Proportion of Genu Valgum and Genu Varum in Students Aged 19-25 Years

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Abstract: Background: Knee joint mal alignments are divided into genu valgum and genu varum. The presence of these mal-alignments leads to complications like tibio-femoral osteoarthritis, compensatory changes in ankle/foot, etc. Taking a community of physiotherapy students, the proportion of genu varum, genu valgum and its association with body mass index (BMI) and foot posture index (FPI) was investigated. The aim of the study was to evaluate the proportion of genu valgum and genu varum in subjects aged 19 - 25 years. Materials and Methods: The data was collected from D.Y. Patil University, Navi Mumbai. A consent form and a validated proforma was used. Age, BMI, FPI, IKD (Inter-knee distance), IMD (Inter-malleolar distance) and Q-angle was recorded, and the data was statistically analysed. Results: 45 out of 100 females had genu valgum which was found to be associated with higher BMI and pronated feet. 9 out of 100 females had genu varum which was found to be associated with lower BMI. Chi-square test was done to find out these associations. Conclusion: Awareness of the proportion of angular mal-alignment in knee would increase the recognition of this problem among the individuals and doctors for better execution of strategies that can help avoid these mal-alignments. [Jain U Natl J Integr Res Med, 2021; 12(4):19-25]

Key Words: Body mass index, Foot posture index, Genu valgum, Genu varum, Pronated, Q-angle

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Introduction: Genu valgum is an orthopaedic condition characterized by medial angulation of knee joint and lateral deviation of femur and tibia on the longitudinal axis so that the mechanical axis shifts laterally and causes pathological stress on femur and lateral tibia, which triggers pain[1]. Genu valgum occurs due to other etiologies such as knee injuries, overweight and obesity, laxity of the ligaments around the knee joint and developmental problems[2].

Genu varum is a common anatomic variation of musculoskeletal alignment and a reason for referral to orthopedic surgeons[3, 4]. Physiological varus is an abnormal internal rotation of tibia occurring after the age of two, while pathological varus may be caused by Blount's disease, systemic disorders (such as nutritional rickets and bone metabolic diseases), bone dysplasia, infection, or neoplasm[3-6]. Although the physiological type can improve with age, pathological type tends to develop during skeletal growth[5].

The presence of these deformations' places people at a risk of developing complications such as patello-femoral joint damage, tibio-femoral joint osteoarthritis, compensatory changes in ankle and foot joints and tibia fractures[5,7-8]. Lower extremity mal-alignment may cause musculoskeletal dysfunctions, including abnormal joint loading and muscle imbalance[9]. In adults, mal-alignment may lead to amplification of osteoarthritis[10]. Therefore, investigating the presence of these musculoskeletal mal-alignments will help in prevention of the associated complications and the progress of these knee and foot mal-alignments.

Very few studies have reported the use of clinical methods such as measuring the inter-condylar distance (ICD)/ inter-knee distance (IKD), inter-malleolar distance (IMD) and Q-angle to evaluate the presence of genu valgum and genu varum.

Similar studies are especially lacking for the Indian population. Also, the proportion of the knee mal-alignments among the subjects aged 19-25 years was found to be unknown.

Therefore, the present study aimed at evaluating the proportion of genu varum, genu valgum with the primary objective of assessing the Q-angle and to find its association with body mass index and foot posture index in subjects.

Material & Methods: Study Design and Sample Size: This was a cross-sectional study including

100 subjects which was done over a period of 6 months.

Study Setting: The study was approved by the institutional ethical committee of the institution. Subjects consent for participation in the study was taken after which the data was collected from D.Y. Patil University, School of Physiotherapy. A self-prepared proforma was used to assess the presence of knee mal-alignment. The participants were required to wear light clothing and no shoes during evaluation. Body mass index, foot posture index, presence or absence of knee mal-alignment and its degree were measured and recorded along with other demographic variables.

Inclusion Criteria: Female subjects willing to participate in the study.

Exclusion Criteria: Subjects not willing to participate, subjects with a history of musculoskeletal disorders, any known orthopedic pathology, someone who had already gone through any previous orthopedic treatment, metabolic disease or fracture, previous lower-limb trauma and hospitalization.

BMI: Weight of the subjects was measured (in kilograms) using a digital weighing machine and the height was measured (in meters) using a stadiometer by asking the subjects to stand straight with the thorax, buttocks and heels in contact with the vertical axis of the gauge. The body mass index (in kg/m^2) was calculated by dividing the weight with the square of height. The participants were classified into different body mass index categories based on the WHO body mass index classification as underweight (<18.5 kg/m^2), normal (18.5–22.9 kg/m^2), overweight (23.0 –24.9 kg/m^2) and obese (≥ 25 kg/m^2) categories[11].

Q- Angle: It was measured by using a goniometer with the patient in standing position and the quadriceps muscles relaxed, by extending a line through the center of the patella to the anterior superior iliac spine and another line from the tibial tubercle through the centre of patella was drawn. The intersection of these two lines was taken as the Q-angle. The normal values for it are 13 to 18 degrees. Men tend to have Q-angle closer to 13 degrees, and women at the high end of this range[12.] In this study, subjects having Q-angle of less than 16 degrees were considered as genu varum cases, while Q-angle of more than 18 degrees were considered as genu valgum cases.

ICD/IKD And IMD: The subjects were asked to stand with the hip and knee joints in full extension when measuring the ICD/IKD and IMD with a measuring tape. The ICD was measured (in comes) with the ankles touching each other.

Similarly, the IMD was measured (in comes) with the knee epicondyles touching together. An ICD of more than 3 comes was considered as genu varum case. IMD of more than 8 comes was considered as genu valgus[13.]

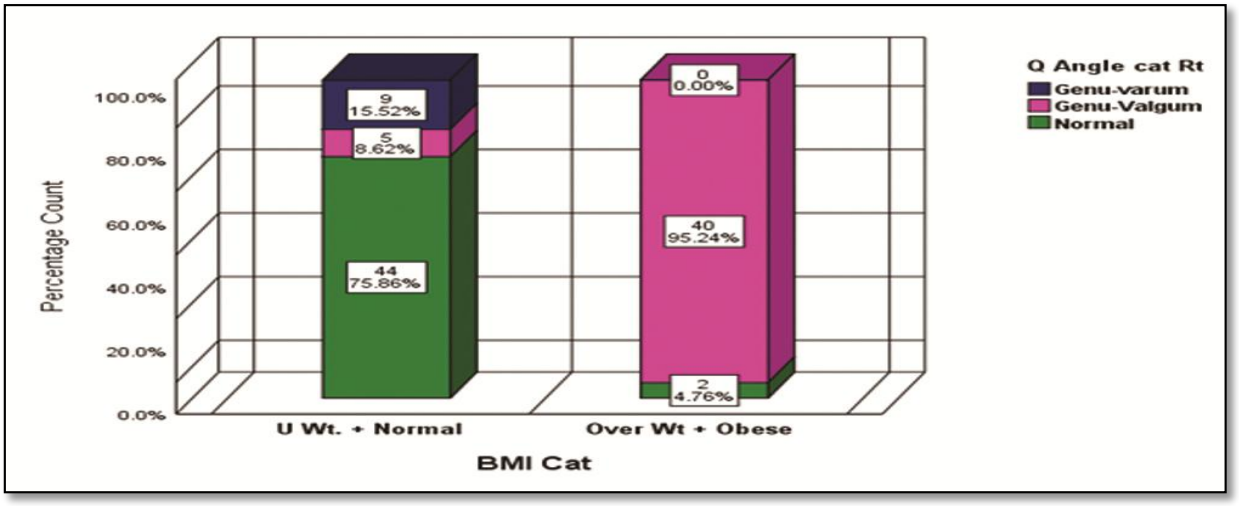
FPI: When evaluating for FPI the participants were asked to stand with their arms by the side and looking straight ahead. Then they were asked to march on the spot for attainment of a comfortable stance position. Each foot was evaluated by palpating the talar head, curves below and above the malleoli, calcaneal inversion/eversion, talo-navicular congruence, medial arch congruence and forefoot abduction/adduction. The subjects were classified into normal foot (0 to +5), pronated foot (+6 to +9) and highly pronated foot (10+) categories. The scoring was done using a scale, ranging from -2 to +2[14].

The data collected was statistically analysed using the Chi-square test. The chi-square test was done to found an association between Q-Angle with BMI and FPI, IMD with BMI and FPI AND IKD with BMI and FPI. Descriptive analysis was done with the help of pie charts and bar diagrams using data analysis add-ons in MS Excel.

Results: According to the objectives of the study, the results showed that the proportion of genu valgum was higher in females and in those with higher BMI while, genu varum was more prevalent among the females with lower BMI. Also, the females with higher body mass index and genu valgum showed the presence of pronated foot. The subjects who participated were females with a mean age of 21.78 years.

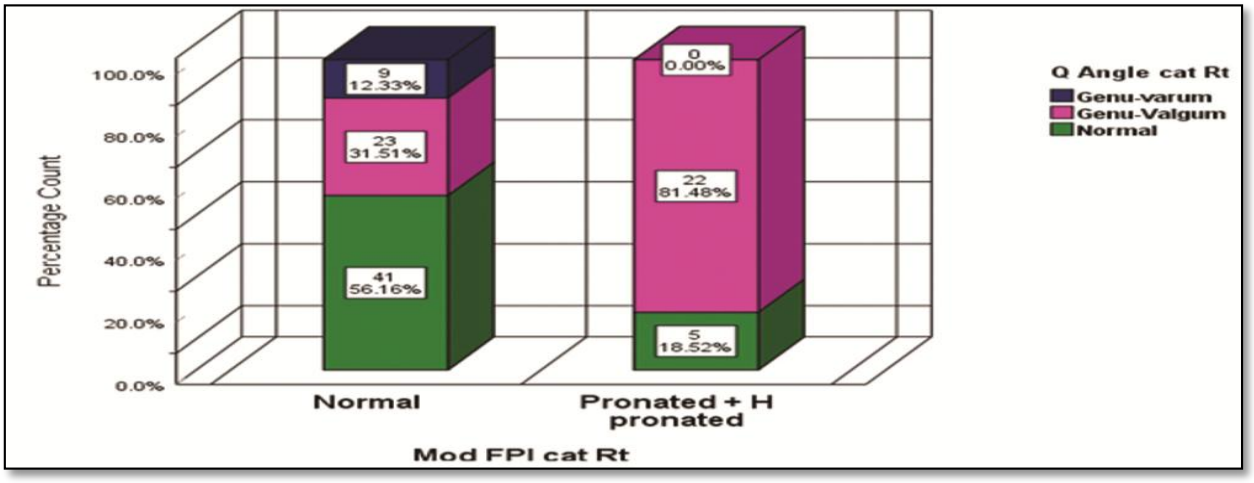
Fig 1 and 2 shows the association between Q-angle with BMI and FPI. Chi-square test was done to find out this association. The results were compared at 5% level of significance where P-value was taken as 0.05. There was a significant association found between Q-angle with BMI and FPI.

Figure 1: Distribution Of Q-Angle Categories Within BMI Categories



Using the chi-square test, it was found that, P value of the chi-square test = 0.000 which is < 0.05. A value < 0.05 suggested that the proportion of genu valgum was significantly higher in overweight + obese category.

Figure 2: Distribution Of Q-Angle Categories Within FPI Categories



Using the chi-square test, it was found that, P value of chi-square test = 0.000 which is < 0.05. A value < 0.05 suggested that the proportion of genu valgum was significantly higher in pronated + highly pronated category. Table 1 and 2 shows the association between IMD with BMI and FPI. Chi-square test was done to find out this association. The results were compared at 5% level of significance where P- value was taken as 0.05. There was a significant association found between IMD with BMI and FPI.

Table 1: Association Between Modified BMI & IMD Categories

Inter-Malleolar Distance Cat		Mod BMI Cat		Total	Test Statistics
		U Wt. + Normal	Overweight + Obese		
Normal	Count	58	14	72	
	% within Inter-malleolar distance	80.6%	19.4%	100.0%	
	% within BMI	100.0%	33.3%	72.0%	
Genu-Valgum	Count	0	28	28	Chi-Square = 53.704
	% within Inter-malleolar distance	0.0%	100.0%	100.0%	DF= 1
	% within BMI	0.0%	66.7%	28.0%	P value = 0.000
Total	Count	58	42	100	
	% within Inter-malleolar distance	58.0%	42.0%	100.0%	
	% within BMI	100.0%	100.0%	100.0%	

The proportion of genu valgum cases were significantly higher in over-weight and obese category as P value = 0.000 which is < 0.05.

Table 2: Association Between Modified FPI Categories & IMD Categories

Inter-Malleolar Distance Cat		Mod FPI Cat Rt/Lt		Total	Test Statistics
		Normal	Pronated + H Pronated		
Normal	Count	63	9	72	Chi-Square = 27.43 DF= 1 P value = 0.000
	% within Inter-malleolar distance	87.5%	12.5%	100.0%	
	% within FPI	86.3%	33.3%	72.0%	
Genu-Valgum	Count	10	18	28	
	% within Inter-malleolar distance	35.7%	64.3%	100.0%	
	% within FPI	13.7%	66.7%	28.0%	
Total	Count	73	27	100	
	% within Inter-malleolar distance	73.0%	27.0%	100.0%	
	% within FPI	100.0%	100.0%	100.0%	

The proportion of genu valgum cases was significantly higher in pronated and highly pronated category as P value = 0.000 which is < 0.05. Table 3 and 4 shows the association between IKD/ICD with BMI and FPI. Chi-square test was done to find this association. The results were compared at 5% level of significance where P- value was taken as 0.05. There was a significant association found between IKD and BMI. There was no significant association found between IKD and FPI.

Table 3: Association Between Modified BMI & IKD Categories

Inter-Knee Distance Cat		Mod BMI Cat		Total	Test Statistics
		U Weight + Normal	Overweight + Obese		
Normal	Count	49	42	91	Chi-Square = 7.162 DF= 1 P value = 0.007
	% within Inter-knee distance	53.8%	46.2%	100.0%	
	% within BMI	84.5%	100.0%	91.0%	
Genu-Varum	Count	9	0	9	
	% within Inter-knee distance	100.0%	0.0%	100.0%	
	% within BMI	15.5%	0.0%	9.0%	
Total	Count	58	42	100	
	% within Inter-knee distance	58.0%	42.0%	100.0%	
	% within BMI	100.0%	100.0%	100.0%	

The proportion of genu varum cases was significantly higher in under-weight and normal category as the P value = 0.000 which is < 0.05.

Table 4: Association Between Modified FPI Categories & IKD Categories

Inter-Knee Distance Cat		Mod FPI Cat Rt/Lt		Total	Test Statistics
		Normal	Pronated + H pronated		
Normal	Count	64	27	91	Chi-Square = 3.658 DF= 1 P value = 0.056
	% within Inter-knee distance	70.3%	29.7%	100.0%	
	% within FPI	87.7%	100.0%	91.0%	
Genu-	Count	9	0	9	

Varum	% within Inter-knee distance	100.0%	0.0%	100.0%	
	% within FPI	12.3%	0.0%	9.0%	
Total	Count	73	27	100	
	% within Inter-knee distance	73.0%	27.0%	100.0%	
	% within FPI	100.0%	100.0%	100.0%	

The difference between the proportion of genu varum cases between pronated and highly pronated groups was statistically insignificant since the P value = 0.056 which is > 0.05. Statistical insignificancy was due to less genu varum cases out of the total 100 subjects.

Discussion: The first objective of this study was to evaluate the proportion of genu valgum and to find its association with BMI. The results showed that, total 45 out of 100 females had an increased Q-angle value. Also, genu valgum was found to be linked with higher BMI which is being over-weighted or obese as the P-value of chi-square test = 0.000 which is < 0.05 (Figure 1).

As the lower extremities endures the weight of the body, an increased BMI can result in higher medial and lateral compressive forces of the femoral condyles against the tibial condyles in the knee joint leading to an increase or decrease in frontal plane angulations. A greater compressive force across the lateral condyles than across the medial condyles results in genu valgum[15]. The results of this study such as the relationship between being over-weighted and having genu valgum were found to be consistent with a study by Fahimeh soheilipour et al which concluded that there was a strong and significant relationship between incidence of obesity and genu valgum[16].

Similarly, inter-malleolar distance was also used as an assessment measure for genu valgum. As depicted in table 1; 28 out of 42 over-weighted and obese subjects were having an increased inter-malleoli distance values which further indicated the presence of genu valgum as P value = 0.000 which is < 0.05. This finding was found to be consistent with a study by Fahimeh Soheilipour et al which stated that there is a direct correlation between increased BMI of patients with inter-malleoli distance (r= 0.166, P = 0.055)[16]. The second objective of this study was to evaluate the proportion of genu varum and to find its association with BMI. The results showed that, 9 out of 100 females had decreased Q-angle value also, genu varum was found to be positively

associated with lower BMI which is being under-weighted (Figure 1). A greater compressive force across the medial condyles than across the lateral condyles results in genu varum[15]. The results of this study such as the relationship between being under-weighted and having genu varum were found to be consistent with a study by Noam Shohat et al which stated that in underweight subjects the prevalence of all severity levels of genu varum, and mainly the more severe conditions, were higher[17].

Similarly, inter-knee distance was also used as an assessment measure for genu varum. As depicted in table No 3; 8 out of 8 under-weighted subjects and 1 out of 50 subjects with normal BMI were found to have an increased inter-knee distance value which further indicated the presence of genu varum. This finding was found to be consistent with a study by Fahimeh soheilipour et al which stated that there is an inverse correlation between increased BMI and two knees distance (r= -0.155, P = 0.009)[16].

The third objective of this study was to assess the foot to find out the presence of pronation or supination and to find its association with Q-angle. As seen in Figure 2; out of 100 subjects only 26 subjects were found to have pronated foot while, only 1 student showed highly pronated foot. On the other hand, none of the subjects were found to have supinated foot. In Figure 2; It can be seen that in pronated + highly pronated category, out of 27 individuals no cases of genu-varum were observed, 22 genu valgum cases and 5 normal individuals were observed.

Based on the theory of kinetic chain, the changes in one segment or a part of body may cause changes in other parts of the body and affect their status. According to this theory, reduced plantar arch results in the internal rotation of tibia, making the knees undergo a valgus position

and the hips rotate internally. For this reason and because of decreased plantar arch in the subjects with genu valgum deformity, their knees undergo valgus position and displace internally[18, 19]. Also, foot pronation leads to a mal-alignment known as flatfoot. The results of this study were consistent with a study done by Mohsen Pourghasen et al which concluded that there is a positive correlation between increased BMI and flatfoot [20].

Less information is available regarding the proportion of the knee mal-alignment in healthy individuals therefore, in the current study, we outlined the proportion of genu valgum and genu varum by using inter-malleolar distance, inter-knee distance/inter-condylar distance and Q-angle as clinical assessment components to inspect for the knee mal-alignment. Also, FPI was used to inspect for the associated foot mal-alignment. The positive association found between body mass index, genu valgum and pronated foot suggests that the individuals who are over-weight and obese are more likely to have genu valgus and pronated foot. Maintaining the weight within the normal ranges according to the age is important because being overweight or obese predisposes people to various joint mal-alignments which would eventually lead to complications later in life.

The results of this study cannot be used as a reference for comparison in future studies because these results are generalized to this particular population of females in the study. This was a cross-sectional study, so it does not address other variables that could influence the presence of valgus/varus knee. Finally, further research involving these factors are solidly recommended so that a cause-effect relationship can be established.

Conclusion: Clinical evaluation such as evaluating the Q-angle, inter-malleolar distance and inter-knee distance should be used for early detection of the mal-alignment of knees. Routine evaluation of all these components should be done. Awareness of the presence of these mal-alignments would help preventing the associated complications and the progress of the knee and foot mal-alignments. Awareness of the proportion of angular mal-alignment would increase the recognition of this problem amongst the individuals and doctors for better execution of strategies that can help avoid these mal-alignments.

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