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Association of Age, Gender and Body Mass Index with Proprioception in Knee Joint in Healthy Individuals

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Abstract

Background: *The word proprioception is derived from Latin word "proprius" means it is one's own and "reception" means it receives. In Musculoskeletal rehabilitation, proprioception plays significant role in maintaining normal motor control. The proprioception is an important non-invasive clinical procedure which helps in diagnosing pre-existing and treating knee conditions. Proprioception assessment is foremost because loss in proprioception will lead to altered weight bearing at joints and alteration of normal body movement causing fall or injury. Purpose of this study is to find out the association of knee joint proprioception with age, gender and BMI in healthy individuals.* ***Methods:*** *Total 132 participants are included in the study. Their height and weight was measured to calculate their BMI. After that, proprioception was assessed with the help of goniometer mounted on the stand. Knee joint proprioception was measured for Test angles 30°, 45° and 60° toward extension. At all angles test was performed three times in sequence.* ***Result:*** *The collected data were analyzed in SPSS software version 21.0. At 30° correlations between both side of knee joint proprioception with Age, Gender and BMI was non-significant except left side of proprioception with gender. However, at 45° correlations between both side of knee joint proprioception with Age, Gender and BMI was found significant. Additionally, similar of most result was found at 60° except left side of knee joint proprioception was found not significant with BMI.* ***Conclusion:*** *Knee joint proprioception decreases with ageing and are more in females than males. This study finds weak to moderate correlation with BMI.*

Keywords: *Proprioception, Knee joint, Age, Gender, BMI, healthy individuals.*

1. Introduction

The word proprioception is derived from Latin word "proprius" means it is one's own and "reception" means it receives.[1] The history of investigating an ability of people to perceive, accurately control the movement without any visual input have become thirst area.[2]In Musculoskeletal rehabilitation, proprioception plays significant role in maintaining normal motor control. Although, having this importance, the widespread accepted definition is not available.[3]The first definition of proprioception was published by Sherrington who stated that it is as "a deep field of receptors in which stimuli are traceable to actions of the organism".[1]According to clinicians, global proprioception as "a specialized type of the sense of touch" [4] and "the sense of position and movements of the limb"[5] and it is seems to be "...used to reference the afferent information arising from proprioceptors"[6] Globe DJ et al. defined perception for proprioception as "The ability of an individuals to determine body segment positions and movements in space, and is based on sensory signals provided to the brain from muscles, joint and skin receptors".[1,7]

Accuracy in assessing proprioception can help us establish if there is a loss of proprioception and if so, what precautions and treatments should be taken. It will assist us in understanding the situation. Range of numerative value and the degree of change that we observe can take preventative measures to avoid injury.

There is an inadequate of research on the connection between body mass index and proprioception, and very few studies have been done on young, healthy individuals. The majority of studies have been done in the populations of adolescents, older people, and athletes.

Therefore, purpose of this study is to find out the association of knee joint proprioception with age, gender and body mass index in healthy individuals.

Thus, the aim of the study **was to assess the proprioception (joint position sense) of knee joint in healthy individuals with respect to age, gender and body mass index.**

Procedure:

The above study was forwarded and approved by institutional ethical committee. After that, it was registered with the Clinical Trial Registry- India. After obtaining the ethical approval healthy individuals were approached and explained the study. All those who were willing to participate in study were requested to fill out informed Consent Form (Annexure I). A Participant information sheet (Annexure II) was given to each participant and they were explained regarding the assessment involved in the study. All the participants were screened as per the assessment sheet (annexure III). Participants who were falling under the exclusion criteria were excluded from the study. All those participants who fulfil inclusion criteria were explained detail about the entire study procedure in their language and they were recruited in the study.

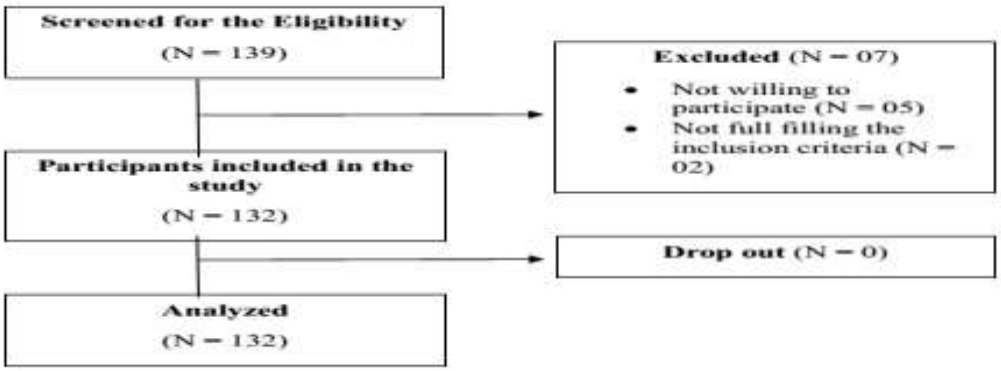
Their height and weight were measured to calculate their BMI. After that, proprioception was assessed with the help of goniometer mounted on the stand.

The Test Procedure is as follows:

Step 1 - Measurement of Height and Weight

The participants were asked to remove his/her foot ware. The participant's weight was recorded in kilograms and the height was recorded in centimetres using digital weighing scale and stadiometer respectively.

Step 2 - Measurement of Joint Position Sense was measured using goniometer subject seated in chair sitting position



participants were recruited in the present study with a mean age of 26.58 years. The descriptive characteristics of all variables are as follows:

Table - 1. The above table shows the Mean and Standard Deviation of the knee joint proprioception for age, gender and BMI.

Characteristics	Mean	Standard Deviation	Range
Age	26.58	6.82	18 - 40
BMI	24.01	4.73	15 - 37
Left-30^{O}	32.8	4.62	22 - 50.33
Left-45^{O}	48.2	4	36.67 - 56
Left-60^{O}	63.29	4.16	53.67 - 78.33
Right-30^{O}	34.1	4.91	20.67 - 48.67
Right-45^{O}	47.87	3.89	38.33 - 60.67
Right-60^{O}	62.17	3.65	53.67 - 72.33
Gender	Male: 40 Female: 92		

Correlation between 30º Left Reported Angle with age, gender and BMI

Left 30o			
Correlation	**Pearson's R**	**P Value**	**Conclusion**
Left side knee joint angle with Age	0.11	0.21	No Significant Correlation
Left side knee joint angle with BMI	0.14	0.102	No Significant Correlation

Left 30º			
Correlation	**Point Biserial**	**P Value**	**Conclusion**
Left side knee joint angle with Gender	0.174	0.046	Significant Correlation

Correlation between 45º Right Reported with age, gender and BMI

Right 45º			
Correlation	**Pearson's R**	**P Value**	**Conclusion**
Right side knee joint angle with Age	0.099	0.025	Significant Correlation
Right side knee joint angle with BMI	0.195	0.024	Significant Correlation

Right 45º			
Correlation	**Point**	**P Value**	**Conclusion**
Right side knee joint angle with	0.092	0.292	No Significant

Correlation between 60º Left Reported Angle with age, gender and BMI

Left 60º			
Correlation	**Pearson's R**	**P Value**	**Conclusion**
Left side knee joint angle with Age	0.124	0.015	Significant Correlation
Left side knee joint angle with BMI	-0.07	0.424	No Significant Correlation

Left 60º			
Correlation	**Point Biserial**	**P Value**	**Conclusion**
Left side knee joint angle with Gender	0.117	0.01	Significant Correlation

Correlation between 60º Right Reported Angle with age, gender and BMI

Right 60º			
Correlation	**Pearson's R**	**P Value**	**Conclusion**
Right side knee joint angle with Age	0.214	0.013	Significant Correlation

Right side knee joint angle with BMI	0.137	0.011	Significant Correlation

Right 60º			
CORRELATION	**POINT BISERIAL**	**P VALUE**	**CONCLUSION**
Right side knee joint angle with Gender	0.133	0.012	Significant Correlation

This study aimed to observe the association of knee joint proprioception at three different angles which gives an idea on variance.

The knee is a complex variety of hinge joint, responsible for movement and stability of lower limb and activity like sitting, standing, walking, running etc. To complete this activity joint position sense is essential which is provided by mechanoreceptors which located in and around the knee joint. Any injury at or around the knee joint will affect the action of mechanoreceptors leading to alteration in joint positon sense.

In this study out of 139 participants, 132 participants included and 7 were excluded due to not fulfilling the inclusion criteria and denied for consent.

Knee Joint Proprioception and Age

In this study correlation of left and right knee proprioception at 30° with age, was not significant, whereas at the angle of 45° and 60°, it was found significant.

The finding of this study is supported by previous studies which are as follows.

Ribeiro et al., Male participants of different ages were compared, with the average age of the younger group having 20.6 years, and the older group having 72.2 years. They found that the older group had double the error scores in joint position measurements than the younger group. [29]

Pai et al., **Petrella et al.**, **Kaplan et al.**, and **Hurley et al.** also report an increase in knee joint position sense in older adults despite the use of unpredictable joint position sense assessment methodologies. [16, 30-32]

The observed age-related deterioration in joint position sense may be elucidated by age-related changes in both central and peripheral components. Several studies had shown anatomical and physiological changes in muscle spindle with age. At peripheral level, total amount of muscle spindles reduces with age and thus the dynamic response. In case of muscle denervation, the intrafusal fibers reduce; however, thickness of muscle spindle increases. An increase in the amount of collagen and fibrous tissue arranged in the inner capsule may also be the cause of the alterations in muscle spindle architecture. [18-21,29,34,35] The studies have shown thickness of extrafusal fibers also increases with age. Secondly, nerve conduction velocity decreases which results reduction in spindle sensitivity.[21,36] This has impact on recruitment of mechanoreceptors of a joint which declines with the age. [19,37,38]

As people age, the dendrite system in the motor cortex declines, which results in fewer motor neurones in the central nervous system. This alters the fundamental aspect of proprioception, or the integration of sensory input.[21,29,33] The remaining motor neurons are bigger and have a slower conduction rate.[39] Additionally, there is incontrovertible proof of a decline in grey matter, which results in a less efficient central nerve system.[19,40] for a list of all possible age-related changes to proprioception.

The same findings were also supported by one of the studies done by **M. V. Hurley et al.** stating that proprioception acuity relies on accurate sensory input, central integration and the afferent muscle spindle sensitivity plays an important role which decreases with age and leads to loss in proprioception. With this Quadriceps function is also affected. It showed that acuity of joint sense and postural stability reduced with age.[32]

In this study, participants had no underlying conditions therefore the reduction in proprioception with age can be recognized to degenerative changes,[41] ligament laxity,[42] muscle weakness and capsular stiffness.[15,43]

Another study by of **Saxton et al.** also stated that as age increases subjects tend to overshoot the criterion angle more often.[41]

However, **Pickard et al.** who also found no significant differences between young and older population groups in terms of proprioception. They stated that older group participated in regular physical activity which may have countered a proprioceptive decline. Thus, this evidence has indicated that physical activities do not attenuate the of proprioception with age.[44]

Knee Joint Proprioception and Gender

In this study correlation of left knee proprioception at 30°, 45° and 60° with gender was found significant, whereas at the right knee proprioception at 30° and 45° it was found not significant but 60° it was found significant.

The study of this result was supported by **Rania N. Karkousha**, she stated that proprioception accuracy in female is reduced while comparing with male. This is because the soft tissues have oestrogen receptors, which are responsive to female sex hormones. Increased estradiol concentrations decrease collagen synthesis and fibroblast proliferation as oestrogens has measurable direct effects on soft tissue strength, muscle function, collagen metabolism, and behaviour. This mechanism could have indirect effect on the neuromuscular system, which controls the proprioception awareness.[25]

Second, females' tendons and ligaments have different structural, morphological, and biomechanical characteristics from those seen in males. The anatomical configuration of anterior cruciate ligament and cartilage varies in both the gender.[25]

Henry JC et al. studied the proprioception difference on athletic population between males and females and showed that females had decreased stiffness and decreased dynamic stabilisation showing reduced proprioception than males. It should be emphasised that this may result in increased imbalance and falls, and women have a higher risk of injuries than males. This is another possible explanation for the probable difference in proprioception in the general population.[45]

Knee Joint Proprioception and BMI

In this study correlation of left knee proprioception with BMI at 30° and 60° was found not significant, whereas same side at 45° it was found significant. For right knee proprioception at 30° it was found not significant but at 45° and 60° it was found significant.

The finding of this study was supported by previous done by **Paschalis et al.** The influence of BMI on knee joint position sense in three knee flexion target angles was investigated. Overweight (BMI>29kg/m^2) participants exhibited considerably worse joint position awareness abilities, according to the findings. This could be attributable to muscular atrophy in overweight persons, as well as a decreased number of active muscle spindles and thus worse proprioceptive ability. As a result, when treating overweight individuals, clinical practitioners may need to account for some deficiencies in knee joint position perception. Relationships, however, do not provide proof of cause and effect; it is possible that the higher BMI was not the reason of the drop in knee Joint position sense scores. Again, clinical practitioners should not adjust their treatment solely based on BMI.[27]

Another reason behind fetching this result could be the length of the lever during knee extension. Taller participants are likely to have longer lower limbs, which would increase torque produced (as torque = force x perpendicular distance from the axis of rotation) during knee extension compared to a shorter lower limb. The muscular sense will be more when lever is moving away from axis toward the mid-range target. This may improve the "muscular sense" of the longer lever, specifically the mid-range goal angle employed in knee joint position perception.

4. Conclusion

The present study concludes that there was no statistically significant correlation at 30° both knee joint proprioception with age, gender and BMI; except left side at 30° knee proprioception with gender. There was significant correlation between both sides of knee proprioception at 45° with age, gender and BMI; except right of knee joint proprioception at 45° with gender. At 60° there was significant correlation of both side knee proprioception with age, gender and BMI; except left 60° knee proprioception with BMI.

Limitation:

The lower limb dominance was not included
The age group was limited
Unequal gender distribution
Hormonal level in female participants was not included
Muscles Strength was not included as one of the outcome measures.

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