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Joint position sense testing at the wrist and its correlations with kinesiophobia and pain intensity in individuals who have sustained a distal radius fracture: A cross-sectional study

Raquel Cantero-Téllez, Ph.D, OTR/L, PT, CHT [a,*,1,2], Lori A. Algar, OTR/L, CHT, OTD [b], Leire Cruz Gambero, OTR [a], Jorge Hugo Villafañe, Ph.D, PT [c], Nancy Naughton, OTD, OTR/L, CHT [d]

[a] Physiotherapy Department, Faculty of Health Sciences. University of Málaga. IBIMA FE-17 Hand Research Team, Málaga, Spain
[b] Outpatient Hand Therapy, Orthopaedic Specialty Group PC, Fairfield, CT, USA
[c] Physiotherapy Department, Faculty of Sport Sciences, Universidad Europea de Madrid, Villaviciosa de Odón, Spain
[d] Hand Surgery Associates, Scranton, PA, USA

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A B S T R A C T

Background: Sensorimotor impairment following distal radius fracture (DRF) has been associated with a significant decline in function. Joint position sense (JPS) testing is a meaningful and responsive way to assess sensorimotor impairment for individuals who have sustained a DRF; however, there are factors that may influence the results of JPS testing, including kinesiophobia and pain intensity.
Purpose: This study aimed to evaluate the influence kinesiophobia may have on wrist JPS testing and if pain intensity impacts kinesiophobia and JPS in individuals with a DRF.
Study Design: This was a cross-sectional study.
Methods: Participants referred from two medical centers with a diagnosis of DRF treated with at least 3 weeks of immobilization were enrolled in the study. Data were collected at 1 week and 6 weeks post-immobilization period. Demographics were summarized with descriptive statistics, and linear relationships between kinesiophobia, pain intensity, and wrist JPS were examined using Pearson correlation coefficient.
Results: Forty-eight participants were included in this study (mean age 42.9 years). Significant positive correlations were found between the Tampa Scale for Kinesiophobia (TSK) and Numeric Rating Scale (NRS; $r = 0.951$, $p < 0.001$), TSK and JPS error ($r = 0.942$, $p < 0.001$), as well as NRS and JPS error ($r = 0.898$, $p < 0.001$). These correlations indicate that higher levels of kinesiophobia are associated with increased pain intensity and greater JPS error. *T*-tests reveal no significant difference between male and female for the TSK, NRS, or JPS scores.
Conclusions: There is an association for individuals with high levels of kinesiophobia and both greater pain and errors with JPS testing.

Introduction

Mechanical sciences consider the human body as a complex biomechanical system with kinematics and dynamics.[1] The radiocarpal joint, one of the joints of the wrist, is a condylar synovial joint of the distal upper limb that connects the forearm to the hand and serves as a transition. A distal radius fracture (DRF) occurs at the radiocarpal joint and is one of the most common fractures in the upper extremity.[2] Clinical symptoms, such as pain, decreased grip strength, decreased range of motion, or impaired sensorimotor (SM) control may be present and then persist months after DRF.[3] Clinically meaningful wrist sensorimotor impairment has been linked to significant functional decline in the first 12 weeks after DRF.[3] Disruption to the proprioception or SM system is likely to have an adverse impact on motor control and the regulation of muscle stiffness.[2] Joint position sense (JPS), also known as proprioception or kinesthetic sense, is an important component of the SM control system

* Corresponding author. Health Sciences Faculty, Physical Therapy Department, University of Málaga. IBIMA FE-17 Hand Research Team, C/ Arquitecto Francisco Peñalosa, 3, 29071, Málaga, Spain.
E-mail addresses: cantero@uma.es (R. Cantero-Téllez), lori.algar@gmail.com (L.A. Algar), leiregam@uma.es (L. Cruz Gambero), mail@villafane.it (J.H. Villafañe), nancynaughton10@gmail.com (N. Naughton).
[1] Twitter handle: @CanteroRaquel
[2] https://orcid.org/0000-0002-3251-8918

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and refers to the ability of an individual to perceive the position and the movement of their own joints without relying on visual or external cues. Wrist JPS is important for manual dexterity[4] and for assisting with production of balanced muscle force needed in hand function and injury prevention.[5]

Although different measures have been used in the literature to assess the outcomes after a DRF, active JPS has been determined to be the most clinically meaningful indicator related to functional loss.[3] JPS testing is also highly responsive for assessing conscious wrist SM control deficits.[6] However, the JPS test requires active wrist movement and therefore may be influenced by variables, such as pain and its related psychological factors.[7,8]

Psychological variables play a role in the development of chronic health disorders affecting proprioceptive function, muscle strength, and functional ability, and additionally explain a large part of the variability in disability associated with similar levels of impairment.[9] Kinesiophobia is described as the excessive and irrational fear of movement and physical activity in belief that it will cause injury or reinjury.[10] Individuals with kinesiophobia may avoid or limit movements and activities overestimating the risk of injury or reinjury and demonstrate hypervigilance toward bodily sensations or pain.[10] This fear can significantly impact not only a person's quality of life and functional abilities,[11,12] but kinesiophobia may also be a factor contributing to the limited and variable physical activity participation in older adults.[13] Previous studies indicate that kinesiophobia (via elevated baseline kinesiophobia scores) is associated with decreased status related to pain, proprioception, and functional performance and can also induce pain recurrence or cause changes in the somatosensory system. [14,15]

Information on the relevance of kinesiophobia to wrist JPS and postural control is lacking. Although JPS testing is identified as the most common way to assess wrist proprioception, there are several factors that may influence the results of this assessment, warranting further investigation. Therefore, the objectives of this study are to (1) evaluate the relationship between kinesiophobia and wrist JPS testing and (2) assess if pain intensity impacts kinesiophobia and JPS in individuals who have sustained a DRF.

Methods

Study design and enrollment

This study was a cross-sectional design study and was completed with participants who were attending skilled hand therapy services via the typical protocol following a minimum of 3 weeks of immobilization after sustaining a DRF. The study was performed with approval from the institutional review board at the University of Málaga. All procedures were in accordance with the ethical standards of the institutional and national ethics compliance committees, and the Declaration of Helsinki of 1975, as revised in 2008. Appropriate informed consent was obtained from all participants prior to enrollment in the study.

A total of 73 individuals diagnosed with a DRF by an orthopedic or general physician from two local hospitals were recruited for study participation at the time their immobilization phase of treatment was completed. Individuals were provided with information regarding this study by means of a written document that provided a telephone and email contact for the principal investigator who they were instructed to contact if they were interested in participating. All interested participants were referred to and treated at a large hand therapy center by a certified hand therapist following routine protocol.

Inclusion criteria for the study were individuals who (1) sustained a DRF, (2) were aged 18 years and older, (3) required at least 3 weeks of immobilization for their DRF, and (4) could read and understand the study materials. No distinction was made between surgical and nonsurgical treatment for the DRF with the caveat of a 3-week immobilization period. Participants were excluded if they had (1) started skilled therapy prior to the end of the immobilization phase, (2) upper extremity neuromusculoskeletal abnormalities other than DRF that would limit testing, (3) a history of upper extremity fractures or dislocations or surgery, (4) neurological disorders, or (5) a wrist flexion/extension active arc of motion of less than 30 degrees.

Outcome assessment and measures

The first study assessment took place between 5 and 10 days following the completion of the immobilization phase and during the initial therapy evaluation. The initial assessment included collection of demographic information, participant completion of the Tampa Scale for Kinesiophobia (TSK), pain rating via the Numeric Rating Scale (NRS), and JPS testing. Informed consent was obtained at the time of the first data collection. A second data collection occurred 6 weeks after the completion of the immobilization phase and included pain rating via the NRS and JPS testing. The data collection and routine skilled hand therapy treatment were completed by an occupational therapist and a certified hand therapist with more than 23 years of experience.

Pain intensity

The severity of pain with activity was measured according to the NRS. The NRS scale is a unidimensional measure of pain intensity that asks the participant to rate their pain intensity from 0 to 10, with 0 being no pain at all and 10 being the worst pain ever experienced.[16,17] The NRS is a reliable instrument with demonstrated sensitivity to changes for orthopedic injuries.[16,17]

Kinesiophobia

The fear of movement or kinesiophobia was evaluated using the TSK. The TSK includes 17 statements such as, "I'm afraid that I might injure myself if I exercise," and the participant is asked to select their level of agreement with each statement (strongly disagree, somewhat disagree, somewhat agree, and strongly agree; Appendix A). Scores range from 17 to 68, with higher scores indicating a greater fear of pain, movement, and injury.[18] There is a cutoff score of 36 indicating presence or absence of kinesiophobia.[18] The TSK scale is a reliable (r = 0.78) and valid tool for measuring fear of movement and has demonstrated good internal consistency (Cronbach alpha = 0.80).[11]

JPS testing

All JPS testing was completed using a consistent testing protocol and a standardized goniometer for active wrist position measurement.[6] All participants were seated comfortably with the involved elbow resting on a table in a flexed position. The forearm was positioned in a neutral position, and the fingers were in a resting flexed position. The investigator showed the participant (with eyes closed) a reference wrist position by passively moving the wrist into 30º of extension. Each participant was asked to memorize this angle and hold the position for 3 seconds. The participants were asked to move their wrist in a fully flexed position and then refind the position of 30º of wrist extension with vision occluded during the testing. When a participant verbally confirmed that the target angle was achieved, the wrist position was measured and recorded. The difference between the reference angle (30º of wrist extension) and the actively reproduced wrist angle was used as a criterion for the JPS deficit. The greater the angle difference, the greater the JPS deficit. A zero value was assigned if an exact reproduction of the reference wrist extension angle was achieved.[6] Positive or negative values were assigned for angle differences that were greater or less than the reference angle, but only the absolute values of the recorded angle differences were used. The mean of two trials was used for data analysis. The intratester reliability of this test has been reported to be high (intraclass correlation coefficient 0.85).[3]

Data analysis

Data were analyzed using SPSS version 28.0 (SPSS Inc, Chicago, IL, USA). G*Power 3.1.9.4 statistical software (NeuIsenburg, Aichach, Germany) estimated the need for a sample size of 48 participants for 80% statistical power (with α value of 0.05 and β value of 0.2) and Pearson correlation coefficient of 0.5 (moderate relationship).[19] Descriptive statistics (mean and standard deviation [SD]) were calculated for all subjects. The study data were normally distributed according to Shapiro-Wilk testing.

Demographic characteristics were described using descriptive analysis.

Pearson correlation coefficient (r) was used to determine the linear relationship between kinesiophobia, pain, and wrist JPS. Correlation coefficients between 0 and 0.3 were considered weak, 0.4-0.6 were considered moderate, and 0.7-1.0 were considered strong.[19] A p value of ≤0.05 was used to determine the statistical significance of linear regression analysis to determine whether kinesiophobia could potentially interfere with wrist JPS testing in subjects who sustained a DRF.

Results

Clinical characteristics of the participants

The study included 22 women and 26 men for a total of 48 participants. Of the 73 participants initially contacted diagnosed with a DRF by an orthopedic or general physician from two local hospitals, six did not respond. Sixty-seven participants were initially recruited for study participation; however, 11 did not meet the inclusion criteria, 2 did not sign the informed consent, and six did not attend the second assessment. The average age of the participants was 42.91 years (SD = 15.41). The mean duration of immobilization for women was 5.1 weeks (SD = 1.91) and 5.2 weeks (SD = 1.68) for men. At baseline, the participants reported moderate levels of kinesiophobia as measured by the TSK, with a mean score of 43.7 (SD = 13.02) for women and 42.5 (SD = 15.07) for men. The participants also reported mild pain intensity, as indicated by the NRS, with a mean score of 4.4 (SD = 1.35) for women and 4.3 (SD = 1.58) for men (Table 1).

Table 1
Participant's Demographic and Clinical Characteristics

Variable	n = 48	Percentage/mean (SD)
Treatment (%)	48	100
Conservative	29	60.4
Surgical	19	39.4
Dominant hand (%)	48	100
Right	42	87.5
Left	6	12.5
Hand injury (%)	48	100
Right	30	62.5
Left	18	37.5
Age, mean (SD)	48	42.9 (15.4)
Women	22	45.8/41.2 (15.4)
Men	26	54.2/44.4 (15.7)
Time of immobilization (wk), mean (SD)	48	5.10 (1.9)
Women	22	45.8/5.18 (1.7)
Men	26	54.2/5.04 (2.1)
TSK baseline, mean (SD)	48	43.7 (13.0)
Women	22	45.8/45.1 (10.2)
Men	26	54.2/42.5 (15.1)
NRS baseline, mean (SD)	48	4.4 (1.4)
Women	22	45.8/4.6 (1.01)
Men	26	54.2/4.2 (1.6)

NRS = Numeric Rating Scale; SD = standard deviation; TSK = Tampa Scale for Kinesiophobia.

Associations between kinesiophobia, pain intensity, and proprioceptive deficits

Pearson's correlation coefficients were calculated to assess the relationships between variables. Significant positive correlations were found between TSK and NRS (r = 0.951, $p < 0.001$), TSK and JPS error (r = 0.942, $p < 0.001$), as well as NRS and JPS error (r = 0.898, $p < 0.001$). These correlations indicate that higher levels of kinesiophobia are associated with increased pain intensity and greater JPS error (Table 2).

Table 2
Relationship Between Variables (TSK, NRS, and JPS Error)

Variables	r	p	n
TSK-NRS	0.951**	0.001	48
TSK-JPS error	0.942**	0.001	48
NRS-JPS error	0.898**	0.001	48

JPS = Joint Position Sense; NRS = Numeric Rating Scale; TSK = Tampa Scale for Kinesiophobia.
**The correlation is significant at 0.01.

Regression analysis of predictors on outcome variable

A regression analysis was conducted to examine the predictors of the outcome variable. The model's goodness-of-fit statistics indicated that the predictors accounted for a substantial proportion of the variance in the outcome variable (R^2 = 0.89). In model 1, both TSK baseline and NRS baseline were entered as predictors. The overall model was statistically significant ($F_{2.35}$ = 140.23, $p < 0.001$), suggesting that the predictors significantly contributed to the prediction of the outcome variable. The predictor variables collectively accounted for 88.9% of the variance in the outcome variable. TSK baseline exhibited a positive relationship with the outcome variable (B = 0.237, SE = 0.046, $p < 0.001$), indicating that higher baseline levels of kinesiophobia were associated with increased values of the outcome variable. Similarly, NRS baseline also showed a positive relationship with the outcome variable (B = 0.298, SE = 0.437, $p < 0.001$), indicating that higher baseline pain intensity was associated with increased values of the outcome variable (Table 3).

Table 3
Effect of TSK and NRS at Baseline as Predictors for JPS Error

Predictors	F	R^2	B	SE	p	$1 - \beta$
Model 1	140.23	0.89	0.072	0.581	< 0.001	1
TSK baseline			0.237	0.046		
NRS baseline			0.298	0.437		

JPS = Joint Position Sense; NRS = Numeric Rating Scale; SE = standard error; TSK = Tampa Scale for Kinesiophobia.
TSK baseline exhibited a positive relationship with the outcome variable (B = 0.237, SE = 0.046, p < 0.001). NRS baseline also showed a positive relationship with the outcome variable (B = 0.298, SE = 0.437, p < 0.001). The regression equation was statistically significant $F_{2.35}$ = 140.23. $p < 0.000$. $\beta - 1 = 1$. The value of R^2 = 0.89 indicates that the 88.9% of the change in the JPS score can be explained by the TSK and NRS at baseline.

Table 4
Differences in Kinesiophobia, Pain Intensity, and JPS Error Between Sex of the Participants

Variables	Women (n = 22), mean (SD)	Men (n = 26), mean (SD)	t	p
TSK baseline	45.1 (10.24)	42.5 (15.07)	0.705	0.484
NRS baseline	4.6 (1.01)	4.3 (1.58)	0.703	0.485
JPS error	9.8 (2.67)	9.1 (3.11)	0.763	0.451

JPS = Joint Position Sense; NRS = Numeric Rating Scale; SD = standard deviation; TSK = Tampa Scale for Kinesiophobia.

Differences in kinesiophobia, pain intensity, and proprioceptive deficits based on gender

A t-test was performed to compare the mean scores between male and female participants in TSK, NRS, and JPS. The baseline mean score for women was 45.1 (SD = 10.24), and the baseline mean score for men was 42.5 (SD = 15.07). The t-test revealed no significant difference between genders in TSK scores (t = 0.705, p = 0.484). In terms of NRS, women had a baseline mean score of 4.6 (SD = 1.01), whereas men had a mean score of 4.3 (SD = 1.58). The t-test showed no significant difference between genders in NRS scores (t = 0.703, p = 0.485). JPS error scores for women had a mean error of 9.8 (SD = 2.67), while men had a mean error of 9.1 (SD = 3.11). The t-test did not reveal a significant difference between genders in JPS error (t = 0.763, p = 0.451; Table 4).

Discussion

The present study investigates the relationship between kinesiophobia, pain intensity, and wrist JPS testing error following a DRF. JPS assessment has garnered growing interest in recent years. Recent studies have started to uncover factors, such as the evaluator's expertise can impact the measurement [20]. There is also available evidence investigating the relationship of fear of movement and proprioception; however, these studies involve patients with chronic pain.[21-24] We are unaware of prior studies that explore the impact of kinesiophobia on JPS testing in acute or traumatic injuries, such as DRF. Previous clinical trials that have investigated JPS and DRFs have focused on function,[3] grip strength,[25] or wrist position and JPS. [20]

Psychosocial and cognitive behavioral factors have been found to contribute to both the extent and severity of pain and disability reported by patients with chronic pain.[26] Thus, an evaluation of psychological factors is relevant and clinically meaningful for clinicians when assessing and treating individuals with wrist injuries such as DRF.[27,28]

Karagiannopoulos et al[5] found that high pain scores showed significantly greater JPS deficits following a DRF. Similar findings have been reported in a descriptive study where a significant moderate association between JPS deficit and pain status was noted at 8 weeks after intervention for DRF.[3]

There are limited studies that evaluate correlations between fear of movement and JPS. Previous studies have found significant positive correlations between kinesiophobia and cervical joint position errors in neck extension and right and left rotation[29] and knee JPS errors in individuals with bilateral knee osteoarthritis.[24] Additionally, kinesiophobia was found to be a significant predictor of neck[29] and knee JPS.[24]

Fear of movement has been described as a factor that lasts over time as opposed to a transient response to injury.[30] Al-Amiry B et al[30] concluded that there is a high incidence of kinesiophobia 6-8 years after surgery for a total hip arthroplasty. These findings warrant the consideration of kinesiophobia and its impact following surgery for DRF and its long-term impact with proprioception and this diagnosis. Proprioception does affect function; therefore, kinesiophobia may likewise have a long-term impact on functional status following DRF injury and surgery, further necessitating the detection and understanding of kinesiophobia following DRF.

Our current study agrees with previous studies on kinesiophobia and the impact on JPS, with the suggestion that proprioception is linked to the fear of movement. Our study found a strong correlation between kinesiophobia and pain, kinesiophobia and JPS testing, and pain and JPS testing. The current study found that 88.9% of change in the JPS score can be explained by the scores on the TSK and NRS at baseline. While this is a higher level of prediction than previous studies,[24,29] the difference may lie in the fact that our study participants had acute trauma vs the chronic pain of participants in the previously noted studies. Aydogdu et al[31] have examined kinesiophobia via the TSK, JPS, and functional status of men following anterior cruciate ligament reconstruction. Similar to our study, these researchers found a relationship between kinesiophobia and activity level; however, they did not find a relationship between kinesiophobia and JPS.[31] A power calculation for sample size was not performed by Aydgdu et al,[31] causing the sample size to lack an ability to find the relationship if one did exist.[31] Finally, specific to sex, our findings are in agreement with a prior study [32] that found no significant difference in TSK scores, JPS error scores, or NRS baseline scores between women and men.

This study was not without limitations. The study did include enough participants to meet our original power calculation and only had an overall completion rate of 72%. The TSK was administered at a single time point and was not repeated for test-retest purposes. In addition, the TSK is a self-reported measure and may be impacted by variables such as participant bias.

Limitations

Of the 73 participants initially contacted, six did not initiate contact with the research team to express their intention to participate in the study. Given that participation incurred no charges or financial obligations for the participants, we can confidently dismiss the presence of financial bias. However, the lack of recorded reasons for declining participation could potentially introduce an incidence-prevalence bias.

Given that the primary objective of the study was to establish a potential correlation between fear of movement, pain intensity, and how these factors might influence proprioception, the type of surgical intervention or the severity of the injury was not considered. Future studies should consider whether a surgical approach or the severity of the fracture could contribute to this association.

Furthermore, in this preliminary study, other movements, such as dart-throwing motion, were not considered when establishing the JPS error.

Clinical implications

This study highlights the impact that kinesiophobia may have on individuals who have sustained a DRF and suggests the importance of assessment and treatment of kinesiophobia in individuals who have sustained a DRF in order to maximize the patient's activity level and functional outcome.

Conclusions

High levels of kinesiophobia on the TSK are associated with greater pain intensity and JPS error for individuals who sustained a DRF and required at least 3 weeks of immobilization without a difference between male and female. Future studies on this topic, with consideration for other psychosocial variables, including depression, anxiety, and catastrophic thinking, may further contribute to clinical care for individuals with DRF.

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Declaration of competing interest

There are no conflicts of interest to disclose.

Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.jht.2023.12.008.

References

1. Poitras I, Dupuis F, Bielmann M, et al. Validity and reliability of wearable sensors for joint angle estimation: a systematic review. *Sensors (Basel).* 2019;19(7):1555. https://doi.org/10.3390/S19071555
2. Muurling M, Lötters FJB, Geelen JE, et al. A long-term effect of distal radius fracture on the sensorimotor control of the wrist joint in older adults. *J Hand Ther.* 2021;34(4):567–576. https://doi.org/10.1016/J.JHT.2020.07.002
3. Karagiannopoulos C, Sitler M, Michlovitz S, et al. A descriptive study on wrist and hand sensori-motor impairment and function following distal radius fracture intervention. *J Hand Ther.* 2013;26(3):204–215. https://doi.org/10.1016/J.JHT.2013.03.004
4. Goble DJ. Proprioceptive acuity assessment via joint position matching: from basic science to general practice. *Phys Ther.* 2010;90(8):1176–1184. https://doi.org/10.2522/PTJ.20090399
5. Reddy RS, Tedla JS, Dixit S, et al. Cervical proprioception and its relationship with neck pain intensity in subjects with cervical spondylosis. *BMC Musculoskelet Disord.* 2019;20(1):1–7. https://doi.org/10.1186/S12891-019-2846-Z/TABLES/3
6. Karagiannopoulos C, Sitler M, Michlovitz S, et al. Responsiveness of the active wrist joint position sense test after distal radius fracture intervention. *J Hand Ther.* 2016;29(4):474–482. https://doi.org/10.1016/J.JHT.2016.06.009
7. Moseley GL, Herbert RD, Parsons T, et al. Intense pain soon after wrist fracture strongly predicts who will develop complex regional pain syndrome: prospective cohort study. *J Pain.* 2014;15(1):16–23. https://doi.org/10.1016/J.JPAIN.2013.08.009
8. Wilcke MKT, Abbaszadegan H, Adolphson PY. Patient-perceived outcome after displaced distal radius fractures. A comparison between radiological parameters, objective physical variables, and the DASH score. *J Hand Ther.* 2007;20(4):290–299. https://doi.org/10.1197/J.JHT.2007.06.001
9. Mendes-Fernandes T, Puente-González AS, Márquez-Vera MA, et al. Effects of global postural reeducation versus specific therapeutic neck exercises on pain, disability, postural control, and neuromuscular efficiency in women with chronic nonspecific neck pain: study protocol for a randomized, parallel, clinical trial. *Int J Environ Res Public Health.* 2021;18(20):10704. https://doi.org/10.3390/IJERPH182010704
10. Das De S, Vranceanu AM, Ring DC. Contribution of kinesophobia and catastrophic thinking to upper-extremity-specific disability. *J Bone Joint Surg Am.* 2013;95(1):76–81. https://doi.org/10.2106/JBJS.L.00064
11. Luque-Suarez A, Martinez-Calderon J, Falla D. Role of kinesiophobia on pain, disability and quality of life in people suffering from chronic musculoskeletal pain: a systematic review. *Br J Sports Med.* 2019;53(9):554–559. https://doi.org/10.1136/BJSPORTS-2017-098673
12. Vranceanu AM, Barsky A, Ring D. Psychosocial aspects of disabling musculoskeletal pain. *J Bone Joint Surg Am.* 2009;91(8):2014–2018. https://doi.org/10.2106/JBJS.H.01512
13. Naugle KM, Blythe C, Naugle KE, et al. Kinesiophobia Predicts Physical Function and Physical Activity Levels in Chronic Pain-Free Older Adults. *Front Pain Res (Lausanne).* 2022;3:874205. https://doi.org/10.3389/FPAIN.2022.874205
14. Alahmari KA, Reddy RS, Silvian P, et al. Influence of chronic neck pain on cervical joint position error (JPE): comparison between young and elderly subjects. *J Back Musculoskelet Rehabil.* 2017;30(6):1265–1271. https://doi.org/10.3233/BMR-169630
15. Walankar PP, Panhale VP, Vyas KM. Impact of kinesiophobia on physical function and quality of life in functional ankle instability individuals: an observational study. *Bull Fac Phys Ther.* 2021;26(1):1–6. https://doi.org/10.1186/S43161-021-00032-0
16. Breivik EK, Björnsson GA, Skovlund E. A comparison of pain rating scales by sampling from clinical trial data. *Clin J Pain.* 2000;16(1):22–28. https://doi.org/10.1097/00002508-200003000-00005
17. Lundeberg T, Lund I, Dahlin L, et al. Reliability and responsiveness of three different pain assessments. *J Rehabil Med.* 2001;33(6):279–283. https://doi.org/10.1080/165019701753236473
18. Yilmaz Tunca Ö, Uygur F, Uluğ N, et al. Tampa Kinezyofobi Ölçeği'nin Türkçe versiyonu ve test-tekrar test güvenirliği. *Fizyoterapi Rehabilitasyon.* 2011;22(1):44–49 Accessed August 29, 2023 ⟨http://search/yayin/detay/123472⟩.
19. Hulley S., Cummings S., Browner W., Grady D., Newman T. Designing clinical research: an epidemiologic approach. 4 th ed. Designing Clinical Research Fourth Edition. Published online 2013:330.
20. Karagiannopoulos C. Active wrist joint position sense (AWJPS) test offers variable reliability levels and scores among multiple wrist angles and tester-experience levels. *J Hand Ther.* 2023. https://doi.org/10.1016/J.JHT.2022.09.005 Epub ahead of print, S0894-1130(22)00092-8.
21. Arimi SA, Ghamkhar L, Kahlaee AH. The relevance of proprioception to chronic neck pain: a correlational analysis of flexor muscle size and endurance, clinical neck pain characteristics, and proprioception. *Pain Med.* 2018;19(10):2077–2088. https://doi.org/10.1093/PM/PNX331
22. ALMohiza MA, Reddy RS, Asiri F, et al. The mediation effect of pain on the relationship between kinesiophobia and lumbar joint position sense in chronic low back pain individuals: a cross-sectional study. *Int J Environ Res Public Health.* 2023;20(6):5193. https://doi.org/10.3390/IJERPH20065193
23. Alshahrani MS, Reddy RS. Relationship between kinesiophobia and ankle joint position sense and postural control in individuals with chronic ankle instability—A cross-sectional study. *Int J Environ Res Public Health.* 2022;19(5):2792. https://doi.org/10.3390/IJERPH19052792
24. Alshahrani MS, Reddy RS, Tedla JS, et al. Association between kinesiophobia and knee pain intensity, joint position sense, and functional performance in individuals with bilateral knee osteoarthritis. *Healthcare (Basel).* 2022;10(1) https://doi.org/10.3390/HEALTHCARE10010120
25. Li L, Li S. Grip force makes wrist joint position sense worse. *Front Hum Neurosci.* 2023;17:1193937. https://doi.org/10.3389/FNHUM.2023.1193937
26. Nijs J, Polli A, Willaert W, et al. Central sensitisation: another label or useful diagnosis? *Drug Ther Bull.* 2019;57(4):60–63. https://doi.org/10.1136/DTB.2018.000035
27. Dilek B, Yemez B, Kizil R, et al. Anxious personality is a risk factor for developing complex regional pain syndrome type I. *Rheumatol Int.* 2012;32(4):915–920. https://doi.org/10.1007/S00296-010-1714-9
28. Pons T, Shipton EA, Williman J, et al. Potential risk factors for the onset of complex regional pain syndrome type 1: a systematic literature review. *Anesthesiol Res Pract.* 2015;2015:956539. https://doi.org/10.1155/2015/956539
29. Asiri F, Reddy RS, Tedla JS, et al. Kinesiophobia and its correlations with pain, proprioception, and functional performance among individuals with chronic neck pain. *PLoS One.* 2021;16(7) https://doi.org/10.1371/JOURNAL.PONE.0254262 e0254262.
30. Al-Amiry B, Rahim A, Knutsson B, et al. Kinesiophobia and its association with functional outcome and quality of life 6-8 years after total hip arthroplasty. *Acta Orthop Traumatol Turc.* 2022;56(4):252. https://doi.org/10.5152/J.AOTT.2022.21318
31. Aydoğdu O, Sari Z. The association between kinesiophobia and proprioception, postural stability, activity level, knee function, and quality of life following anterior cruciate ligament reconstruction. *J Exerc Ther Rehabil.* 2021;7(3):247–252 Accessed August 29, 2023 ⟨https://dergipark.org.tr/en/pub/jetr/issue/59488/559937⟩.
32. Larsson C, Ekvall Hansson E, Sundquist K, et al. Kinesiophobia and its relation to pain characteristics and cognitive affective variables in older adults with chronic pain. *BMC Geriatr.* 2016;16:128. https://doi.org/10.1186/S12877-016-0302-6

JHT Read for Credit

Quiz: # A70

Record your answers on the Return Answer Form found on the tear-out coupon at the back of this issue. There is only one best answer for each question.

#1. Regarding pain, kinesiophobia, and position sense
  a. younger subjects scored the worst on all three factors
  b. men consistently scored worse on all three factors
  c. woman consistently scored worse than males on all three factors
  d. no significant difference between male and female subjects' scores

#2. Data were collected
  a. daily from 2 weeks post cast removal
  b. at the time of cast removal
  c. at 1 and 6 weeks post immobilization
  d. at 1 month post immobilization

#3. The relationship between pain, position sense, and kinesiophobia was analyzed using
  a. Pearson coefficient
  b. ICC
  c. ANOVA
  d. student-t test

#4. Kinesiophobia was measured using
  a. an electronic goniometer
  b. the Tampa Scale
  c. videography
  d. a VAS

#5. Kinesiophobia adversely affected both pain and position sense
  a. false
  b. true