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EFFECT OF AGE, GENDER, BODY MASS INDEX AND PHYSICAL ACTIVITY LEVEL ON KNEE JOINT POSITION SENSE IN NORMAL ADULTS

Physiology

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ABSTRACT

Background: Proprioception deficits are common after ligament injury and degenerative joint diseases of knee. There is a paucity of studies investigating the effect of various factors on knee joint position sense in normal non-athletic individuals. **Purpose of the study:** To investigate the effect of age, gender, Body Mass Index (BMI) and Physical activity level on knee joint position sense in normal adults. **Methodology:** 114 healthy individuals in the age group 30 to 60 years (73 males and 51 females) participated in the study. Subjects with history of pain or injury to lower limbs were excluded. Physical activity index (PAI) was calculated using General Practice Physical Activity Questionnaire (GPPAQ). Digital inclinometer was used to measure the joint position sense (JPS) errors of the knee joint. Subjects were seated on high chair and blindfolded to avoid any visual cues. Inclinometer was placed on the dominant leg and was passively brought to an angle of 45 degrees. Subject was instructed to reproduce the given angle. Error in repositioning of given angle was noted. **Results:** T-test was used to analyse the difference in JPS between males and females while ANOVA was used to analyse the effect of age, BMI and physical activity index. JPS errors were found to be significantly different among the two genders ($t=1.97$, $p=0.05$) and also among age-groups ($F=19.53$; $p=0.0001$). Tukey's pair-wise comparison showed that JPS errors were more in upper age groups. However, JPS level was not significantly different in various categories of BMI and physical activity level. **Conclusion:** Knee joint position sense errors increase with ageing and are more in females as compared to males. This study could not find any effect of Physical activity levels and BMI on knee joint position sense.

KEYWORDS

Proprioception, Knee Joint position sense, Age, Gender, BMI, Physical activity

INTRODUCTION

Proprioception is critical for normal motor control and is therefore a very important component of musculoskeletal rehabilitation. It is the innate ability of human beings to perceive and accurately control limb movements without visual input.[1]

Two most common protocols for proprioception testing are: Threshold to detect passive motion (TTDPM) and Joint position sense (JPS).[2,3] In TTDPM protocols, the participant is most often seated and blindfolded, and the leg is passively moved. The participant indicates, mostly via a hand switch, that he/she has detected this movement.[4] This is a measure of dynamic proprioception or kinaesthesia. JPS tests involve measurement of an error angle. Researcher places the blindfolded participant's leg in a particular angle. The participant is then required to reproduce the same angle. The difference between a target knee angle and the reproduced angle completed by the participant is calculated.[4] This is a measure of static proprioception. Out of these two types of tests, majority of researchers focus on the Joint Position Sense test as they are easy to perform, reproducible and have a good intra-tester and inter-tester reliability.[4,5,6]

Instruments like electronic goniometers, digital inclinometers, video-controlled environments, smartphone-based applications etc. are proved to be highly valid, reliable and sensitive to measure joint position sense for research purpose.[4-6]

Deterioration in certain musculoskeletal and neurological systems has been seen as a result of aging. There is also evidence of proprioceptive decline with an increase in age. Goble et al found that joint position sense is more accurate throughout childhood and adolescence, peaks in young adulthood, then progressively declines after this.[7] Relphet al observed that there are definite changes in knee joint position sense with the increasing age.[8] However, no such data is available that considers a range of adult ages across a healthy population in India. This information is needed by the clinicians for the treatment of proprioceptive decline and prevention of falls in elderly population.

There is limited research that considers the effect of gender on proprioception. Females seem to have less proprioceptive accuracy as compared to males.[8,9] Females demonstrated increased pivoting instability and less proprioceptive acuity in weight bearing pivoting tasks as compared to males.[10] But studies comparing the differences in proprioception among the two genders in non-athletic populations are lacking, especially in India.

Body mass index (BMI) is defined by the World Health Organization as a standard measure of mass of a patient with concurrent consideration of height.[11] Adverse consequences of becoming overweight are well known. It is quite possible that reduction of proprioception may also be one of these consequences. The effect of BMI on knee proprioception has rarely been investigated in the literature. Clinicians should be aware of the effects of BMI on proprioception; hence more evidence is required in this area.

It is well known that regular physical activity has many health benefits. There is enough evidence which suggests that an enhanced proprioceptive ability is among one of those benefits. But majority of research is focused on sports persons participating in rigorous physical training.[12-15] However, effects of various levels of physical activity on proprioception in non-athletic Indian population is lacking in the literature.

AIM OF THE STUDY:

To investigate the effects of age, gender, BMI and physical activity on knee joint position sense in normal adults

METHODOLOGY:

114 healthy adults in the age group 30 to 60 years consented to participate in the study. The study was conducted in the Department of Physiology, Indira Gandhi Institute of Medical Sciences, Patna, India from June 2019 to February 2021. This study has got the approval of the Institute Ethics Committee (Letter no. 836/IEC/IGIMS/2019).

The participants were given a brief explanation of the procedure to ensure that they felt comfortable being blindfolded during the test. Written consent was obtained from those willing to participate. Subjects with history of lower extremity injury or pain were excluded.

Height and weight measurements were taken to calculate the BMI. Participant was questioned regarding their level of physical activity according to General Practice Physical Activity Questionnaire (GPPAQ).[16] It is a validated screening tool, used in primary care to assess the physical activity levels of adults. It provides a simple, 4-level physical activity index (PAI) i.e., Inactive, Moderately Inactive, Moderately Active and Active.[16]

Joint Position test was done using a Digital inclinometer, which is a valid, reliable and sensitive instrument to measure joint position sense

for research purpose.[5,6]The protocol followed in the present study was as suggested by Relph et al and Olsson et al.[8,17]Subject was seated on a high chair, eyes blindfolded to avoid visual cues. Inclinometer was fixed on the patient's dominant leg with the help of straps. The subjects' leg was passively moved till the inclinometer showed a reading of 45 degrees and the position was maintained for 5 seconds. He/she was told to memorise the position and then the knee joint was brought back to the resting position. Next the participant was instructed to try to stop at the same angle. Reading on the inclinometer was noted. Mean of three trials was taken as the reading. Error in reproducing desired joint position in degrees was recorded which can be calculated by the difference in the target angle and the angle reproduced by the subject. Only absolute error scores were noted, which means that the direction of error (target overshooting or undershooting) was not considered.[5,6] The results of JPS test can be mathematically presented by:JPS error = (Given angle-Reproduced angle). JPS error is also called proprioception deficit.

RESULTS:

This study was conducted on 114 healthy adult volunteers in the age group 30 to 60 years, 73 males and 51 females, mean age 47.38 years. The descriptive statistics are given in Table 1.

Table 1: Descriptive statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Age(years)	114	30	60	47.38	8.745
Height (cm)	114	150	190	166.91	11.783
Weight (kg)	114	50	90	70.80	12.052
BMI (m/kg^2)	114	18.5	34.3	25.3	3.1

Table 2: Subject Groups and Statistical tests

Independent Variables	Groups	N	Statistical Test Used
Gender	1. Male 2. Female	73 41	t-test
Age (years)	1. 30-40 2. 41-50 3. 51-60	31 42 41	ANOVA
Body Mass Index (BMI) (m/kg^2)	1. Underweight<18.5 2. Normal 18.5-24.9 3. Overweight25-29.9 4. Obese >30	0 52 59 3	ANOVA
Physical Activity Index (PAI)	1. Inactive 2. Moderately Inactive 3. Moderately Active 4. Active	10 27 50 27	ANOVA

Subjects were categorized into groups based on the independent variable, i.e., gender, age, BMI and PAI, to analyse their effect on the dependent variable, i.e., Joint position sense. (Table 2) Data were analysed using SPSS statistical software, version 26, (IBM, USA). The results are summarized in Table 3.'

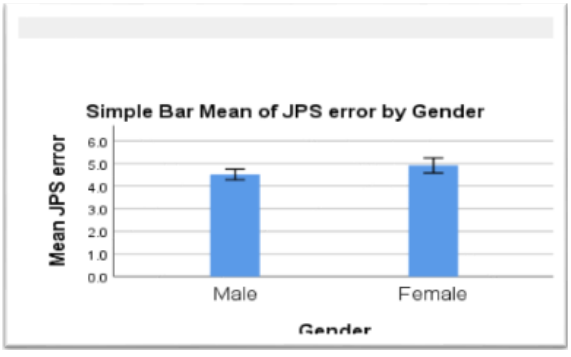
Table 3: Results

Variables	N	JPS error Mean (95%CI)	Test Statistic	P-value
Gender				
Male	73	4.51 (4.27 - 4.75)	t = 1.97	0.0513*
Female	41	4.90 (4.57 – 5.24)		
Age Groups			F = 19.53	0.0001*
31 - 40	31	3.99 (3.67 – 4.31)	1 vs 2 p=0.059*	*
41 - 50	42	4.50 (4.20 – 4.798)	1 vs 3 p=	
51 – 60	41	5.30 (5.05 – 5.54)	0.0001**	
			2 vs 3 p=	
			0.0001**	
BMI				
Normal	52	4.69 (4.39 – 4.98)	F= 0.07	0.9344
Overweight	59	4.62 (4.36 – 4.88)		
Obese	3	4.67 (3.45 – 5.89)		
Physical Activity Index				
Inactive	10	4.53 (3.93 – 5.13)	F = 0.52	0.6672
Moderately inactive	27	4.78 (4.37 -5.19)		
Moderately active	50	4.71 (4.44 – 4.98)		
Active	27	4.46 (4.02 – 4.90)		

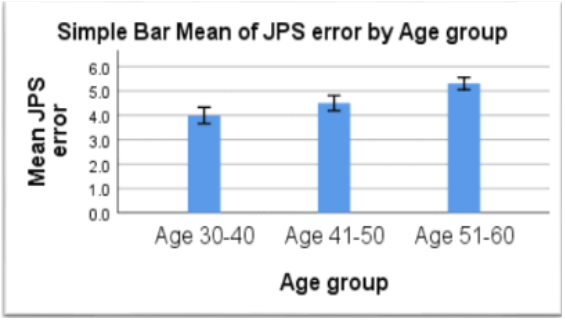
*Significant at 0.05 level **Significant at 0.01 level

Student's t-test was applied to investigate the difference between JPS errors among two groups, i.e., male and female gender. The results showed that JPS errors were significantly different among the two groups, with females having more errors as compared to males (t=1.97, p=0.051). (Table 3, Graph 1)

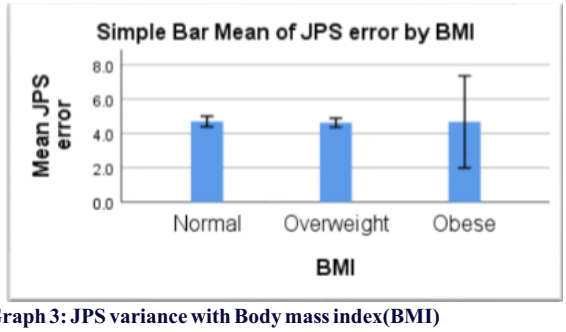
Analysis of variance (ANOVA) test was applied to test the difference of means for more than two categories, i.e., for age groups, BMI and Physical activity index (PAI). JPS was found to be significantly different among three age-groups (F=19.53; p=0.0001). Moreover, Tukey's post-hoc pair-wise comparison showed that JPS errors increased with increase of age, i.e. JPS errors of age group 51-60 years were significantly higher as compared to age-groups 31-40 years (p=0.0001) and age-groups 41-50 years (p=0.0001). (Table 3, Graph 2) However there was no significant difference in the JPS test in various categories of BMI and physical activity index. (Table 3, Graphs 3 and 4)



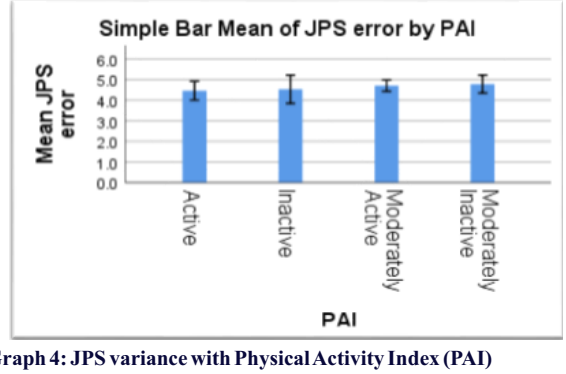
Graph 1: JPS variance with gender



Graph 2: JPS variance with Age



Graph 3: JPS variance with Body mass index(BMI)



Graph 4: JPS variance with Physical Activity Index (PAI)

DISCUSSION:

The results of this study show that there is a decline in the proprioception as the age advances. The effect of aging on knee joint position sense has been studied in previous research. The observations of the present study are similar to those of previous studies, which concluded that joint position sense deteriorates with age. Ribeiro et al found that JPS errors of older people were twice as compared to younger age group.[12]This could be due to the central and peripheral changes as a result of ageing. The peripheral changes due to age are manifested in the form of decrease in the amount of muscle spindle as well as their dynamic response.[18] A reduction in nerve conduction velocity as a result of aging further decreases the sensitivity of the muscle spindle.[19] Also, the central control of proprioception is disturbed, ranging from decrease in number of motor neurons, reduction in grey matter and reduced nerve conduction velocity.[18,19,20]

This study also observed that there was a significant difference between Joint position sense in males as compared to females. This confirms the previous findings which observed that men have better proprioception as compared to women.[9,10]But this observation is contrary to those made by Relph et al who found no significant differences between JPS in the two genders.[8] One possible theory to explain our findings could be that since females have more joint laxity, so the receptors present in joint capsule and ligaments need more stimuli to detect positional changes and movement.[9]Another possible reason can be the difference in hormone levels in the two genders; but since we did not record the hormone levels and menstrual cycle phases, so no conclusion could be drawn. The difference in proprioceptive ability between the two genders could possibly explain the reason of more incidences of ligament injuries in female athletes as compared to males.

The present study showed no significant difference in the proprioception in subjects of different categories of BMI i.e., Normal, Overweight and Obese. This is in contrast to findings by Paschalis et al who observed that overweight subjects had higher JPS errors.[22] Since the relationship in their study was only moderate (r=0.204), so no cause and effect evidence could be concluded. Other studies were done on specific populations like athletes, pre-pubertal boys etc.[23,24] Hence there is limited evidence that BMI affects proprioception. So BMI alone should not be the only criteria to modify proprioception exercises.

The results of this study demonstrated no significant difference in knee joint position sense between the subjects of four different Physical Activity Levels (Inactive, Moderately Inactive, Moderately Active and Active). This is in contrast with the observations of previous studies which indicated that subjects participating in regular exercises showed improved proprioception.[8,9,12-15] Those studies were done on subjects who participated in proprioception based sports like Tai-chi and activities like dancing, swimming, running etc. But the present study used GPPAQ, which categorizes an individual's physical activity index on the basis of daily physical activities. Hence it can be inferred that proprioception improves as a result of training, whereas simple daily activities may not have much effect on this function.

CONCLUSION:

Knee joint position sense declines with advancing age, and females have more repositioning errors as compared to males. There is no effect of BMI and physical activity level on knee joint position sense. There is need of future studies which could investigate the effect of age, gender, BMI and Physical activity level using tests involving more functional positions.

Conflict of interest: None

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