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Influence of gender difference on knee proprioception in non-specific low back pain among young adults: cross-sectional study

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Abstract

Backgrounds: Non-specific low back pain (NSLBP) is a prevalent condition affecting individuals across all age groups and constitutes a major contributor to the global disease burden. Patients with low back pain (LBP) frequently present with proprioceptive deficits that may extend beyond the lumbar spine. Due to the anatomical and biomechanical connections between the lumbar spine and the knee joint, it is conceivable that LBP may negatively affect knee joint proprioception. Moreover, there is a significant deficiency in the literature concerning gender differences in knee proprioceptive function among young adults with NSLBP.

Purpose: This study aimed to investigate the influence of NSLBP on knee proprioception among young adults and impact of gender differences on knee proprioception in individuals with NSLBP.

Methods: Eighty-Eight participants diagnosed with NSLBP. their age range 18-26 years old with body mass index less than 30 kilogram/meter2 of both genders, allocated into 2 equal groups divided into A (males) and B (females). Both groups were assessed for the Oswestry Disability Index (ODI), deviation from a static absolute target angle, and knee joint proprioception measured using a digital inclinometer. SPSS was used to perform statistical analyses with a significance level of $p< 0.05$.

Results: Results revealed no significant differences in mean knee proprioception between group A (mean = 30.97, SD = 3.62) and group B (mean = 30.28, SD = 5.42), $p > 0.05$. Proprioceptive accuracy and disability index scores showed no significant gender-based differences.

Conclusion: NSLBP young adults did not seem to have significantly lower knee proprioception as compared to a static absolute objective. Moreover, there were no gender differences in proprioceptive performance or impairment levels.

Keywords: Non-specific low back pain, Proprioception, Gender Difference.

Introduction

Low back pain (LBP) is a widespread clinical condition observed across all socioeconomic settings and age groups, ranging from pediatric to geriatric populations. LBP represents the leading cause of disability on a global scale. In most cases, a specific nociceptive source cannot be clearly determined. Only a small proportion of affected individuals exhibit a clearly identifiable pathological etiology. (1). Over 85% of cases are classified as non-specific LBP (NSLBP) because no specific nociceptive origin can be found (1, 2). Although NSLBP doesn't have any specific cause, it is commonly connected to changes in the integration of the central nervous system, motor control, and the processing of sensory input (3, 5). Proprioceptive dysfunction can be a significant factor in these changes. People with LBP repeatedly have impaired proprioception, while proprioception is important for joint stability and motor coordination. The impaired proprioception can be related to the damaged mechanoreceptors in the lumbar structures (6, 7). Proprioceptive deficits in NSLBP may extend beyond the lumbar region, as they can affect the joint position sense (JPS) at the knee, and because of the biomechanical connection of the knee and the lumbar spine these deficits can continue the kinetic chain (8). Knee proprioception, which is mediated by mechanoreceptors, is essential for dynamic movement and postural control (9, 10). Deficiencies in knee proprioception can increase the risk of injury and cause joint instability.

Proprioceptive acuity may be modulated by factors such as age, sex, hormonal changes, and activity level. Research has shown gender-related differences in proprioception and neuromuscular control, with female individuals, particularly postmenopausal, exhibiting diminished proprioceptive sensitivity, potentially due to hormonal influences and neuromuscular imbalances (11, 12). Based on all the previous studies, this study investigates the impact of NSLBP on knee proprioception among young adults and explores if any gender-related differences exist in proprioceptive performance in this population. The findings may enhance understanding of sensorimotor consequences of NSLBP and inform gender-specific preventive strategies.

Materials and Methods

1. Design and Setting

A cross-sectional study was conducted at the Faculty of Physical Therapy, Misr University for Science and Technology, with the aim of examining gender differences in knee proprioception among young adults with non-specific low back pain (NSLBP). Informed consent has been obtained from each participant, and they were informed that no harm would be done. The consent form explaining nature, details and objective of current trial. The investigator conducted an initial demo to explain to participants demographic information and ensure they met research criteria. The study conducted between December 2024 and February 2025 and received ethical approval from the

Institutional Review Board (IRB) of the Faculty of Physical Therapy at Cairo University (Approval No. P.T.REC/012/005429). It was also registered on ClinicalTrials.gov under the identifier NCT06716515.

2. Sample Size Calculation

Sample size of this study was calculated, an alpha value of 0.05, a desired power of 80%, and a high effect size (d= 0.67) as reported by (Ranjbar *et al*, 2023) [8], 88 participants were required for the study (G * Power, version 3.0.10), generated sample size = at minimum 78 subjects, adding 10 (1*5*%) as drop out, so, total sample size = 88).

3. Participants

Forty-four patients from both genders were recruited from Misr University for Science and Technology, Faculty of Physical Therapy. The inclusion criteria: 1) Equal gender representation (44 participants per group), 2) age vary between 18 and 26 years, 3) body mass index (BMI) under 30 kg/m², 4) evaluation of the dominant knee (the leg used for kicking), 5) a pain level between 3 and 8 on the Numerical Pain Rating Scale (NPRS), 6) Oswestry Disability Index (ODI) score below 20. 7) Participants were also required to fully understand and follow the examiner's instructions. The exclusion criteria: 1) any restrictions in active or passive knee joint movement; 2) clinical signs of knee dysfunction, such as abnormal range of motion, muscle weakness, or misalignment; 3) history of knee injuries requiring medical intervention; 4) current knee pain or previous knee surgery; 5) and inability to comprehend or follow instructions.

Following participants' collection then allocation into.

Group A (Males) was assessed for knee proprioception by using digital inclinometer, assessed for functional disability by ODI and assessed for pain by NPRS, Group B (Females) was assessed the same as group A.

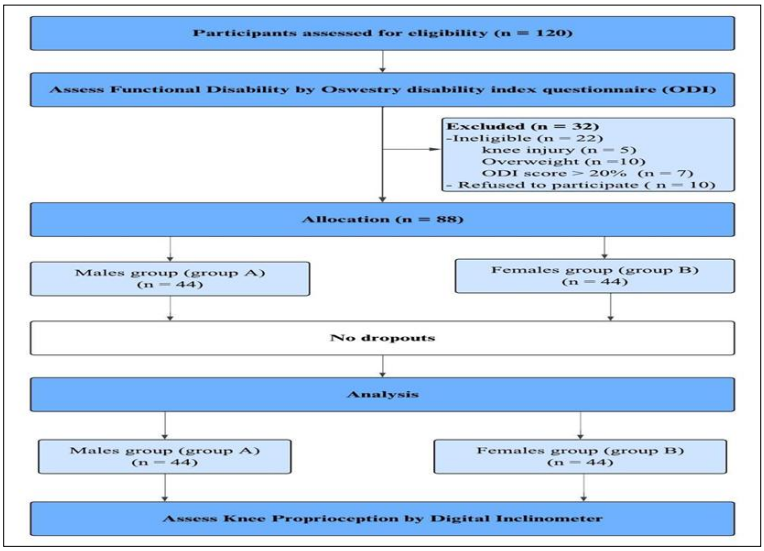

Fig 1: flow chart of study participants

4. Instruments

Instrument for measurement

They include Digital inclinometer (DI), Numerical pain rating scale (NPRS), Oswestry disability index questionnaire (ODI) 1- Digital inclinometer (DI) to assess knee proprioception. It has appeared as a reliable and useful instrument for assessing knee joint position sense (JPS), specifically during open kinetic chain (OKC) tasks (13). Its use appeared to be cost-effective and direct, which makes it appealing in clinical settings with limited resources or equipment (13). A more efficient assessment procedure is also made possible by the DI's portability, single-reference alignment, and one-handed operation (14, 15). Fig (2)

Fig 2: Digital Inclinometer (SPI Tronic, Penn tool co, Maplewood, NJ, Made in USA)

With a simple 10-point scale that ranges from 0 (no pain) to 10 (worst imaginable pain), the Numerical Rating Scale (NRS) is a popular and reliable instrument for evaluating patient-reported pain. The NRS is a modified version of the Visual Analog Scale (VAS) it is more user-friendly especially when applied verbally which makes it more accessible to people with cognitive, language, or cultural difficulties (16). The NRS is also considered a useful and efficient option for clinical and research settings even though the VAS's continuous millimeter-based structure may allow it to detect minute changes in pain more sensitively. In acute or time-sensitive situations the Verbal Numeric Scale (VNS) a verbal version of the NRS, significantly enhances the process by enabling patients to describe their level of pain by words (17).

The ODI questionnaire (Arabic version)

The Oswestry Disability Index (ODI) is considered one of the most used instruments for measuring functional impairment in people with LBP especially non-specific LBP (NSLBP). It is still the gold standard for evaluating physical performance and disability in this population because of its outstanding psychometric qualities which include high internal consistency, test-retest reliability, and face validity (18-20). It is comprised of ten questions total, nine of which target everyday tasks like sitting, standing, walking, sleeping, and personal care, and one of which focuses on the severity of pain (20). Higher numbers indicate greater disability. Disability is expressed as a percentage score. According to Algarni *et al*. (2014) [21], scores are usually interpreted as follows: 0–20% for little disability, 21–40% for moderate disability, 41–60% for severe disability, 61–80% for crippled disability, and 81–100% for bedridden or exaggerated symptoms. Using a rigorous translation/back-translation approach to ensure linguistic and contextual fidelity, the ODI has been validated and translated into many languages, including a culturally appropriate Arabic version based on the approved Tunisian translation (21). Its continued recommendation by expert panels further underscores its clinical and research utility (22).

Procedures

Participants with non-specific low back pain (NSLBP) had their knee joint proprioception and functional impairment evaluated by a standardized evaluation technique. Before that assessment each participant completed a demographic form and provided their informed consent. The Numerical Rating Scale (NRS) was used to determine the intensity of the pain (16, 17). The validated Arabic version of the Oswestry Disability Index (ODI) was used to evaluate functional disability due to LBP. (18, 21).

A digital inclinometer (DI), applied 15 cm distal to the fibular head, was used to assess the knee joint's proprioception. **Fig (3)** Participants started from a 90° knee flexion posture, then they made were instructed to try to reach a 30° target angle, after that they held this position for five seconds before going back to the starting position. Joint position error (JPE), expressed in degrees, was used to measure the repositioning accuracy (13, 14). In order to ensure proprioceptive concentration, the assessments were conducted in an open kinetic chain where the participants were seated and blindfolded to block off visual input (8). The dominant limb, which is the leg that is preferred for kicking, was used for all measures (9). Fig (4)

Fig 3: Measuring Knee Repositioning Error by Digital Inclinometer

Fig 4: Target angle of 30° from the initial position (90° knee flexion)

Statistical Analyses

SPSS version 20 was used to statistically analyze the collected data (SPSS Inc., Chicago, IL). The data was summarized using descriptive statistics, such as mean, standard deviation (SD), minimum, maximum, and percentage. An independent t-test was used to report group differences in the variables that were measured. A criterion of $p < 0.05$ was used to establish statistical significance.

Results

1. Characteristics of the Patients Studied

Table 1: Age, BMI, and numerical pain scale of studied patients (n = 88)

Characteristics	Male group(n=44)		Female group(n=44)		X2	P
	No.	%	No.	%		
Age						

• 18-20	16	36.3	19	43.1	0.78	0.67
• 21-23	19	43.1	15	34		
• 24-26	9	20.6	10	22.9		
Mean±sd	22.0±1.9		21.9±2.1		F=0.04	0.83
BMI						
• Underweight	0	0	3	6.9	3.1	0.2
• Normal	34	77.2	31	70.4		
• overweight	10	22.8	10	22.7		
Mean±sd	23.2±3.0		22.2±3.0		F=2.4	0.11
Numerical pain scale						
Mean±sd	4.5±1.2		4.6±1.4		F=0.08	0.76

General demographic features are shown in Table 1. The mean age of males and females was 22.0±1.9 and 21.9±2.1 years, respectively, with no significant difference between the groups (p=0.83). There was no statistically significant difference between the mean BMIs of males and females (23.2±3.0, 22.2±3.0, respectively, (p=0.11). Males reported a mean score of 4.5±1.2 on the numerical pain scale, whereas females reported 4.6±1.4 (p=0.76). Comparable values for age, BMI, and pain levels are displayed for both groups in Figs 1, 2, and 3.

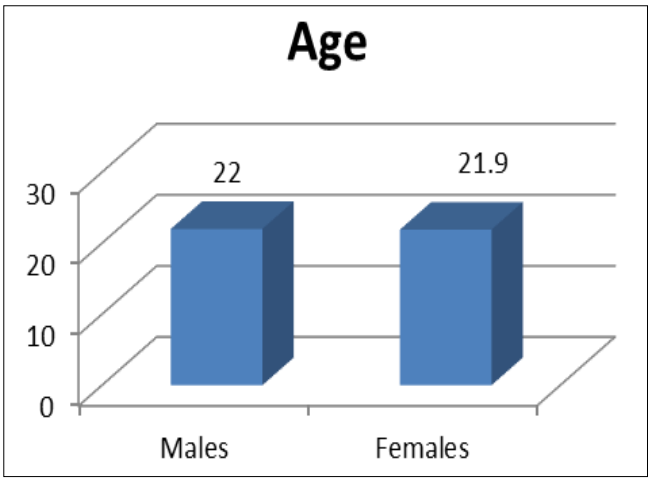

Fig 1: Mean age of the male group and the female group

Fig 1 shows that the mean values of age of males and females are not much different, as they have close values.

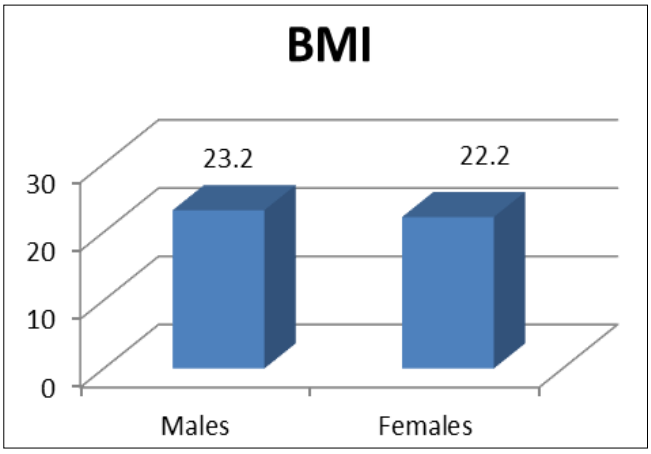

Fig 2: Mean BMI of the male group and the female group

Fig 2 shows that the mean values of BMI of males and females are not much different, as they have close values.

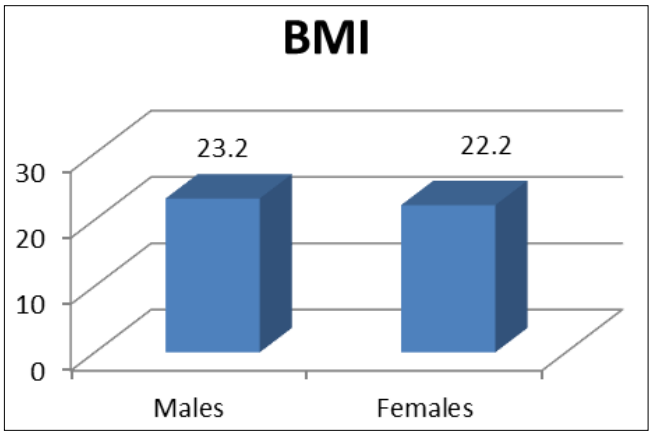

Fig 3: Pain of the male group and the female group

Fig 3 shows that the mean pain values of males and females are not much different, as they have close values.

2. Description of Study Variables

Table (2): Description of knee proprioception and disability index of the studied sample (n=88)

Items	Minimum	Maximum	Mean	SD	Mean (%)
KP	19.33	43.67	30.63	4.60	70.1
Disability index	2	20	11.17	5.18	55.8

With a mean score of 30.63 (70.1% of the maximum value), the study participants' (KP) is shown in Table 2 and indicates moderate proprioceptive function. On the other hand, the DOI shows moderate levels of disability, with a mean value of 11.17 (55.8% of the maximum value), the disability index also shows moderate levels of disability in the sample.

3. Impact of Gender on Study Variables

Table 3: Impact of gender on KP, disability index, and the deviation of KP from the absolute target

Items	Male group(n=44)		Female group(n=44)		F	p
	Mean	SD	Mean	SD		
KP	30.97	3.62	30.28	5.42	.492	0.485
disability index	10.29	4.95	12.1	5.3	2.55	0.11
Deviation of KP from the absolute target	2.97	2.24	4.14	3.45	.492	0.485

In Table 3, the mean KP for males and females is 30.97±3.62 and 30.28±5.42, respectively (p=0.485), indicating no significant gender differences. Additionally, women's disability index was higher (12.1±5.3) than men's (10.29±4.95), but the difference was not statistically significant (p=0.11). Moreover, the KP deviation from the absolute objective was found to be 2.97±2.24 for males and 4.14±3.45 for females, with no significant difference (p=0.485).

4. Impact of Non-Specific Low Back Pain (NSLBP) on Knee Proprioception

For the whole study cohort, the mean KP deviation from the absolute objective was 3.56 (26.1% of the maximum value), indicating a moderate proprioceptive loss by NSLBP. There was no significant difference between the mean KP and the absolute goal (mean difference = 0.62, p=0.2), suggesting that NSLBP had little effect on proprioceptive accuracy.

5. Correlations Between Study Variables

Table (4): Correlation between KP, disability index, age, and BMI(n=88)

Items	KP		Disability index		Age		BMI	
	r	P	r	P	r	P	r	P
KP	1							
disability index	0.08	0.42	1					
Age	0.02	0.78	0.004	0.97	1			
BMI	0.01	0.9	0.11	.27	0.01	0.9	1	

The relationships between age, BMI, disability index, and KP are shown in Table 4. KP did not significantly correlate with any other variables (p > 0.05 for all). This proves that proprioceptive results in the study population were not significantly impacted by age, BMI, or disability.

Discussion

The present study sought to clarify whether knee joint proprioception (KP) is impaired in young adults with non-specific low back pain (NSLBP) and whether gender influences this relationship. Baseline demographic variables, including age and BMI, were statistically comparable between male and female participants, thereby reducing potential confounding influences and strengthening internal validity.

Our findings suggest that KP measured by static absolute target deviation was not significantly different across genders and also not significantly decreased in NSLBP patients. This aligns with previous studies showing no significant differences across genders in knee or shoulder joint position sense (JPS) (10, 23-25). The idea that static proprioceptive testing could not be sensitive enough to detect minute neuromuscular differences that might otherwise manifest in dynamic or functional circumstances is further supported by the lack of notable gender-related differences.

Our investigation found no evidence of increased JPS error in females, despite some literature reporting this phenomenon relating it to hormonal and connective tissue differences (26, 27). This may be partly due to the limitations of static assessment techniques or by the nature of the NSLBP disease itself, which may obscure subtle gender-related proprioceptive differences. Although Karkousha *et al*. (2016) [28] reported more knee proprioception problems in healthy adolescent females (28), the contradictory findings are probably due to variations in sample populations and testing procedures.

Our results support other studies that indicate that although NSLBP has been linked to proprioceptive dysfunction (29), these deficiencies might not always be apparent in all age groups, techniques, or anatomical sites. According to Ranjbar *et al*. (2023) [9], differences in proprioceptive findings can be caused by evaluation methodology more so than by NSLBP alone (8).

Overall, this work adds to the body of evidence indicating that gender may not be a significant driver of KP in young people with NSLBP and advances our understanding of the condition's subtle effects on proprioceptive ability. Future studies that use dynamic protocols and account for hormone effects might provide a more complete picture of how sex, pain, and proprioception interact.

Limitations of the study

Some limitations were detected. First, a static absolute target was used to measure proprioception, which may not be as good at identifying subtle or dynamic proprioceptive deficiencies as more thorough techniques like movement-based functional testing or isokinetic dynamometry (8). Second, female participants' menstrual cycle phases were not tracked, which might have affected Knee proprioception performance because of neuromuscular variability linked to estrogen (30, 31). Lastly, our results may not apply to older people or those with chronic or recurrent types of LBP, even though they are applicable to a young adult group with NSLBP.

Conclusion

Our study suggests that no significant differences between males and females and that knee proprioception, as measured with a static absolute target, does not seem to be significantly impaired in young adults with NSLBP. In order to better comprehend proprioceptive function's significance in injury prevention, rehabilitation techniques, and neuromuscular regulation, further research is necessary to examine the underlying mechanisms driving it.

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