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# Association of segmental body composition with cervical spine mobility in adults with nonspecific neck pain

Katarzyna Wojnicz - Ghosheh[1], Bartosz Fiutowski[2], Aleksander Kucza[1], Carlos A. Zárate-Tejero[3], César Hidalgo-García[4] & Agnieszka Chwałczyńska[2]✉

**In order to assess the pain phenomenon, a pilot cross-sectional study was conducted. The aim of this study was to determine the correlation between segmental body composition and cervical spine mobility in individuals with nonspecific neck pain (NSNP). Forty-six individuals aged 18–75 were recruited for the study. After completing the cervical spine safety test, participants completed a socio-medical survey, assessed their pain level using a 10-point VAS scale, quality of life using the SF-36, assessed their total and segmental body mass (upper limbs) using a Tanita BC-418 body composition analyzer, and assessed their active range of motion (AROM) using the CROM system (Performance Attainment Associates, Roseville, MN, USA). Descriptive statistics (median and quartiles) were used to evaluate the obtained results, and nonparametric tests (no normal distribution of the studied variables) were used to compare the results between groups. The results showed that NSNP was associated with job type, stress level, and time spent using a smartphone. Pain severity increased with age, BMI, and increased fat mass. AROM was within the normal range (SFTR system for measuring angles in human joints according to the International Standards for Orthopaedic Measurements) for flexion-extension, right and left rotation, and was slightly lower for right and left lateral flexion. No statistically significant differences in AROM were observed depending on pain levels ($p = 0.628$-$p = 0.869$). Based on the conducted research, it can be concluded that NSNP is associated with lifestyle. Pain intensity was observed to be accompanied by a decrease in AROM in all areas examined. Cervical spine pain levels also increased with age, BMI, and total and segmental fat content. It was noted that AROM does not always correlate with pain intensity, warranting further research. The results indicate that patients consult a physiotherapist with long-term pain. At the same time, lifestyle factors exacerbate pain symptoms, ambiguously affecting AROM, which requires further investigation.**

**Keywords** Active range of motion of the neck, Nonspecific cervical spine pain (NSNP), Body composition and AROM, Body composition and NSNP

Neck pain (NSP) poses a significant personal and socioeconomic burden, ranking among the top five chronic pain conditions in terms of prevalence and years lost due to disability, mixed neuropathic-nociceptive symptoms, or neuropathic symptoms[1,2].

Nonspecific neck pain (NSNP) is defined as pain localized to the posterior, upper, and lateral portions of the neck, without signs or symptoms of significant structural pathology and without significant impairment in daily activities, and in the absence of neurological symptoms or specific pathology[3–12].

The main causes of NSNP are considered to be degenerative and overload changes of various etiologies, including those related to the nature of the profession. These are often considered occupational diseases[13,14].

[1]Doctoral School, Universidad de Zaragoza, Zaragoza 50009, Spain. [2]Faculty of Physiotherapy, Wroclaw University of Health and Sport Sciences, al. IJ Paderewskiego 35, Wroclaw 51-612, Poland. [3]Physiotherapy Department, Faculty of Medicine and Health Sciences, International University of Catalonia, Barcelona 08195, Spain. [4]Unidad de Investigación en Fisioterapia, Faculty of Health Science, Universidad de Zaragoza, Zaragoza 50009, Spain. ✉email: agnieszka.chwalczynska@awf.wroc.pl

NSNP accounts for approximately 25% of all outpatient physical therapy visits, and its lifetime prevalence ranges from 12% to 70% in the general population. Most individuals with NSNP do not experience complete symptom resolution, and 50–85% report a recurrence within 1 to 5 years.

In most cases, a definitive diagnosis cannot be made, and NSNP is classified as nonspecific due to its multifactorial etiology, resulting in the lack of a gold standard for its assessment[3]. From this perspective, there are no consistent characteristics across patient groups with NSNP, and therefore, it is primarily diagnosed based on clinical findings (evaluation of global range of motion (ROM) deficits), which are similar to those associated with grade I and II cervical spine injuries and are not trauma-related[2,15–20]. Problems related to computer and cell phone use are becoming increasingly common in diagnostics. The body position, with the head tilted, arms protracted, and upper limbs extended forward, places excessive strain on the shoulder girdle, upper limbs, and spine, contributing to degenerative changes in the cervical spine. The term "text neck" is increasingly appearing in the literature, linking it to headaches, neck pain, shoulder girdle pain, and arm pain, particularly in younger individuals[21–23]. Text neck is associated with musculoskeletal disorders resulting from abnormally forward head posture while using a computer or cell phone[24,25].Many authors point out that involutional changes, particularly in muscle mass, may be associated with an increased risk of pain, which leads to a desire to limit neck movement[26–40].

The literature lacks information on pain assessment, spinal mobility, and the relationship between body composition and cervical spine range of motion.

Therefore, the aim of this study was to assess pain levels, its changes in relation to lifestyle, and to examine the correlation between body composition—particularly the upper trunk and upper extremities—and cervical spine mobility in individuals with nonspecific neck pain. The following research questions were asked: how do various aspects of lifestyle influence reported pain in the lumbar spine? Does reported pain influence cervical spine mobility? Is there a relationship between segmental body composition and reported pain?

## Materials and methods

Ethical approval for the study was granted by the Senate Committee on Research Ethics at the Wroclaw University of Health and Sport Sciences (decision no. 29/2023). The study was registered in the international clinical trials database (NCT06642233).

The study was conducted by the Declaration of Helsinki. All participants were informed about the study procedures, purpose, and their right to withdraw at any time. All participants gave written informed consent to participate in the study.

The group size was calculated based on the analysis in the G-Power program, where using ANOVA, test power 0.8, effect size 0.5, Alpha < 0.05 and amounted to 45 people.

### Study Group

The main exclusion criteria were lack of consent or communication difficulties. Clinical exclusion criteria included active cancer, vascular anomalies or pathological changes causing vertebrobasilar insufficiency symptoms (e.g., carotid artery obstruction or dissection, vertebral artery insufficiency, embolism), recent significant cervical spine trauma, history of fractures or surgeries in the cervical spine. Other exclusion criteria included the inability to lie down, the inability to perform the flexion-rotation test, or a positive result in any of the cervical spine safety tests (C1/C2 Traction Test, Alar Ligament Test, C1 Segmental Instability Test (Transverse Ligament), Vertebral Artery Blood Flow Test (de Kleyn's Test). The following joint safety tests were performed: Traction test in the C1/C2 segment - The subject was in a sitting position. The examiner used his thumb and index finger to palpate the deep cervical extensor muscles in the space between the atlas (C1) and the axial vertebra (C2). The occiput, along with the C1 vertebra, was stabilized by resting the subject against the examiner's chest and the therapist's other hand, to eliminate uncontrolled global movements of the cervical spine. Next, gentle axial traction was performed on the C1/C2 segment, while monitoring the quality of movement by palpation. During the test, the examiner observed the subject's reaction, paying particular attention to the appearance of neurological or autonomic symptoms. The occurrence of symptoms such as dizziness, nausea, headache, visual or speech disturbances would be interpreted as a sign of possible instability of the head and neck joints and would constitute an absolute contraindication to further manual procedures in the upper cervical spine[41]. Alar ligament test - This test was performed to assess the integrity of the alar ligaments, which are responsible for rotational stabilization of the craniocervical junction. The examiner stabilized the alar vertebra (C2) by placing his index fingers on either side of its spinous process on the occipital side. With the other hand, he performed passive lateral flexion of the subject's head. During lateral tilt of the head to the right, the examiner expected to feel pressure on the finger located on the left side of the C2 vertebra, indicating normal tension of the alar ligament on the side opposite the movement. The lack of movement of the C2 vertebra during lateral flexion was considered a pathological sign, which could indicate elongation, partial, or complete rupture of the alar ligament, and therefore instability of the upper cervical spine[42,43]. C1 Segment Instability Test – Transverse Ligament Test. This test was performed to assess the integrity of the transverse ligament of the atlas, which plays a key role in stabilizing the axial spine relative to the C1 vertebra. With one hand, the examiner stabilized the subject's head and neck in a slight anterior flexion position, while with the other hand, they performed a ventral translation of the C2 vertebra, exerting pressure on its spinous process. The test was considered positive if neurological symptoms, pain, or discomfort occurred during forward head tilt and resolved after ventral translation of the C2 vertebra. This result would suggest transverse ligament insufficiency and potential instability of the C1/C2 segment, which constitutes a significant contraindication to manual therapy in this area[44]. Vertebral Artery Blood Flow Test (de Klein's Test) – The de Klein's test was performed to assess the patency of the vertebral arteries and to exclude the risk of cerebral circulation disorders during cervical extremity movements. The subject was placed in a supine position, with the head positioned beyond the edge of the couch. The investigator passively positioned the subject's head in maximum rotation and lateral flexion in the same direction, then maintained it in the final range of motion for several to several seconds. During the test, symptoms such as dizziness, nystagmus, nausea, headache, visual disturbances, or other neurological symptoms were observed. Their appearance could indicate impaired blood flow in the vertebral artery on the side opposite the direction of lateral flexion and rotation. After the test, the test was performed analogously for the opposite side[44]. Participants also could not have participated in any cervical spine exercise or manual therapy programs within the previous three months, or have any contraindications to bioimpedance testing (e.g., pregnancy, pacemaker, metal implants such as screws, nails, plates), or other contraindications to physical activity.

A total of 48 individuals (52% women), aged 18–75 years, were examined, of which 46 met the inclusion criteria and consented to participate. Two individuals were excluded due to contraindications to bioelectrical impedance analysis (hip joint endoprosthesis). The majority of participants had higher education (70%), were professionally active (78%), and performed sedentary work (73%). The most frequent patients who reported seeing a physiotherapist were those whose pain had persisted for more than 5 years (35%) or more than one year (30%). 17% of the respondents reported that the pain was constant and continuous. For 41%, the pain was frequent but short-lived. 76% of the study participants reported pain radiating most often to the occiput (40%), both shoulders (26%), and the right upper limb (to the shoulder in 26%, the scapula in 15%, and the hand in 13%). Pain symptoms most often worsened during the day (65%).

## Research Methods

The assessments were conducted in a single session at a heated and air-conditioned physiotherapy room (constant temperature) at MTS Holistic Therapy – Holistic Medicine Clinic, by two researchers. Participants wore sports clothing that did not restrict movement.

The following tests were conducted with each participant:

1. Custom Survey: questionnaire about socio-medical data (information about health status, illnesses and injuries, with particular emphasis on cervical spine injuries), physical and occupational activity (IPAQ), and neck pain (data on the location of the pain, the time when the pain appears or intensifies, information on the “radiation” of the pain, possible complications resulting from the occurrence of pain - tingling, muscle weakness. of the upper limb), containing 29 questions (including 2 open-ended).
2. Cervical Spine Safety Tests: Upon receiving consent, 4 cervical safety tests were performed - If any of the safety tests were positive, further testing was discontinued, and the participant was referred for medical consultation.
3. Body Composition - The segmental body composition of the subjects was assessed using the Tanita BC-418 MA eight-electrode body composition analyzer. Tests were carried standing the body composition analyzer was always placed in the same location for each measurement. With the use of the GMON computer software having appropriate conversion algorithms based on values such as resistance, reactance and phase angle compatible with the analyzer, the percentage of fat mass (FM%), fat-free mass (FFM), and predicted muscle mass (PMM) were estimated for the whole body and the upper limbs (right upper limb - RA; left upper limb - LA). Based on the obtained results, the fat-fat-free mass index (FFF) was calculated (FFF = FM/FFM)[29].
4. Pain Assessment - Participants rated their neck pain using the Visual Analog Scale (VAS), where “0” meant no pain and “10” the worst pain imaginable. They indicated the minimum, average, and maximum pain levels experienced over the entire course of their condition[45].

Active Range of Motion (AROM) of the Entire Cervical Segment -The measurement of AROM of the cervical spine was assessed using the CROM system (Performance Attainment Associates, Roseville, MN, USA) (Fig. 1). The device consists of a plastic helmet-shaped structure resembling glasses, which is secured to the participant’s head using a Velcro strap placed at the back. Three disc-shaped dials are attached to this structure; two are inclinometers for measurements in the sagittal and coronal planes, and the third is a compass for measuring

**Fig. 1**. System CROM (Performance Attainment Associates, Roseville, MN, USA.

movements in the transverse plane[27]. The tests were conducted while the participant was seated on a hard chair with adjustable height, ensuring that the participant sat with their feet flat on the floor and hips and knees bent at a 90° angle, with their sacrum and thoracic spine fully supported by the backrest. Before beginning the assessment, the CROM system was adjusted to fit the participant's head. The participant then performed a warm-up consisting of three active movements in each direction of the cervical spine planes. The assessor stood on the left side of the participant to provide manual stabilization of the participant's thoracic spine while taking measurements with the CROM system. The participant performed cervical spine flexion to the maximum asymptomatic range three times, pausing at the end of the movement to read the inclinometer data (the average of the three measurements was used for analysis).The next measurement was the AROM extension of the cervical spine, performed in the same manner, with the average of the three readings used for analysis[19,46].

While seated, the participant tilted their head sideways three times until they reached their maximum asymptomatic range, pausing at the end of the movement to read the inclinometer data to ensure there was no compensation from the lumbar or thoracic spine. The assessor, standing in front of the participant, stabilized the contralateral arm and controlled head movement with the other hand.

The right and left rotational range of motion of the cervical spine was measured in the transverse plane. While seated, the participant performed active rotation three times until the maximum asymptomatic range was reached, pausing at the end of the movement to read the inclinometer data, ensuring there was no compensation from the thoracic or lumbar spine. The assessor, standing to the side of the participant, checked for any movement of the thoracic spine relative to the shoulders and monitored head movements[19,46]. To assess the correct range of motion, the SFTR recording system for measuring angles in human joints was used, in accordance with ISOM (International Standard Orthopaedic Measurements) standards – joints: cervical spine. In the sagittal plane, values were assessed for Extension – 0 – flexion ($40^0$–0-$40^0$), in the frontal plane Side bending to the left – 0 – side bending to the right ($45^0$–0-$45^0$), and Rotation to the left – 0 – rotation to the right ($50^0$–0-$50^0$).

## Statistical methods

The statistical analysis was performed using the Statistica 13.3 software. The Shapiro-Wilk test indicated that the data did not follow a normal distribution. The median and the upper (Q1) and lower (Q3) quartiles were used to describe the group. Responses to survey questions were compared using the chi-square test. Non-parametric tests for independent groups, specifically the Mann-Whitney U test, were used for comparisons of body composition and range of motion. The relationships between variables were estimated using Spearman's rank correlation. A significance level of $p < 0.05$ was assumed.

# Results

## Characteristics of the group

Based on the anthropometric studies, the median age of the subjects was determined to be 50.5 years (Group I 41.0 years; Group II 52.5 years, $p = 0.109$). Subjects from Group I were slightly, but not significantly ($p = 0.186$) taller (176 cm) than those from Group II (168.0 cm). Body weight was comparable in both groups and amounted to 79.95 kg. BMI was 25.65 kg/$m^2$ in Group I and 27.25 kg/$m^2$ in Group II ($p = 0.389$).

Based on the assessment of the maximum pain scale, the study group was divided into Group I ($n$ = 21, 43% women), where the pain level did not exceed 6[1–6] on the VAS scale, and Group II ($n$ = 25, 60% women), where the participants reported pain levels above 6[7–10] on the VAS scale. The division based on pain was dictated by pharmacotherapeutic recommendations, which specify the type of drugs used for a particular level of pain. WHO also determined that pain measured by the VAS method as 0–6 indicates the need to use over-the-counter medications, while 7–10 indicates the need to use strong opioids - medications prescribed by a doctor[47,48]. Before beginning range of motion testing, participants reported pain sensations. In the lower pain group (Group I), pain was most often felt for short periods (57.1%) or as intermittent pain (42.9%). In the higher pain group, intermittent pain was most common (40.7%), but 25.9% experienced continuous pain. The difference in pain sensation is statistically significant ($p$ = 0.016). Estimated pain complications indicate that 66.7% of Group I participants and 77.8% of Group II participants experienced pain radiating to the arm, shoulder blade, or hand. Comparison of responses revealed no statistically significant differences between groups. In the study participants, pain most often occurred during the day (Group I – 66.7%, Gr II – 59.3%, $p$ = 0.849), was exacerbated by stress (Group I 38.1%, Gr II –74.1%, $p$ = 0.003) or physical activity (Group I – 19.0%, Gr II – 18.5%), and an additional 15% of Group II participants indicated the lying position as a factor increasing the pain. Pain most often radiated towards the right arm (95.2% and 70.4%, respectively) and caused dizziness (Group I – 23.58%, Gr II – 67.7%, $p$ = 0.0025), especially after work. In the case of pain, 28.4% of Group I participants and 40.7% of Group II participants used medications, most often over-the-counter painkillers. Only 14.3% of Group I and 18.5% of Group II participants reported experiencing pain using physiotherapy. Statistically significant correlations were observed between pain and type of work performed (−0.450), pain intensity and sitting position (−0.453), and the level of minimal pain and type of work performed (0.455). Participants also indicated a correlation between minimal pain and average pain levels (0.690).

## Custom survey analysis

*Body composition analysis using TANITA device*

When comparing body composition, no statistically significant differences were found. However, Group II was lower body height had an average of 10% higher total body fat, as well as higher body fat in both upper limbs, and had an average 50% higher FFF index. The results are presented in Table 1.

Based on the observed correlations, it was found that individuals with higher fat mass and lower muscle mass, as evidenced by the FFF, RA FFF, and LA FFF indices, report higher levels of perceived pain. Detailed results are presented in Table 2.

| | Group I<br>*N* = 21<br>Median (Q1-Q3) | Group II<br>*N*–25<br>Median (Q1-Q3) | *p* |
|---|---|---|---|
| **Body height [cm]** | **176.00 (166.5–183.5.5.5)** | **168.00 (163.5–179.0)** | **0.187** |
| Body weight [kg] | 79.95 (74.85–92.15) | 79.65 (68.3–89.0) | 0.823 |
| BMI [kg/m$^2$] | 25.65 (22.95–29.55) | 27.25(24.9–30.15.9.15) | 0.390 |
| FM% | 25.30 (21.5–30.65.5.65) | 34.40 (24.1–41.85.1.85) | 0.114 |
| PMM [kg] | 58.75 (40.5–62.25.5.25) | 44.85(41.0–61.4.0.4) | 0.502 |
| RA FM% | 21.35 (16.0–24.8.0.8) | 31.40 (19.1–38.95.1.95) | 0.085 |
| RA PMM [kg] | 3.05 (2.05–3.4) | 2.30 (2.15–3.4) | 0.715 |
| LA FM% | 21.40 (17.45–26.0.45.0) | 32.65 (20.15–40.05) | 0.066 |
| LA PMM [kg] | 2.95 (2.0–3.25.0.25) | 2.20 (2.0–3.0) | 0.750 |
| FFF | 0.34 (0.27–0.44) | 0.53 (0.32–0.72) | 0.112 |
| RA FFF | 0.27 (0.20–0.32) | 0.45 (0.24–0.63) | 0.077 |
| LA FFF | 0.27 (0.21–0.34) | 0.48 (0,26-0.66.66) | 0.079 |

**Table 1**. Comparison of groups regarding body composition. FM – fat mass; FFM - fat-free mass; PMM - predicted muscle mass (PPM); RA - right upper limb; LA- left upper limb, FFF - fat-fat-free mass insex.

| | Age | Body height | Body weight | BMI | FM% | RA FM% | RA FFM | RA PMM | LA FM% | LA FFM | LA PMM |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Age** | | **−0.355** | **0.142** | **0.480** | **0.381** | **0.338** | **−0.021** | **−0.006** | **0.347** | **−0.033** | **−0.031** |
| Minimal pain throughout its duration | 0.219 | −0.070 | 0.047 | 0.131 | 0.076 | 0.082 | 0.105 | 0.106 | 0.094 | 0.123 | 0.125 |
| Moderate pain throughout its duration | 0.205 | −0.077 | 0.079 | 0.171 | 0.207 | 0.203 | 0.052 | 0.060 | 0.213 | 0.068 | 0.066 |
| Maximum pain throughout its duration | **0.341** | −0.215 | −0.096 | 0.084 | **0.308** | **0.300** | −0.131 | −0.118 | **0.316** | −0.126 | −0.119 |
| Body weight | 0.142 | **0.559** | | **0.729** | 0.147 | 0.078 | **0.779** | **0.780** | 0.061 | **0.790** | **0.776** |
| FM% | **0.381** | **−0.521** | 0.147 | **0.654** | | **0.975** | **−0.388** | **−0.389** | **0.969** | **−0.379** | **−0.395** |
| AROM flexion | −0.089 | 0.213 | −0.135 | −0.289 | −0.098 | −0.090 | −0.046 | −0.037 | −0.079 | −0.043 | −0.015 |
| AROM extension | −0.041 | **0.314** | 0.045 | −0.116 | −0.033 | −0.032 | 0.058 | 0.065 | −0.036 | 0.071 | 0.092 |
| AROM lateral bending to the right | −0.144 | **0.334** | 0.068 | −0.112 | −0.056 | −0.065 | 0.082 | 0.092 | −0.074 | 0.123 | 0.139 |
| AROM lateral bending to the left | −0.147 | **0.351** | 0.091 | −0.106 | −0.052 | −0.050 | 0.071 | 0.076 | −0.060 | 0.094 | 0.114 |
| AROM rotation to the right | 0.018 | 0.116 | −0.109 | −0.174 | 0.027 | 0.026 | −0.105 | −0.103 | 0.030 | −0.109 | −0.075 |
| AROM rotation to the left | 0.007 | 0.239 | −0.006 | −0.135 | −0.050 | −0.058 | 0.021 | 0.024 | −0.063 | 0.033 | 0.059 |

**Table 2**. Correlation results for pain, cervical spine range of motion, and body composition. AROM - Active Range of Motion; FM – fat mass; FFM - fat-free mass; PMM - predicted muscle mass (PPM); RA - right upper limb; LA- left upper limb, FFF - fat-fat-free mass index.

| | Group I<br>Median (Q1-Q3) | Group II<br>Median (Q1-Q3) | *p* |
|---|---|---|---|
| **AROM flexion** | **49.00 (38.0–59.0)** | **48.00 (48.0–58.0)** | **0.843** |
| AROM extension | 58.00 (48.0–72.0) | 59.00 (50.0–72.0) | 0.869 |
| AROM lateral bending to the right | 26.00 (22.0–35.0) | 28.00 (23.0–33.0) | 0.635 |
| AROM lateral bending to the left | 28.00 (23.0–35.0) | 26.00 (22.035.0) | 0.808 |
| AROM rotation to the right | 52.00 (40.0–61.0) | 55.00 (43.0–62.0) | 0.628 |
| AROM rotation to the left | 52.00 (37.0–66.0) | 52.00 (40.0–59.0) | 0.800 |

**Table 3**. Comparison of groups regarding the range of motion of the cervical spine. AROM - Active Range of Motion.

## AROM of the cervical spine (active range of motion of the entire cervical segment)

Based on the conducted study, no statistically significant differences were found in the range of motion within the examined cervical spine segment. The results are presented in Table 3.

Numerous correlations were observed between pain and active range of motion. Detailed results are presented in Table 4.

| Type of work performed | AROM flexion | AROM extension | AROM lateral bending to the right | AROM lateral bending to the left | AROM rotation to the right | AROM rotation to the left |
|---|---|---|---|---|---|---|
| Type of work performed | **0.129** | **0.192** | **0.031** | **0.082** | **0.181** | **0.194** |
| The occurrence of neck pain | −0.004 | −0.025 | −0.038 | 0.002 | 0.080 | 0.073 |
| Pain duration | −0.035 | −0.099 | −0.092 | −0.139 | −0.165 | −0.185 |
| Time since the onset of pain | −0.045 | 0.002 | −0.089 | −0.105 | −0.046 | −0.026 |
| Pain in the morning | **−0.334** | **−0.291** | −0.282 | **−0.302** | −0.234 | **−0.303** |
| Sitting position causes increased pain | 0.230 | **0.318** | **0.329** | **0.432** | **0.347** | **0.420** |
| Working at the computer causes the pain to worsen | 0.116 | 0.268 | 0.180 | 0.239 | **0.298** | **0.298** |
| Minimal pain throughout its duration | 0.027 | 0.000 | 0.142 | 0.061 | 0.100 | 0.065 |
| Moderate pain throughout its duration | 0.047 | 0.097 | 0.149 | 0.090 | 0.158 | 0.150 |
| Maximum pain throughout its duration | 0.189 | 0.150 | 0.115 | 0.025 | 0.250 | 0.190 |
| AROM flexion | | **0.811** | **0.708** | **0.646** | **0.768** | **0.713** |
| AROM extension | | | **0.806** | **0.826** | **0.868** | **0.885** |
| AROM lateral bending to the right | | | | **0.897** | **0.696** | **0.744** |
| AROM lateral bending to the left | | | | | **0.755** | **0.808** |
| AROM rotation to the right | | | | | | **0.933** |

**Table 4**. Correlation results for pain and range of motion of the cervical spine. AROM - Active Range of Motion.

## Discussion

Participants in the described project presented to a physiotherapist with symptoms of nonspecific neck pain. Most participants worked in a seated position at a computer, and pain severity was most often associated with this position. Participants who experienced more severe pain often attributed it to stress, which led to increased pain in the afternoon and evening. This is consistent with the findings of Shahidi et al.[47], who reported that stress, anxiety, and depression negatively impact treatment outcomes for musculoskeletal conditions, such as work-related neck pain. Therefore, psychosocial factors and/or mental health symptoms should be considered in clinical reasoning to improve treatment outcomes and support prognosis[48]. According to Piruta and Kułak[24], it is important to focus on timing and posture when using a mobile phone when diagnosing neck pain. The habitual 15° head tilt typical of Text Neck causes cervical spine overload and tension-induced shortening of muscles such as the trapezius and sternocleidomastoid muscles, which, when contracted asymmetrically, can exacerbate pain symptoms. The results of this study showed that the type of work (in this case, computer work) and the associated sitting position were key factors influencing the occurrence and severity of neck pain.

Many authors emphasize that spending more than 3 h per day with the head tilted forward (e.g., at a keyboard or phone), as reported by our participants in the survey, significantly increases the risk of neck and shoulder pain compared to those who used keyboards minimally[24,25,49–51]. This problem is not limited to office workers but also affects young people who spend significant amounts of time in front of phones or computers[21–23,52].

Our analysis found a correlation between the participant's age and the level of maximum pain experienced during the entire duration of the pain episode. This finding aligns with Ünlüer et al.[53], who observed that neck pain is a musculoskeletal issue that intensifies with age. This is due to prolonged periods spent in poor postural positions, leading to increased muscle tension, which, over time, becomes permanent and causes muscle shortening and greater pressure on the skeletal structures, especially the spine. The increasing prevalence of neck pain with age is a growing concern, and as many authors suggest, the issue of Text Neck, which can be classified as nonspecific neck pain (NSNP), begins in adolescence or even in childhood. This necessitates the systematization of diagnostics, risk factor identification, and treatment methods, with a particular focus on physiotherapeutic interventions. In the near future, neck pain may be classified as a lifestyle disease.

The prolonged sitting position can influence not only posture but also body weight. Among participants, particularly in the group with increased pain, there was a higher prevalence of overweight and high body fat. The results indicated a correlation between neck pain and high BMI, which is consistent with the findings of Schneider et al.[54], who found that patients with a BMI of 27 kg/m² or higher were more likely to experience neck pain. Similarly, a large prospective study on the middle-aged population also showed a connection between BMI and neck pain[55]. In the literature on the relationship between body mass and neck pain, BMI is typically the focus, as it reflects the ratio of body weight to height. However, in the case of nonspecific neck pain (NSNP), it is important to consider the condition of the shoulder girdle and upper limbs. Among the participants in this study, those with higher pain levels had lower muscle mass in the upper limbs. The fat-to-lean mass index (FFF) in the upper limbs was found to be 66% higher in group II compared to group I, though the difference was not statistically significant. The amount of fat mass in the upper limbs in the pain group was more than 10% greater than in the comparison group. Lower muscle mass, higher fat mass, and a higher FFF suggest muscle weakness in this area. This may be due to pain or could indicate that pain is a consequence of reduced upper limb functionality. This aspect is not well understood and warrants further research.

Nonspecific neck pain not only causes discomfort but also restricts the range of motion in the cervical spine. The present study did not find statistically significant differences in the range of motion across three planes between the study groups. Similar results were obtained by English et al.[56], who assessed these parameters in a group of young, healthy individuals. Fernández-Pérez et al.[57], in a study of individuals who had suffered neck injuries from car accidents, found that those involved in an accident exhibited a reduction of more than 10° in range of motion in all examined planes. The lack of changes in the range of motion in the current study may be due to the absence of pain during the measurement, as the pain was typically short-lived and occurred throughout the day, strongly associated with seated computer work. In the studies cited, the method of measuring range of motion used an AROM system, where the results are presented in angular form. The most common method of assessing cervical range of motion in the literature is linear measurement, but for assessing cervical mobility, this method is imprecise. The complexity of head movements relative to the neck requires the development of research methods that can isolate movement in the cervical spine. This study found low to moderate correlations between pain occurring in the morning, pain intensity during work, and range of motion in the cervical spine, but these correlations were puzzlingly positive. De Loose et al.[58] reached similar conclusions, but only in relation to sagittal plane movements and cervical range of motion (CROM) in pilots suffering from neck pain compared to healthy pilots. However, Kauther et al.[59] found comparable neck biomechanics in the "neck pain" and "normal" groups, showing that cervical range of motion (CROM) cannot easily be used as a diagnostic criterion for determining pain intensity.

Our analysis of the correlation between height and range of motion revealed a positive correlation with AROM for cervical extension, right lateral flexion, and left lateral flexion. However, we did not find any related studies to support this result. This suggests that when a patient has limitations in one direction, there is a high chance that the same limitations will occur in other directions as well.

### Study limitations

A limitation of this study was the small sample size (46 individuals) and the relatively wide age range of the participants. The limitation of this study was the small sample size (46 people) and the relatively wide age range of the participants. Age differences may partially affect the mobility of the cervical spine, therefore it would be advisable to introduce in the future a division into groups based not only on the level of pain intensity, but also on the age of the participants.

We did not find any literature on the connection between body composition and cervical spine range of motion, which made our study innovative in this regard. However, this also constitutes a limitation that necessitates further research. It would be necessary to determine which of the body composition components, muscle mass or fat mass, has a more significant impact on the range of motion and the occurrence of pain in the cervical spine.

Another limitation of our study is the time it takes for patients to see a physiotherapist. People with back pain often wait to begin therapy, initially taking painkillers, which also affects the results. Less than 20% of respondents seek help from a physiotherapist when experiencing pain; the remainder prefer painkillers. This is due to the limited availability of free physiotherapy services covered by insurance. One of the project's goals is to assess the scale of the problem and the need for systemic changes in the perception of NSNP and the diagnostic process.

## Conclusions

Based on the research conducted, it can be concluded that non-specific neck pain is related to the type of work performed, time spent using mobile phones and stress.

It was observed that increased pain was accompanied by a restriction in range of motion in all planes tested.

As age, body mass (BMI), percentage of body fat (FM%), and percentage of fat mass in the upper limbs increased, the level of pain in the cervical spine also increased. In contrast, greater height was associated with a generally higher range of motion in the cervical spine.

It was also noted that cervical spine range of motion does not always correlate with the occurrence or intensity of pain, which warrants further research to better understand this relationship.

## Data availability

The database and raw results are available from the corresponding author and will be placed in a repository after the completion of the entire research project.Elements of the research methodology needed to reproduce the described procedures and analyses are publicly available.

Received: 9 October 2025; Accepted: 10 March 2026
Published online: 18 March 2026

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## Author contributions

**Katarzyna Wojnicz-Ghosheh: ** Conceptualization, Methodology, Software, Data curation, Writing- Original draft preparation **Bartosz Fiutowski.** : Data curation, Software, Writing- Original draft preparation **Aleksander Kucza** : Methodology, Data curation, Writing- Original draft preparation **Carlos Antonio Zárate-Tejero** Methodology, Data curation, Investigation, Reviewing and Editing,; **César Hidalgo-García: ** Conceptualization, Methodology, Software, Investigation. Supervision; **Agnieszka Chwałczyńska** : Conceptualization, Methodology. Software, Validation, Investigation. Supervision Visualization, Reviewing and Editing,

## Declarations

## Competing interests

The authors declare no competing interests.

## Study pre-registration statement

The study was registered in the international clinical trials database (NCT06642233).

## Ethical approval

Ethical approval for the study was granted by the Senate Committee on Research Ethics at the Wroclaw University of Health and Sport Sciences (decision no. 29/2023).

## Additional information

**Supplementary Information** The online version contains supplementary material available at https://doi.org/10.1038/s41598-026-44316-8.

**Correspondence** and requests for materials should be addressed to A.C.

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