glucose levels were extracted from the results of the last medical examination. Arterial blood pressure and pulse were measured during a pre-trip medical examination.

The statistical analysis was performed in Excel and Statistica for Windows software. The comparison of quantitative data was performed with Mann-Whitney U-test and of categorial data — with $\chi^2$ method. The level of significance was set as $p<0.05$.

## Results

The studied groups differed with $p<0.05$ by working conditions. Russian Railways workers had 12-hour shift and metro employees 8-hour shift in 96% and 81% of cases, respectively. 51% of Russian Railways employees and 91% of metro workers indicated that they had shift work schedule. One fifth of the respondents usually had early shift start time (before 6 a.m.) and the same number — late shift end time (after 10 p.m.). Metro employees 15 times more often overworked compared with employees of Russian Railways. On average, the journey from home to work took 1 hour, half of the respondents took public transport and less than ⅕ went to work on foot (table 2).

In general, the studied groups did not differ by the frequency of working conditions risk factors (table 3). Machinists of Russian Railways were 4 times more likely to complain about overheating in summer and cooling in winter compared with metro workers. Moreover, machinists of Russian Railways were 7.5 times more likely to report that they were forced to repair the railways compared with metro workers.

The study revealed a difference in the frequency of behavioral risk factors between studied groups

Table 3. **The comparison of groups by the presence of working conditions risk factors**

| Parameter | Russian railway | Metro | p | |
|---|---|---|---|---|
| Noise in the cockpit | 42.2% | 48.4% | 0.90 | |
| Vibration in the cockpit | 42.5% | 46.7% | 0.93 | |
| Smell in the cockpit | 34.8% | 13.0% | 0.52 | |
| Cooling in winter | 30.0% | 7.7% | 0.019 | |
| Overheating in summer | 62.9% | 14.4% | 0.017 | 0.93 |
| The posture when driving is forced, sedentary | 40.9% | 31.9% | 0.85 | |
| Have been forced to repair the railways | 15.0% | 2.0% | 0.035 | |
| Have been forced to do a lot of movements while working | 47.9% | 48.2% | 0.99 | |
| Have been forced to go to work when felt unwell | 42.5% | 37.7% | 0.74 | |

Table 4. **The comparison of groups by behavioral risk factors**

| Parameter | | Russian railway | Metro | p | |
|---|---|---|---|---|---|
| Smoking | | 59.3% | 27.7% | 0.048 | |
| Alcohol abuse | | 60.7% | 59.3% | 0.98 | |
| Inadequate intake of vegetables and fruits | | 35.1% | 76.2% | 0.34 | |
| Irregular eating | | 59.1% | 23.3% | 0.040 | |
| Consuming fatty, fried, spicy foods | | 89.1% | 87.9% | 0.97 | 0.099 |
| Consuming semi-finished products, ready-made food | | 82.1% | 85.6% | 0.92 | |
| Eating in fast food restaurants | | 71.2% | 91.6% | 0.046 | |
| Excessive salt intake | | 89.3% | 40.7% | 0.032 | |
| Hypodynamia | | 29.0% | 61.9% | 0.050 | |
| index of adherence to an HLS | low | 59.3% | 27.7% | 0.76 | |
| | satisfactory | 30.0% | 63.9% | | |
| | high | 10.7% | 8.4% | | |

Table 5. **The comparison of groups by biological risk factors**

| Parameter | Russian railway | Metro | p |
|---|---|---|---|
| BMI, kg/m$^2$ | 32.86±12.10 | 27.47±10.56 | 0.022 |
| Waist circumflex, cm | 87.32±16.68 | 94.06±12.36 | 0.001 |
| Hip circumflex, cm | 92.31±16.34 | 96.23±15.60 | 0.014 |
| Waist and hip circumflex ratio | 0.95±0.17 | 0.98±0.12 | 0.001 |
| Systolic blood pressure, mmHg | 119.82±9.86 | 120.14±6.31 | 0.28 |
| Diastolic blood pressure, mmHg | 77.47±5.34 | 76.71±6.27 | 0.012 |
| Pulse, beats per minute | 72.35±7.99 | 75.83±4.91 | 0.11 |
| Blood glucose level, mmol/l | 5.23± 0.40 | 5.04±0.74 | 0.031 |
| Blood cholesterol level, mmol/l | 5.88±2.66 | 5.36±2.23 | 0.23 |

Table 6. **The comparison of groups by medical activity**

| Parameter | | Russian railway | Metro | p | |
|---|---|---|---|---|---|
| Medication intake, including vitamin and mineral complexes | | 31.3% | 35.4% | 0.93 | |
| Considers that work has a negative impact on health | | 100.0% | 84.9% | 0.017 | |
| Over the last 12 months | Considers that prophylactic medical examination is beneficial | 73.2% | 95.1% | 0.31 | |
| | Unscheduled visits to the physician | 36.7% | 3.9% | 0.008 | |
| | Temporary disability certificate | 36.4% | 8.8% | 0.032 | 0.060 |
| | Admission to the hospital | 7.3% | 0.2% | 0.007 | |
| | Ambulance call | 3.5% | 6.3% | 0.90 | |
| | The frequency of visits to the physician have not changed | 73.2% | 78.6% | 0.95 | |
| | Suspended from driving | 1.4% | 12.3% | 0.008 | |

(table 4). Employees of Russian Railways were 2.1 times more likely to smoke and consume excess salt, and 2.5 times more often ate irregularly (1–2 times a day) compared with metropolitan employees. Machinists of Saint Petersburg Metro had 2 times lower physical activity and 1.3 times more often ate in fast food restaurants. High level of adherence to HLS was revealed in 1/10 of participants.

Physiological risk factors also differed between studied groups (table 5). Workers of the Russian Railways had higher body mass index (BMI), diastolic blood pressure and fasting blood glucose level. At the same time metro workers showed higher values of waist and hip circumferences. Other characteristics did not differ significantly between groups.

The study also showed a difference in the frequency of medical activities between studied groups (table 6). Compared with metro workers, employees of Russian Railways over the past 12 months took a temporary disability certificate 4 times more often, visited the physician 9 times more often, and were admitted to the hospital 3 times more often. Metro employees were 8 times more likely to be suspended from driving than employees of Russian Railways.

## Discussion

The results of this research confirmed that there is a difference in the organization of the working process between Russian Railways and the metro, that was described earlier in the literature [5]. These differences were associated with the features of the technological cycle and the rhythm of the large cities; therefore, they cannot be corrected at the present stage. The only way to partially solve the problem is to change the working process of the locomotive fleet. This problem is being successfully solved by both Russian Railways and Saint Petersburg Metro.

Behavioral risk factors that were revealed in machinists play an important role in the development of cardiovascular diseases (CVDs), mainly arterial hypertension and ischemic heart disease. It is disturbing that average BMI value was over 25 kg/m$^2$, and waist and hip circumferences ratio — over 0.9. In other words, this indicates that large number of workers has signs of general and central obesity. These indices, regardless of other risk factors, contributes to the development of chronic non-communicable diseases, that are especially important in machinists who also have working conditions risk factors for CVDs [9].

On the other hand, identified risk factors can be used as basis for the development of preventive strategy: quitting smoking, increasing physical activity, introducing the principles of healthy nutrition. It is clear that such preventive measures are impossible without the implementation of health education programs [10]. An example of such can be a corporate healthcare programs, which already exist at both Russian Railways [11] and the metro [12]. Therefore, the methods of these programs can be expanded and clarified according to the results of our study.

Russian Railways workers had higher levels of diastolic blood pressure compared with metro workers. This can be associated with higher salt intake by Russian Railways workers. It is known that high salt intake is considered as independent predictor of arterial hypertension development [13]. At the same time the reduction of salt intake can be used as preventive factor for the development of this disease [14].

The revealed difference in the medical activity between Russian Railways and metro machinists may be associated with the difference in the organization of medical support, including preventive and rehabilitative measures. The obtained data indirectly indicate that this field should be improved and developed [15]. In particular, in our opinion, it is necessary to pay more attention to education of machinists on the impact of their work on health, since behavioral risk factors the most significant according to the results of our study.

## Conclusion

This study showed the difference between working conditions and the presence of modifiable risk factors among workers of Russian Railways and Saint Petersburg Metro. The results may be useful for the development of preventive programs for the Russian Railways employees. From our point of view, it is necessary to raise this question on the level of the Government of the Russian Federation. Such preventive programs should be referred to the "cost" section, and not to the "profit" section as they are now. This will help to promote active longevity programs in the workplace.

## Findings

1. Employees of the locomotive crews of Russian Railways and the metro in Saint Petersburg, have different working conditions.

2 Machinists and their assistants included in our study differed by behavioral (modifiable) risk factors.

**Conflict of interest:** None declared.

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