

Morphometry of Normal Medial Knee Joint Space in Adults by Digital Radiography and Its Relationship with Some Biosocial Factors

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ABSTRACT: *Background:* Proper function of knee joint depends on the anatomical and physiological properties of knee joint components such as bony configuration of surrounding musculature, ligaments, joint capsule, synovial fluid and articular cartilage. Structural deviations of these structures specially thinning of the articular cartilage, can contribute to pathological condition. *Methods:* This cross-sectional type of descriptive study was conducted over a period of 1 year from July 2023 to June 2024 in the Department of Anatomy, Rajshahi Medical College Hospital, Rajshahi on 190 adult individuals who were attending in the outpatient department of Radiology and Imaging, Rajshahi Medical College Hospital, Rajshahi. Data was analyzed by SPSS software, version-26.0. *Results:* The mean right medial JSW was 4.30 ± 0.09 mm and left medial JSW was 4.23 ± 0.08 mm. There was a statistically significant relationship of right medial knee joint space width with gender ($p < 0.05$), residential status ($p < 0.001$), occupational status ($p < 0.01$) and BMI ($p < 0.01$). There was also a statistically significant relationship between left medial knee joint space width with age ($p < 0.01$), residential status ($p < 0.001$) and BMI ($p < 0.05$). *Conclusion:* Plain radiology is the primary method for assessing joint space width. The radiographic measurement of knee joint space might provide an ideal method for monitoring the changes of joint space width that would be helpful for proper planning of treatment procedure.

Keywords: Medial Knee Joint Space, Digital Radiography and Biosocial Factors.

Article at a glance:

Study Purpose: The purpose of the study was to observe the morphometric features of normal medial knee joint space in adults by Digital Radiography and its relationship with some biosocial factors of the study population.

Key findings: The mean right medial JSW was 4.30 ± 0.09 mm, while the mean left medial JSW was 4.23 ± 0.08 mm.

Newer findings: The right medial knee joint space breadth was statistically significantly correlated with gender ($p < 0.05$), residential status ($p < 0.001$), occupational status ($p < 0.01$) and BMI ($p < 0.01$). Additionally, there was a statistically significant correlation between left medial knee joint space width with age ($p < 0.01$), residential status ($p < 0.001$) and BMI ($p < 0.05$).

Abbreviations: BMI: Body Mass Index, JSW: Joint Space Width and MRI: Magnetic Resonance Imaging.

INTRODUCTION

The knee joint is the crucial joint in the body. The tibiofemoral articulations are separated by articular cartilages and menisci with little contributions from cruciate ligaments.¹ It plays an essential role in movement and carries the body weight in horizontal (running and walking) and vertical (jumping) directions. Ingenious arrangement

of ligaments, menisci and tendons of knee joint provide static stability for the body. The main movement of the knee is flexion and extension; secondary movement is internal and external rotations of the tibia in relation to the femur. The exposure of the knee to external forces makes it very vulnerable in many occupations and sports. A knowledge of the kinematics of the knee is important

for understanding the pathogenesis and treatment of disease particularly when treatment involves surgical reconstruction. The distance between the distal femur and the proximal tibia is known as joint space width (JSW) and it is an indirect way of measuring cartilage thickness. Joint space width is seen in a frontal radiograph as a radiolucent area between the tibia and femoral condyles ranging from 3 to 8 mm. Male have wider joint space width and the female has less wide more often. Knee joint space narrowing can be seen in patients with rheumatic diseases and affected by disease-modifying therapy.²

Osteoarthritis is the most common joint disorder that contributes to the narrowing of the knee joint space. The majority of individuals over the age of 65 years in developed nations have radiographic evidence of osteoarthritis. It may be idiopathic or secondary to previous inflammation or trauma and one of its earliest signs may be the narrowing of the medial compartments of the joint.³ As a result of wear and tear over time, there is a gradual reduction in joint space width with increasing age. Despite of technological advances, the availability of magnetic resonance imaging (MRI) and ultrasonogram (USG) modalities, plain radiography is still the primary method for measurement of radiographic joint space width and assessment structural damage of knee joint.⁴ This is the standard and reproducible tool for the assessment of progressive knee cartilage degenerative conditions with fairly good precision.⁵ Once the diagnosis of arthritis is made, it is also necessary to assess the changes of joint space width while the patients are followed up or undergone medication. The joint's medial compartments narrowing may be one of the initial symptoms of osteoarthritis.⁶ It was observed that osteoarthritis patients normally have joint space width shortening at a rate of 0.1 to 0.2 mm each year. Osteoarthritic features visible on radiographs include joint space narrowing, osteophytosis, subchondral osteosclerosis and subchondral cysts in the knee joint. Radiographic technique is proved to be highly useful not only for the evaluation of the knee cartilage but also for the evaluation of the early knee cartilage degeneration abnormalities.⁷ Standard X-rays using the non-fluoroscopic fixed-flexion technique can be used as reproducible as fluoroscopic techniques with the added advantages of lower costs and considerably less radiation hazard.⁸ Before diagnosis of abnormal findings, it is essential to know the normal range of joint space width as it varies with age, sex and race.

There was no published article regarding the joint space width on Bangladeshi population, hence the aim of the study was to establish the normal reference value of joint space width for diagnosis and follow up of knee cartilage diseases.

METHODS

The study was conducted in the Department of Anatomy, Rajshahi Medical College, Rajshahi after obtaining the clearance from the Ethical Review Board (IRB) on 30o fixed-flexion erect knee radiographs of 190 adult individuals. Before data collection, written consent was obtained from each study subject. A semi-structured data collection form was used to document the data on the age, sex, residence, educational and occupational status of the respondents. Stature and body weight were measured using standard methods. Patients who came in the OPD for the X-ray of other parts of the body without knee joint complaints. Stature of the patients was measured by using a measuring tape with barefoot and body weight was measured by weight measuring machine. The body mass index (BMI) was calculated based on these measures (kg/m²). An anteroposterior weight bearing X-ray was performed with the X-ray beam set on the joint center. Study participants undergone a single knee X-ray of the non-dominant knee acquired in the fixed-flexion position. The patient stood in front of the cassette with the posterior thigh in contact with the cassette. Irradiation was applied in the horizontal direction. Measurements were taken by erect bilateral knees in an anteroposterior (AP) view. The joint space width of both medial and lateral compartments of each knee were measured using in-built electronic calipers. All the X-ray films were made by same machine and reading was taken by a single observer. The data were analyzed via Statistical Package for the Social Sciences (SPSS, version 24.0, Chicago, IL) software. Qualitative variables were described by frequency and percentage, while quantitative variables were described by the mean and standard deviation. Difference of means between the two groups were tested by unpaired 't' test and three groups by ANOVA test. The statistical significance was evaluated as an appropriate probability level $p < 0.05$ for all tests.

RESULTS

Out of 190 individuals, it was found that 77 (40.50%) were ≤ 30 years age group, 73 (38.40%) were

31-40 years and 40 (21.10%) were > 40 years. Gender distribution showed that 98 (51.60%) of the respondents were male and remaining 92 (48.40%) were female. Residential status revealed that 154 (81.10%) were from urban area, 26 (13.70%) from semi-urban and remaining 10 (5.30%) from rural area. BMI was normal in 76 (40.00%) respondents, overweight in 95 (50.00%) and obese in 19 (10.00%) (Table 1).

Table 1: Distribution of the respondents by their biosocial factors (n=190).

Age in years	Frequency	Percentage
≤ 30 years	77	40.50%
31-40 years	73	38.40%
> 40 years	40	21.10%
Gender		
Male	98	51.60%
Female	92	48.40%
Residence		
Rural	10	5.30%
Urban	154	81.10%
Semi-urban	26	13.70%
BMI		
18.5 to 24.9 (Normal)	76	40.00%
25.0 to 29.9 (Overweight)	95	50.00%
30.0 to 39.9 (Obese)	19	10.00%

Table 2 showed the measurement of right and left medial JSW of the respondents. It revealed that mean right medial JSW was 4.30 ± 0.09 mm and left medial JSW was 4.23 ± 0.08 mm.

Table 2: Measurement of medial joint space width (JSW) of the respondents (n=190).

Variables	Mean±SD	Minimum	Maximum
Right medial knee JSW (mm)	4.30 ± 0.09	4.12	4.80
Left medial knee JSW (mm)	4.23 ± 0.08	4.00	4.60

There was statistically significant relationship of right medial knee joint space width with gender ($p < 0.05$), residential status ($p < 0.001$), occupational status ($p < 0.01$) and BMI ($p < 0.01$). But there was not relationship of right medial knee joint space width with age ($p > 0.05$) (Table 3).

Table 3: Relationship of right medial knee joint space width (JSW) with biosocial factors (n = 190).

Variables	Right medial knee joint space width (mm) (mean±SD)	p-value
Age		
≤ 30 years	4.32±0.08	> 0.05*
31-40 years	4.30±0.11	
> 40 years	4.28±0.12	
Gender		
Male	4.32 ± 0.11	< 0.05 [#]
Female	4.28 ± 0.08	
Residential status		
Rural	4.44 ± 0.20	< 0.001*
Urban	4.30 ± 0.09	
Semi-urban	4.27 ± 0.07	
Occupational status		
Housewife	4.26 ± 0.05	< 0.01*

Farmer + Day labour + Others	4.33 ± 0.10	
Govt. + NGO worker	4.31 ± 0.11	
BMI		
Normal	4.32±0.11	
Overweight	4.30±0.09	< 0.01*
Obese	4.24±0.05	

*Data were analyzed by ANOVA-test and was expressed as mean ± SD.

#Data were analyzed by Unpaired t-test and were expressed as mean ± SD.

There was a statistically significant relationship of left medial knee joint space width with age ($p < 0.01$), residential status ($p < 0.001$) and BMI ($p < 0.05$). But there was not relationship of left medial knee joint space width with gender ($p > 0.05$) and occupational status ($p < 0.05$) (Table 4).

Table 4: Relationship of left medial knee joint space width (JSW) with biosocial factors (n = 190).

Variables	Left medial knee joint space width (mm) (mean±SD)	p-value
Age		
≤ 30 years	4.25±0.07	
31-40 years	4.23±0.08	< 0.01*
> 40 years	4.20±0.09	
Gender		
Male	4.24 ± 0.09	
Female	4.22 ± 0.08	> 0.05#
Residential status		
Rural	4.34 ± 0.15	
Urban	4.23 ± 0.08	< 0.001*
Semi-urban	4.21 ± 0.05	
Occupational status		
Housewife	4.21 ± 0.05	
Farmer + Day labour + Others	4.24 ± 0.10	> 0.05*
Govt. + NGO worker	4.23 ± 0.07	
BMI		
Normal	4.25±0.09	
Overweight	4.23±0.08	< 0.05*
Obese	4.19±0.06	

* Data were analyzed by ANOVA-test and was expressed as mean ± SD.

Data were analyzed by Unpaired t-test and were expressed as mean ± SD.

DISCUSSION

In the current study, out of 190 individuals, 77 (40.50%) were in ≤ 30 years age group, 73 (38.40%) were 31-40 years and 40 (21.10%) were in > 40 years. Anas *et al.*¹ reported that 36 (22.50%) of the respondents were within the age group of 15-24 years, 26 (16.25%) were 25-34 years, 36 (22.50%) were 35-44 years, 36 (22.50%) were 45-54 years and 26 (16.25%) were ≥ 55 years. These findings were not similar with this study. In this study, 98 (51.60%) were male and remaining 92 (48.40%) were female. Similar findings

were reported in the study done by Jansen *et al.*⁹ Female was found more than male in a study by Beattie *et al.*¹⁰ where 73 respondents were female and 46 were male. Female predominant findings were also found in the studies by Zamin *et al.* and Kayastha *et al.*^{5, 11} BMI of the respondents showed that BMI was normal in 76 (40.00%), overweight in 95 (50.00%) and obese in 19 (10.00%) respondents showed in this study. Anas *et al.*¹ found that BMI was 16.84 ± 0.95 kg/m² in underweight, 21.05 ± 1.59 kg/m² in normal and 25.23 ± 0.17 kg/m² in overweight respondents.

Mean right medial knee joint space width of the respondents was 4.30 ± 0.09 mm found in this study. Nearly similar findings were noticed in the studies by Anas *et al.*¹ Higher values were found with the study done by Dacre *et al.*¹² Lower values were found with the study by Tokuhara *et al.*¹³ In this study, the mean right medial knee joint space width was 4.32 ± 0.08 mm among the ≤ 30 years age group of the respondents, 4.30 ± 0.11 mm among the 31-40 years and 4.28 ± 0.12 mm > 40 years; it was statistically not significant ($p > 0.05$). Similar findings were found with the study done by Beattie *et al.*¹⁰ in which MJSW was not significantly decreased with increasing decade ($p > 0.05$). Similar findings were also observed with the studies by Dacre *et al.*; Gensburger *et al.*; Jain *et al.*; Anas *et al.* and Sargon *et al.*^{1, 12, 14, 15, 16} Dissimilar results were found in a study done by Jansen *et al.* in which mean medial joint space width was 2.7 ± 1.6 mm. Different findings were also seen in the studies by Kayastha *et al.* and Zamin *et al.*^{5, 9, 11}

In the present study, the mean right medial knee joint space width was 4.32 ± 0.11 mm in male and 4.28 ± 0.08 mm in female; it was significantly significant ($p < 0.05$). Similar findings were also showed in the study done by Anas *et al.* in which right medial knee joint space was 4.98 ± 0.44 mm in male and 4.84 ± 0.48 mm in female.¹ Nearly similar findings were also revealed in the studies done by Beattie *et al.*; Lanyon *et al.*; Jones *et al.*; Faber *et al.*; Cicuttini *et al.*; Ding *et al.* and Duren *et al.*^{10, 17, 18, 19, 20, 21, 22} Findings were not similar with the study done by Zamin *et al.* where the mean right medial knee joint space was 0.26 ± 0.05 mm in male and 0.25 ± 0.07 mm in female.¹¹ Dissimilar findings were also viewed with the study done by Kayastha *et al.*⁵ The mean right medial knee joint space width was 4.32 ± 0.11 mm in normal, 4.30 ± 0.09 mm in overweight and 4.24 ± 0.05 mm in obese respondents revealed by this study. So, the mean right medial knee joint space width was decreased with increasing BMI and it was statistically significant ($p < 0.01$). Similar findings were noticed with the study by Anas *et al.*¹ where the right medial knee joint space was 4.78 ± 0.78 mm in normal, 4.70 ± 0.42 mm in underweight and 4.36 ± 0.32 mm in overweight respondents. Overweight subject showed much lower knee JWS compared to normal and underweight subjects with the studies by Dacre *et al.*; Sargon *et al.* and Lanyon *et al.* which were consistent with this study.^{12, 16, 17} In this study, the mean left medial knee joint space width of the respondents was 4.23 ± 0.08 mm. Nearly similar

findings were observed with the study done by Anas *et al.* in which mean left medial knee JSW was 4.74 ± 0.76 mm.¹ Similar findings were also reported in a study done by Zamin *et al.*¹¹ The mean left medial knee joint space width was higher found in the studies done by Gensburger *et al.* and Jain *et al.*^{14, 15} There remains variation in radiographic joint space that is unexplained by body size measures. The variation may be attributable to a number of factors including physical activity and metabolic or hormonal variation during cartilage growth and development, environment, geographical distribution. Differences at the levels of physical activity could potentially explain some variation in cartilage thickness in weight bearing joint. In the study, the mean left medial knee joint space width was 4.25 ± 0.07 mm among the ≤ 30 years age group, 4.23 ± 0.08 mm among the 31-40 years and 4.20 ± 0.09 mm > 40 years; it was statistically highly significant ($p < 0.01$). Similar findings were reported in the study done by Kayastha *et al.* where there was a strong positive correlation of left knee joint space width with age.⁵ Similar findings were also observed in the study done by Anas *et al.*¹ Dissimilar results were found in a study done by Zamin *et al.*¹¹ In the current study, the mean left medial knee joint space width was 4.24 ± 0.09 mm in male and 4.22 ± 0.08 mm in female; it was significantly not significant ($p > 0.05$). Similar findings were showed in the study done by Anas *et al.*, where the left medial knee joint space was 4.97 ± 0.48 mm in male and 4.86 ± 0.47 mm in female.¹ Findings were not similar with the study by Zamin *et al.*¹¹ where the mean left medial space width was 0.23 ± 0.01 mm in male and 0.19 ± 0.08 mm in female. Dissimilar reports were also found by Duren *et al.* and Kayastha *et al.*^{22, 5} The sex disparity in joint space width may simply arise from the inability of thin cartilage to withstand wear and tear as easily as thick cartilage. In the present study, the mean left medial knee joint space width was 4.25 ± 0.09 mm in normal, 4.23 ± 0.08 mm in overweight and 4.19 ± 0.06 mm in obese respondents; it was statistically significant ($p < 0.05$). Similar findings were observed in a study done by Anas *et al.* where left medial knee joint space was 4.78 ± 0.79 mm in normal, 4.51 ± 0.44 mm in underweight and 4.34 ± 0.34 mm in overweight respondents.¹

CONCLUSION

The study concluded that with advancing age, knee joint space width was steadily decreased and the knee joint space width was more in male than

female. Also, overweight respondents have smaller knee joint space width than normal and underweight people. As people get older, they should give more attention to control the body weight and to take knee protective measures.

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Authors' contributions

MAMR, MFIM: Concept and design, data acquisition, interpretation, drafting and final approval. JN, RP and CR: Data acquisition, interpretation, drafting, final approval and agree to be accountable for all aspects of the work.

Declarations

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Ethical approval

Ethical approval of the study was obtained from the Ethical Review Committee, Rajshahi Medical College, Rajshahi. Informed consent was taken from all participants. All the study methodology was carried out following the relevant ethical guidelines and regulations.

Consent for publication: Taken.

Conflict of interest: Authors declared no conflict of interest.

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