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# Impact of sitting position on the formation of spinal curvatures in the sagittal plane of taxi drivers-preliminary report

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## ABSTRACT

**Introduction:**

Human body posture is an individual feature influenced by environmental conditions and the type of performed work. The curvatures change with age, quality and style of life. Civilizational development has led to a sedentary lifestyle, which has an influence on postural defects formation.

The aim of this study was to verify the effect of length of time for taxi drivers on spine curvature formation compared to people who adopt a sitting position.

**Materials and methods:**

The study comprised 60 subjects: 30 controls and 30 study subjects (taxi drivers), all with work history longer than 10 years. Triplicate measurements of spinal curvatures were taken using the Rippstein Plurimeter in a relaxed position, and results were saved according to the SFTR system. In addition, body height and weight were measured to calculate body mass index (BMI).

**Results:** The average work time in the examined group was 57.7 and the control group 6.8 hours per week. The mean values of thoracic kyphosis and lumbar lordosis in the examined group were 36.3 and 17.9 degrees, respectively, versus 30.3 and 20.8 in the control group. Age and length of service had an impact on the shaping of the spinal curvatures. Greater value of BMI was associated with deeper thoracic kyphosis, but not with shallower lumbar lordosis.

**Conclusions:** Adverse changes in shaping spinal curvatures progress with increasing age and length of the employment performed in the sitting position. Body mass index and body weight above the normal level contribute to deepening thoracic kyphosis.

**Keywords: lumbar lordosis; thoracic kyphosis; curvature measurement; professional exposure; anatomical curvatures; physiology of work, curvature of the spine; sagittal plane; Rippstein plurimetr**

## INTRODUCTION

Posture of the human body is individual feature and individually variable. It depends on body structure and the ability to maintain and control the sitting or standing position [1].

Stance organ of the body is the spine, which changes with age of human. On the beginning convex in child, as grows starts to form bendings in the sagittal plane: in the cervical and lumbar spine forward, whereas in the thoracic and sacral backwards. The bends, known as curvatures, are most visible in adults. On the shaping have influence: individual development, morphological properties of muscles, general health, type of work and environmental conditions [2-6].

The development of technology and civilization has become a cause sedentary lifestyle, thus influencing on changes in the formation of the spinal curvatures. When one of them becomes shallower or increased, we can say about posture defects. Defects of the posture in the sagittal plane are: round back, concave round, round - concave and flat. [1,7,8,9].

Daily intake of a forced sitting position in the car is not only a nuisance, but it can contribute to the emergence of discomfort, pain or postural defects in the sagittal plane.The sitting position influences on the change in the load of the muscular, ligamentous and skeletal systems. In addition, the seating position makes pelvis bends toward the rear, and the lumbar lordosis is reduced. Modification or change in this position is greatly reduced. The reason for this limitation is primarily a small working space. The work of drivers is associated especially with the long-term intake of a sitting position. It is all the more annoying, the longer the driver must maintain it. Therefore, people spending a lot of time in a sitting position in a car are in a high risk group of spine diseases [10-16].

The variety of types of car seats, driving technique and style, influences on the changes in muscle tension leading to the formation of back pain [17,18].

Permanent stays in a sitting position not only negatively affect the attitude, but it can also adversely affect the ventilation of the lungs. Therefore, it becomes important to take care of physical activity during free time and to perform appropriate exercises that positively influence on the condition of the spine. In the driver's work should pay attention to the ergonomics while performing different tasks, and the number of interruptions. It is worth noting that taxi drivers should take part in courses and trainings on work ergonomics. Despite the occurrence of adverse factors such as the adoption of a forced sitting position, it should be added that the group is covered by preventive examinations, training on the proper ergonomics of work and the impact of physical activity on improving the reduction of posture defects [11, 12, 19, 20].

## OBJECTIVE OF THE WORK

The aim of the study was to verify the relationship between age, length of service, body mass index (BMI) and the number of hours spent in the car in a sitting position during the week and curvature of the spine in the sagittal plane for taxi drivers based on a clinical trial.

## MATERIAL AND METHODS

The study included 30 taxi drivers between the ages of 30 to 50 years (mean age 42 years), with work experience longer than 10 years, who were treated for congenital and acquired diseases of the musculoskeletal system affecting posture. Subjects were assessed amount of curvature thoracic and lumbar spine in the sagittal plane by SFTR system. (System for measuring and recording ranges of joint movement. Abbreviation SFTR is: S - sagittal (sagittal plane), F - frontal (front face), T - transverse (transverse plane), R - rotation (rotational movements).

The test was carried out using plurimetr. Rippstein plurimetr' in the natural position. Measurements of curvature (lumbar lordosis and thoracic kyphosis) was performed in triplicate. The average of these measurements was used for the analysis. The tests were performed on the day in which the driver had one day of rest, and the stoppage of at least 12 hours to long-term attachment of the sitting position does not have any direct impact on the test results. The measurements were carried out in the place where the respondent lived, after obtaining written permission to conduct the examination. The examination was performed in the room in which were comfortable to temperature, and appropriate lighting to do the examination. The group of participants of the research program was also obliged to fill the questionnaire. The questionnaire was created for a given research group. It contained a metrics and questions about job seniority, weekly number of hours spent in a sitting position and in the car, breaks at work, lumbar pillows used while driving, the type and frequency of physical activity performed in free time. In addition, measurements of height and body weight were made to calculate the BMI index.

In recruiting research group were used a professional taxi driver help and social networking site.

To analyze the collected data were used methods of descriptive statistics and analysis of interdependencies.

Descriptive characterization of the studied group was made using the position and dispersion measures: the average, minimum value, maximum value, standard deviation. Using the Pearson correlation coefficient were assessed the relationship between: age, BMI, work experience and the number of hours spent in a sitting position in the car and the shaping of curvatures of the spine (kyphosis and lumbar lordosis). Significance tests were performed on the calculated correlation coefficients. The level of significance was $p < 0.05$.

To analyze the examination results and statistical evaluation was used the MS EXCEL and Statistica PL.

## RESULTS

Average values of thoracic kyphosis and lumbar lordosis in the research group amounted 36.30 ° and 17.90 °. The highest value of thoracic kyphosis is 42 ° and the lowest is 20 °. The value of lumbar lordosis was 11-23 °. The value of thoracic kyphosis deviated by 3.99 °, and the value of lumbar lordosis by 2.63 ° (Tab 1).

In the control group, the average values of thoracic kyphosis and lumbar lordosis were 30.27 ° and 22.80 °. The highest value thoracic kyphosis was 38,00°, and the lowest was 20,00°. The value of lumbar lordosis was 15,00–32,00°. The value of thoracic kyphosis deviated by 3.57 °, and the value of lumbar lordosis by 4.03 ° (Tab 1).

Taking into account the values of correlation coefficients and their significance tests, it can be noticed that in the entire examined group (n = 60) the greatest impact on the increase in the value of thoracic kyphosis is the age and number of hours spent in the car during the week.

Seniority, excessive body mass and BMI above the normal range also influence the deepening of the curvature. The length of seniority and age contribute to the reduction of lumbar lordosis.

Statistical analysis has shown that variables such as body mass, the number of hours spent in the car every week, and BMI also have no significant effect on the value of this curvature (Tab 2).

Conducted studies of dependencies between daily physical activity, several times a week, once a week, several times a month, once a month and values of curvatures of the spine in the sagittal plane (lumbar lordosis and thoracic kyphosis). The research shows that only performing daily physical activity is related to the formation of lumbar lordosis ($p < 0.001$).
There is no statistically significant relationship between the value of lumbar lordosis and thoracic kyphosis in both groups of patients.

## DISCUSSION

It was shown that the average thoracic kyphosis in drivers were 36.33 degrees. Analyzing the average of this curvature it can be concluded that by Stauffer [20], White and Panjabi [21] and Ferguson [22] which are in the normal range [23]. A comparison of the test group average values of the lumbar lordosis of the reference data, taking into account also the value adopted by Stauffer [20] and by Kasperczyk [1] must be considered that are within normal limits. The highest and the lowest value in the group of kyphosis drivers - when modeled on Stauffer's researches [20] - is correct, while Panjabi and White the highest value of thoracic kyphosis in the examined taxi drivers they consider to be incorrect [21]. Regards the results of Kasperczyk [1] and Stauffer [20] it can be concluded that the lowest value of the lumbar lordosis of investigated drivers is below normal values, and the maximum value of lumbar lordosis for the test drivers is lower than normal. Own researches shows that kind of profession has an impact on the shaping of spinal curvatures in the sagittal plane [13, 24].
The examined drivers have unsettled parameters of the spine curvature, which may be the result of a sedentary lifestyle or too little physical activity. In the literature can also find information that sitting work and a small amount of movement have an impact on the formation of postural defects in the sagittal plane. This may result in an increased risk of disc herniation, especially in the lumbar spine [7, 24, 25, 26, 27, 28].
Own study shows that spending large amounts of time in a forced sitting position does not affect positively on the shape of the spine in the sagittal plane. This position may cause the flattening of the lumbar spine [10, 13], adversely affects on the shape of the thoracic spine and enlarges kyphosis.
Increased BMI values and excessive body weight can be caused by a sedative lifestyle, sedentary work or limited physical activity. The research shows that only daily physical

activity positively affects the formation of curvatures of the spine, leading to the increase of anterior-posterior curvature in the thoracic segment and reduction of lordosis in the lumbar region [29].

Own research indicates a high correlation between age and increase of the thoracic curvature, which is confirmed in the literature [7]. There were also a correlation between age and shallow of lordosis in the lumbar spine [30]. The literature does not show such changes in men of similar age [31, 32, 33].

## CONCLUSIONS

Unfavorable changes in shaping the curvature of the spine deepen with the length of seniority performed in the sitting position. Excessive body weight and BMI above the normal limit deepen the thoracic kyphosis, but it does not significantly affect the shallow lumbar lordosis. No relationship was observed between the value of lumbar lordosis and thoracic kyphosis.

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**TABLE 1. Descriptive statistics for variables characterizing the study group (n = 60)**

| Variable | Taxi drivers (n=30) | | | Control group (n=30) | | | P |
|---|---|---|---|---|---|---|---|
| | SD | min | max | SD | min | max | |
| **Age** [years] | 42 ±6.9 | 30 | 50 | 34,5 ±4,9 | 30 | 48 | <0.0001 |
| **Body height [cm]** | 177.9 ±6.3 | 164 | 190 | 180.8 ±6.4 | 170 | 193 | 0.09 |
| **Body mass [kg]** | 87,6 ±11,6 | 72 | 120 | 81,1 ±11 | 63 | 106 | <0.03 |
| **Seniority [years]** | 16,6 ±6,4 | 10 | 30 | 12,50 ±4,1 | 10 | 23 | <0.001 |
| **Amount of hours spent in the car in the sitting position during the week [hour]** | 57,7 ±18,3 | 28 | 100 | 6,8 ±4,9 | 1 | 20 | <0.00001 |
| **BMI** | 27,7 ±3,5 | 21,6 | 37.2 | 24,8 ±3,1 | 19 | 33.1 | <0.001 |
| **Thoracic kyphosis value (°)** | 36,3 ±4 | 20 | 42 | 30,3 ±3,6 | 20 | 38 | <0,00001 |
| **Lumbar lordosis value (°)** | 17,9 ±2,6 | 11 | 23 | 22,8 ±4,1 | 15 | 32 | <0,00001 |

**TABLE 2. Correlations of lumbar lordosis and thoracic kyphosis of the independent variables in the whole study group (n = 60)**

| Level (r) of significance (p) | | Pearson's correlation coefficient | | | | |
|---|---|---|---|---|---|---|
| | | **Age [years]** | **Body weight [kg]** | **Seniority [years]** | **Amount of hours per week spent in the car** | **BMI** |
| **Kyphosis value** | r | 0.5 | 0.27 | 0.4 | 0.53 | 0.33 |
| | p | <0.00001 | <0.05 | <0.001 | <0.00001 | <0.01 |
| **Lumbar lordosis value** | r | -0.47 | 0.33 | -0.46 | -0.49 | -0.35 |
| | p | <00001 | <0.01 | <0.00001 | <0.00001 | <0.001 |