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scientific reports

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Upper limb muscle strength and neuromuscular coordination and other factors as determinants of kinesiophobia in people with cervical and cervicothoracic spine dysfunction

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The aim of this study was to analyze the incidence of neuromuscular coordination disorders and upper limb muscle strength in people with functional disorders of the cervical and cervicothoracic spine. A total of 407 participants took part in the study. The level of kinesiophobia was assessed using the Tampa scale. For cervical spine dysfunction, the pain was measured using the visual analogue scale (VAS) and the cervical disability index (NDI). Neuromuscular control was tested using the Deep Cervical Neck Flexor test with the Stabilizer device. Upper limb muscle strength was measured using a dynamometer test. The data obtained revealed a correlation between higher Tampa scale scores and most of the variables assessed. A positive correlation between age (rho = 0.27; $p < 0.001$), pain (rho = 0.43; $p < 0.001$), and NDI (rho = 0.43; $p < 0.001$) was registered. A negative relationship was found between neuromuscular coordination (rho = 0.41; $p < 0.001$) and muscle strength of most muscles(rho − 0.14 to -0.28, $p < 0.01$). Higher Tampa scale values correlate with poorer neuromuscular coordination, older age, pain, weaker NDI score, and strength of some upper limb muscles in the cervical and cervicothoracic spine functional impairment group. There is no correlation between kinesiophobia presence and gender.

Keywords Fear of movement, Movement phobia, Dynamometer, Neck muscles, Deep cervical neck flexor test

Functional disorders of the cervical and cervicothoracic spine are a common problem in the general population. Global age-standardized prevalence and incidence rates are estimated at 3551.1 and 806.6 per 100,000 persons[1]. The negative impact of these dysfunctions on health at both the individual and population levels imposes an urgent need to identify predisposing factors. Knowledge of these factors will allow for Implementing strategies aimed at prevention, early detection, and initiation of appropriate physiotherapy[2]. One of the symptoms of functional disorders is pain in the cervical spine, which has a varied etiology[3]. To prevent the onset of pain, patients use avoidance behavior aimed. These are often exaggerated reactions[4]. Excessive, unreasonable fear of physical activity due to fear of injury or re-injury is referred to as kinesiophobia[5,6]. If a person is unable to perform a motor task because they believe it will increase pain, kinesiophobia develops.

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As defined by Kori, the phenomenon of pain is a component of kinesiophobia[5]. Kinesiophobia and the associated pain have an impact on the individual and society, and in addition, the nature of the workplace increasing strain on the neck[7]. Neck/shoulder and hand/arm pain can lead to a deterioration in work activities, and contribute to sickness absence, reduced productivity, performance, and occupation disability[8]. It constitutes a self-perpetuating vicious circle that requires adequate identification of causes, risk factors, and the introduction of therapeutic intervention[9]. Tampa Scale can be used in physiotherapy practice to diagnose kinesiophobia[4]. In our clinical practice, we observed impaired upper limb muscle strength and control of the deep neck flexors in participants with cervical spine dysfunction and kinesiophobia. We made these observations by performing functional tests. The deep muscles serve important postural functions[10].

To date, little knowledge is known about the link between kinesiophobia and deep muscle dysfunction and what relevance this has in physiotherapy practice. Without a doubt, a patient who is not physically active does not stimulate the muscle tissue to work physiologically, and abnormal muscle tone can translate into impaired muscle coordination and endurance[10]. Although such abnormalities are considered a protective response inhibiting further stimulation of painful structures, they may contribute to further tissue damage, exacerbate pain by sensitizing the nervous system, and perpetuate dysfunctional movement patterns[11]. A large number of dependents, especially personality traits, helps to understand why, in some cases, an acute pain episode turns into a chronic pain syndrome, and the sequelae persist despite tissue healing and pose a challenge to the therapist[12,13].

The medical literature describes the existence of an association between the occurrence of kinesiophobia in patients with functional impairment of the cervical and cervicothoracic spine and age, gender, pain incidence, and cervical disability index. There is a lack of information on the association of kinesiophobia with upper limb muscle strength and neuromuscular coordination in these participants.

Based on our clinical observations, we formulated the hypothesis that all the factors mentioned above are related to the occurrence of kinesiophobia. Our study aims to verify the research hypothesis. We formulated the following specific research questions:

1. What is the prevalence of kinesiophobia in the study population?
2. Is there a relationship between upper limb muscle strength and the prevalence of kinesiophobia depending on the gender breakdown?
3. What were the results of the Deep Cervical Neck Flexor test depending on the severity of the problem according to the International Classification of Functioning, Disability and Health?

Method

Characteristics of the study sample

Participants in the study included the VRneck SOLUTION project 'Innovative system for diagnosis, therapy, and training of functional disorders and injuries of the cervical and cervicothoracic spine'. Individuals aged between 18 and 80 years, both with and without cervical spine pain, were eligible for the study. Before the start of the study, participants gave their informed consent to participate in the study. Participants with a history of cervical trauma or surgery, pregnant women, patients with malignant neoplasm, rheumatic diseases, and other conditions that may affect joint and neuromuscular function in the cervical spine were not included in the study. Detailed exclusion criteria are presented in the Online Resource.

The study was conducted at the Medical Rehabilitation Clinic of the Central Clinical Hospital of the Medical University of Lodz, the CREATOR Prevention and Rehabilitation Centre in Lodz, and the BMK Rehabilitation Centre in Wroclaw. The survey was carried out in the period from 01.01.2022 to 31.01.2023.

The study included (1) obtaining sociogeographical information about the study participants, (2) assessing kinesiophobia using the Tampa scale, (3) assessing disability due to cervical spine complaints using the Neck Disability Index (NDI), (4) assessment of cervical spine pain severity using the Visual Analogue Scale (VAS), (5) assessment of deep cervical flexor muscle activation using Test Deep Cervical Neck Flexor (DCNF), and (6) assessment of upper limb muscle strength. The muscle structure parameters were assessed by a physiotherapist. Other parts of the medical examination were performed by the doctor.

Sociodemographic data

Sociodemographic information was revealed during the medical examination. The data included age and gender. Gender was defined based on the respondent's self-description.

Kinesiophobia

Assessment of the level of kinesiophobia on the Tampa scale was carried out using a 17-question questionnaire. Participants were informed that the Tampa scale questions pertained to their fear of moving of the neck. Each question was to be answered on a four-point Likert-type scale. The obtained results ranged from 17 to 68 points[13]. A score above 37 was interpreted as a diagnostic of kinesiophobia[12].

Neck disability index

The assessment of disability due to cervical spine complaints was carried out using the NDI questionnaire. The respondents answered 10 questions about functioning in activities of daily living. The volunteers marked the response most relevant to their situation between 0 and 5 points. The level of disability was the sum of the scores of all categories. The higher the value, the greater the respondent's disability was[14].

Pain complaints

Cervical spine pain severity was assessed at rest using a visual-analogue scale. The respondents specified the severity of the pain they felt on a line with numerical markers from 0 (no pain) to 10 (most severe pain)[15].

Neuromuscular coordination

The isolated activation of deep neck flexor muscles was assessed using the DCNFT method, employing a Stabilizer device manufactured by Chattanooga in 2019. We performed the test according to the protocol of Jull et al. assessing isometric muscle contraction[16]. Impairment in the DCNFT combined with restricted movements and palpable dysfunction of the upper cervical joint had 100% sensitivity and 94% specificity in identifying cervicogenic headache[17]. The study was conducted with the patient in a supine participant with the head in a neutral position. A device cuff was placed under the cervical lordosis with a baseline pressure of 20 mmHg. The test participant's task was to flex the upper part of the cervical spine by maintaining pressure for 3 s. The test was performed at five functional levels; each level was 2 mmHg greater than the previous one. Only levels that the test participant performed correctly, i.e. without the involvement of the sternocleidomastoid muscles, were credited. The second stage consisted of 10 repetitions for 10 s at the highest pressure level at which the participant had performed correctly at stage (1) The score obtained was the product of the difference between the pressure value from the highest scored level and the initial value from stage 1 by the number of correct repetitions from stage (2) The final score obtained in the test reflects the performance of the deep neck flexor muscles (maximum 100 points). We interpreted the DCNFT score as an indicator assessment of neuromuscular coordination.

Upper limb muscle strength test

We measured muscle strength using a hydraulic push-pull and handheld dynamometer by Baseline, year of production 2020. In the Riemann et al. study both the intra- and inter-examiner reliability measured with pull-push Baseline dynamometer for shoulder internal and external rotators in six different positions was acceptable (from moderate to excellent) with intraclass correlations (ICCs) ranged from 0.570 to 0.938 for intra-rater and from 0.635 to 0.923 for interrater reliability[18]. In turn, Vasava et al. indicated excellent internal reliability (ICC = 0.956 and ICC = 0.949 for right and left side) as well as excellent interrater reliability (ICC = 0.970 and ICC = 0.971 for right and left side)[19]. When using the push-pull dynamometer, the physiotherapist applied pressure at a specific point on the participant's body to test the muscle structures responsible for movement. The score represents the point when the participant could not overcome the resistance exerted by the physiotherapist. When using the hand strength measurements, the test participant squeezed the measuring device[20]. An interview-based measurement of muscle strength on the dominant side of the body was performed. The average result of the three trials constituted the final test score. In ambidextrous participants, three measurements were taken, on one side and the other, and the arithmetic mean was drawn. Indicator muscles belonging to a given spinal motor segment and the corresponding movements of the upper limb were analyzed. A description of the test performance is presented in Table 1.

Statistical analysis

The analysis was checked for normality of distribution using the Shapiro-Wilk test. Statistical analyses were performed using Statistica, version 13 (TIBCO Software Inc.). Analysis of the results included descriptive statistics and the use of tests:

- For comparison of numerical data between groups, the Student's *t*-test or Mann-Whitney *U* test was used, depending on the distribution.
- To test the relationship between two qualitative variables, Pearson's Chi^2 test was used.
- The Pearson correlation coefficient was used to determine the correlation between age and Tampa scale results (level of kinesiophobia).
- In order to determine the correlation between variables excluding the impact of other variables, partial correlation coefficients were calculated.
- The V-Cramer contingency coefficient.
- Logistic regression analysis of risk factors for counting odds ratio (OR).

Data were presented as mean and standard deviation or as median and Q1-Q3. A value of $p = 0.05$ was taken as the threshold for statistical significance.

Test structures	Test movements	Starting position	Place of measurement	Stabilization
M. infraspinatus, M. supraspinatus	External rotation	Sitting, arms along the torso, forearm flexion 90°, palm facing inwards	Above the wrist	Outer side of the elbow using the therapist's hand
M. deltoideus	Abduction of the arm	Sitting, abduction of the arm to 90°, elbow bent 90°, hand in pronation	On the arm, proximal to the elbow	Therapist behind and to the side of the participant, hand on participant's tested shoulder
M. biceps brachii	Elbow flexion and supination of the forearm	Sitting, arm flexion 45°, elbow flexion 45°, hand in supination	Inner side of the arm, above the wrist	Of the tested arm
M. triceps brachii	Extension of the elbow joint	Sitting, arm and elbow flexion 45°, hand in supination	Outer side of the arm above the wrist	Of the tested arm
M.flexor digitorum, M.adductor pollicis, M.abductor digiti minimi, MM.interossei	Hand-grip strength	Sitting, arms adducted, naturally rotated, maintained the right angle at the elbow, forearm positioned naturally, wrists in flexion between 0 and 30°	The participant's hand - hand dynamometer	Forearm resting on the couch

Table 1. Methodology of the muscle strength assessment test.

Results

Sociographic data

The 407 participants in the study included 282 women (69.3%) and 125 men (30.7%). The mean age in the study group was 44 years (median 44; range: 19–78 years; standard deviation ± 16 years). The comparative characteristics of the study groups, for those with and without kinesiophobia, are shown in Table 2.

Kinesiophobia

Among the participants, the Tampa kinesiophobia score ranged from 18 to 53 (median 30; mean score 30.8; standard deviation ± 7.5). In 323 participants (79.4%), the score was no greater than 36 and they were therefore classified as having no kinesiophobia. The remaining participants (20.6%) had a score greater than or equal to 37. These patients were diagnosed as having kinesiophobia.

Neck disability index

The results of the disability assessment due to cervical spine complaints using the NDI questionnaire ranged from 0 to 26 points (median 6; mean 7.7; standard deviation ± 6.3).

Pain complaints

Cervical spine pain severity scores assessed using a visual analogue scale ranged from 0 to 9 in the study group (median 3; mean 3.1; standard deviation ± 2.4).

Neuromuscular coordination

The results of the assessment of isolated activation of the deep neck flexor muscles using DCNFT were reported to range from 0 to 100 (median 12; mean 29.1; standard deviation ± 34.6). We also offered an interpretation of the score obtained to classify the subject into a disability range according to the International Classification of Functioning, Disability and Health (ICF):

- 0–4 - extreme problem,
- 5–24 -severe problem,
- 25–49 - moderate problem,
- 50–95 - mild problem,
- 96–100 - no problem[21].

In half of the subjects diagnosed with kinesiophobia, we found an extreme problem and a significant one in 31%. In subjects without phobia, the severity of the problem was lower. An index value of 96–100, considered no problem, was shown by three times as many participants without phobia. The calculated contingency coefficient equals 0.19, indicating a not-very-strong relationship. The comparison of the DCNFT and the problem scale according to the ICF is presented in Fig. 1.

Upper limb muscle strength test

Muscle strength results for the upper limb external rotators measured with a dynamometer ranged from 0 to 9.7 kg (median 10; mean 10.6; standard deviation ± 5.2) in the study group. The results for the arm adductor muscles were recorded in the range of 0 to 9.7 kg (median 10.7; mean 12.5; standard deviation ± 6.6). A range of 0 to 9.8 kg (median 14.2; mean 14.2; standard deviation ± 5.9) was recorded for arm squeeze strength. Subsequently, for elbow extensor muscles, results ranging from 0 to 27.7 kg (median 8; mean 8.1; standard deviation ± 5.5) were recorded for elbow extensor muscles. Muscle strength results for the elbow flexors and forearm supinators ranged from 1.1 to 41.7 kg (median 11.3; mean; standard deviation ± 7.5).

Variable	All		Kinesiophobia		No kinesiophobia		p
	(X ± SD) *N* (%)	Me, (Q1, Q3)	(X ± SD) or *n* (%)	Me, (Q1, Q3)	(X ± SD) or *n* (%)	Me, (Q1, Q3)	
Sex (women or men)	W = 282 (100%) M = 125 (100%)	–	W = 65 (23.1%) M = 19 (15.2%)	–	W = 217 (76.9%) M = 106 (84.8%)	–	0.07
Age (years)	44.0 ± 16.0	44.0 (31.0, 56.0)	52.1 ± 13.1	52.5 (44.5, 63.0)	41.9 ± 15.6	41.0 (28.0 52.0)	$p < 0.001$
Neck disability index (point)	7.7 ± 6.3	6.0 (2.0, 13.0)	11.9 ± 6.8	12.5 (6.0, 17.0)	6.6 ± 5.7	5.0 (2.0, 11.0)	$p < 0.001$
Visual analogue scale (mm)	3.1 ± 2.4	3.0 (1.0, 5.0)	4.5 ± 2.5	5.0 (3.0, 6.0)	2.8 ± 2.2	3.0 (1.0, 4.0)	$p < 0.001$
Deep cervical neck flexor test (point)	29.1 ± 34.6	12.0 (0, 48.0)	16.6 ± 26.5	5.0 (0, 16.0)	32.4 ± 35.8	16.0 (2.0, 60.0)	$p < 0.001$
Muscle strength - external rotation (kg)	10.6 ± 5.2	10.0 (8.0, 13.7)	8.7 ± 5.3	8.7 (5.0, 10.0)	11.0 ± 5.1	10.0 (8.0,14.7)	$p < 0.001$
Muscle strength of the shoulder abductor (kg)	12.5 ± 6.6	10.7 (8.0, 19.3)	10.3 ± 6.4	10.0 (5.0, 15.5)	13.1 ± 6.6	12.0 (8.0, 19.3)	$p < 0.001$
Hand grip strength (kg)	14.2 ± 5.9	14.2 (10.0, 16.7)	11.9 ± 4.8	11.3 (9.2, 15.0)	14.8 ± 6.0	14.9 (10.3, 18.3)	$p < 0.001$
Muscle strength elbow extension (kg)	8.1 ± 5.5	8.0 (2.0, 11.0)	7.3 ± 5.7	5.65 (2.0, 10.0)	8.4 ± 5.4	8.7 (2.0, 11.3)	0.07
Elbow flexion and forearm supinator muscle strength (kg)	12.6 ± 7.0	11.3 (8.0, 19.7)	10.9 ± 7.2	10.0 (4.0, 18.7)	13.1 ± 6.9	12.0 (8.0, 20.0)	0.02

Table 2. Characteristics of the study group depending on the presence of kinesiophobia. Source: compilation based on data.

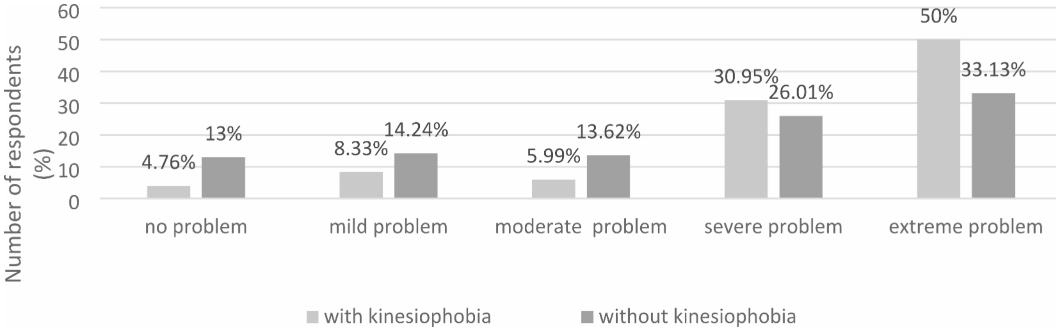

Fig. 1. Assessment of neuromuscular control (DCNFT) in the study population based on the quantitative scale used in the ICF classification.

Variable	All	Women	Men
Deep cervical neck flexor test	−0.28***	−0.38***	−0.08
Muscle strength–external rotation	−0.03	−0.09	0.03
Muscle strength of the shoulder abductor	−0.14**	−0.19**	−0.11
Hand grip strength	−0.12**	−0.16**	−0.19*
Muscle strength elbow extension	−0.04	−0.09	−0.04
Elbow flexion and forearm supinator muscle strength	−0.03	−0.05	−0.003

Table 3. Partial correlations with Tampa scale results controlling for age, VAS, and NDI. *$p<0.05$. **$p<0.01$. ***$p<0.001$. Source: compilation based on data.

Correlation scores

The occurrence of kinesiophobia was not dependent on gender ($p=0.07$). Participants with kinesiophobia were older than patients without kinesiophobia (52.1 vs. 41.9 years, respectively; $p<0.001$), and showed higher disability scores due to cervical spine complaints (NDI: 11.9 vs. 6.6, $p<0.001$), showed higher cervical spine pain severity scores (VAS: 4.5 vs. 2.8; $p<0.001$), lower scores on the isolated deep neck muscle activation assessment (DCNFT: 11.6 vs. 32.4, $p<0.001$), lower upper arm abductor strength (strength in kg: 10.3 vs. 13.1, $p<0.001$), lower external rotator strength (strength in kg:8.6 vs. 11; $p<0.001$) and lower hand strength (strength in kg: 11.8 vs. 14.7, $p<0.001$) (Table 2).

In order to determine the relationship between the level of kinesiophobia and other indicators, a correlation analysis was performed. The level of kinesiophobia increased with age both in the entire study group ($r=0.27$, $p<0.001$) and in the groups of women ($r=0.23$, $p<0.001$) and men (0.34, ($p<0.001$) (data not shown in the table). Due to significant differences in age, VAS, and NDI between the two groups (Kinesiophobia vs. No-kinesiophobia), these factors could influence muscle strength and the DCNFT test. For this reason, partial correlation, controlling for age, VAS, and NDI were performed (Table 3). According to the results of these analyses, the level of kinesiophobia increased with worsening Deep Cervical Neck Flexor test results, but not in men. There was also a negative correlation between the Tampa scale results and the muscle strength of the shoulder abductor in women and with Hand Grip Strength (both in women and men) (Table 3).

Logistic regression analysis showed that the significant risk factors of kinesiophobia were: higher age of the participant, higher pain level, higher degree of disability, lower isolated deep neck muscle activation, and lower muscle strength with the exception of elbow extension muscle strength (not a statistically significant factor). The analysis is presented in Table 4.

Discussion

Our study was the first to demonstrate an association between kinesiophobia and the level of neuromuscular coordination of the deep neck flexor muscles. Individuals in whom kinesiophobia was absent achieved nearly twice the DCFN test values. We cannot compare our observations with those of other authors because we did not find any paper in the available scientific literature referring to this parameter. An indirect validation of our findings can be seen in the similar relationship reported among participants with chronic back pain. It was noted that an exaggerated approach to pain was related to altered neuromotor control and muscle activity[22]. Increased pain avoidance may translate into adaptive strategies and reduce deep muscle activity, increasing tension on superficial structures[23].

We found no association between the occurrence of kinesiophobia and gender. The results presented by other authors are discrepant on this issue. Stenberg et al. found no association between the prevalence of kinesiophobia and gender[24]. Some researchers have indicated that women achieve higher Tampa scale values indicating kinesiophobia[25,26] and some that among men[27,28]. We showed that the age of the subjects remained related to the prevalence of kinesiophobia. Age was an independent risk factor for the development of kinesiophobia. Each

Variable	OR (95% CI)	P
Sex	0.6 (0.34; 1.05)	0.07
Age	1.04 (1.03; 1.06)	$p<0.001$
NDI	1.15 (1.1; 1.19)	$p<0.001$
VAS	1.38 (1.23; 1.54)	$p<0.001$
Neuromuscular coordination	0.98 (0.98; 0.99)	$p<0.001$
Muscle strength–external rotation	0.91 (0.86; 0.96)	$p<0.001$
Muscle strength of the shoulder abductor	0.93 (0.9; 0.97)	$p<0.001$
Hand muscle strength	0.9 (0.86; 0.95)	$p<0.001$
Muscle strength elbow extension	0.96 (0,92; 1.01)	0.1
Muscle strength elbow flexion and forearm extension	0.96 (0.92; 0.99)	0.01

Table 4. Logistic regression analysis of risk factors of kinesiophobia. Source: compilation based on data.

additional year of age increased the risk of kinesiophobia by 4%. Our result corresponds with the observations of Naugle et al. who also showed that the level of kinesiophobia increases with the age of the subjects participants[29].

Among the variables we analyzed, the NDI showed the strongest association with the presence of kinesiophobia. In our study, we found that the higher the score obtained on the NDI questionnaire, the more likely the subject was to have kinesiophobia. Our results are consistent with those published by Amiri et al.[30].

In our study, we showed that the intensity of cervical spine pain was related to the presence of kinesiophobia. An increase of a numerical value of one on the VAS scale increased the probability of a diagnosis of kinesiophobia by 38%. We found a direct correlation of moderate strength between Tampa scale score and pain intensity. The available literature does not provide simple correlations between cervical spine pain complaints and kinesiophobia. In Asiri et al. analysis, patients with chronic neck pain described a strong positive and strong correlation between these two factors[31]. The strength of the correlation may have been influenced by the chronic nature of the dysfunction, which was not taken into account in our study. The difference in the size of the patient groups studied may be responsible for the discrepancy between our results and those of Asiri et al. Our study group was nearly seven times larger than that of Asiri et al. (407 vs. 64). In our study, we found that the mean Tampa scores (30.8 vs. 59.7) and mean VAS pain intensity were significantly lower (3.13 vs. 5.62) than in the comparison study. Also, the mean age of the participants was lower in our study (44 years vs. 54 years) which, in light of the results, may account for the lower severity of kinesiophobia[31]. However, not everyone agrees that there is a link between the presence of kinesiophobia and neck pain[32].

Our hypothesis assuming the existence of correlations between kinesiophobia and limb muscle strength proved true for most of the muscle structures studied. Intriguingly, we found that the occurrence of these correlations was dependent on the gender of the participants. In women, the correlations were statistically significant for all the muscles studied, while in men they were significant only for three muscles (external rotation, shoulder abduction, and hand squeeze). The occurrence of gender differences in muscle strength may not be surprising. Women have on average 50–60% of the muscle strength of men[33]. Men also have a stronger hand grip in most age groups[34]. In the available literature, we did not find a description of the relationship between kinesiophobia and all the components of upper limb movements we examined. There are studies primarily assessing the relationship between kinesiophobia and hand strength. Das De et al. identified kinesiophobia and catastrophic thinking as predictors of upper limb disability. The authors used the Disabilities of the Arm, Shoulder and Hand (DASH) questionnaire. However it was a self-assessment test, in which only hand muscle strength was examined[35]. A dynamometer study, like ours, was conducted by Asiri et al. They too found a negative correlation between the presence of kinesiophobia and hand grip strength in people with chronic neck pain. However, they only examined hand muscle strength and did not include a gender breakdown. Decreased hand strength may be due to an overall decrease in motor activity, including activities of daily living involving.

We believe our results are valuable due to the large number of patients included in the study and the extensive range of tests and measurements conducted. This is a very large group compared to the group described, for example, by Asiri et al. (64 subjects)[31]. In most publications, the range of measurements taken is quite limited. For instance, while Das De et al. only performed measurements of hand muscle strength, our study assessed muscle strength of the shoulder extensors, shoulder external rotators, hand strength, elbow extensors and flexors, and forearm supinators[35].

The prevalence of kinesiophobia in the study group is worrying, occurring in one in five participants. Kinesiophobia is also considered a central factor in the development of pain from acute to chronic, causing sequelae in the muscular, skeletal, cardiovascular, respiratory, and psychological systems[12,36]. These complaints can progress into musculoskeletal diseases, which rank among the most expensive conditions to treat[37].

In clinical practice, the patient's responses to pain complaints are seldom considered, which may result in a lack of treatment progress. The correlation found in this study supports the need for patients to receive superior analgesic therapy to break the vicious circle present in kinesiophobia and prevent the development of a chronic form of the condition.

Kinesiophobia and its determinants should be addressed throughout the treatment process, both in the initial examination and in the evaluation of the effects of physiotherapy. One of the goals of physiotherapy should be to reduce the level of kinesiophobia[36]. An individual who fears the imagined consequences of physical activity is a patient with a reduced likelihood of following physiotherapy recommendations[38]. It is advisable to introduce psychological management besides physical training[39], e.g. cognitive-behavioural strategies, such as assessing and challenging unhelpful thoughts and beliefs, solution-focused techniques, relaxation, stress management and graded activity[40]. These measures may allow the barriers to be broken down and the patient to return to physical activity, counteracting disability and recurrence of symptoms.

Study limitation

We did not include all upper limb muscles in the strength assessment, but only selected ones. This is because we wanted to refer to muscles that may indicate functional disorders of the motor segments of the spine in the cervical and cervicothoracic segments and cause a reflex reaction. Nonetheless, the number of muscles assessed appears adequate for the purposes of this study.

In our study, we did not take into account all determinants of kinesiophobia. A number of other factors can potentially affect the level of kinesiophobia. Studies by other authors suggest that it may be, for example, the level of education[41], physical activity[42] or occupational level[43]. However, there is little data on these factors in relation to cervical spine pain. Therefore, it is worth including them in future studies.

Conclusions

Kinesiophobia is associated with poorer neuromuscular coordination. People with kinesiophobia have problems identified as extremely large and significant in the assessment of neuromuscular coordination. The risk of kinesiophobia increases with age, pain level, and degree of cervical spine disability. Kinesiophobia may be associated with weaker strength in some upper limb muscles, particularly in women. Gender is not a determining factor in the prevalence of kinesiophobia in people with cervical and cervicothoracic spine disorders.

Data availability

The measurement data used to support the findings of this study are available from the corresponding author upon request.

Received: 19 August 2024; Accepted: 8 January 2025
Published online: 01 April 2025

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Funding

The study was funded as part of the project "VRneck SOLUTION—Innovative system for diagnosis, therapy, and training of functional disorders and injuries of the cervical and cervicothoracic parts of the spine", which received funding from the National Centre for Research and Development from the Intelligent Development Operational Programme 2014–2020 (under Priority Axis IV: Increasing scientific and research potential, Activity: Scientific research, Subactivity: Application projects), grant no. POIR.04 0.01.04-00-0113/19. from the Intelligent Development Operational Programme 2014–2020 (under Priority Axis IV: Increasing scientific and research potential, Activity: Scientific research, Subactivity: Application projects).

Declarations

Competing interests

The authors declare no competing interests.

Additional information

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1038/s41598-025-86109-5.

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