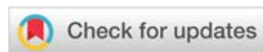


ORIGINAL ARTICLE

Variation of Q'angle in Multiparous Pregnant Females: An Observational Cross-Sectional Study

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ABSTRACT

Introduction: There are hormonal, biomechanical and postural adjustments that occur during pregnancy that can affect the alignment of the lower limb and musculoskeletal function. Multiparous pregnant females are at higher risk of musculoskeletal problems because of multiple biomechanical stresses and ligamentous laxity. Alteration of the Q angle is regarded as an important sign of patellofemoral dysfunction and knee malalignment. There is limited literature on the relationship between variation in the Q-angle and physical activity levels in multiparous pregnant females, and the effect of physical activity during pregnancy on musculoskeletal health and postural stability are likely to be different.

Objective: To investigate the changes in Q-angle and the relationship between physical activity and Q-angle in multiparous pregnant females.

Methodology: The study was a cross-sectional observational study conducted in the gynecology department of DHQ Hospital Mandi Baha-ud-Din, Aziz Bhatti Hospital and Rehmat hospital Gujrat for six months period from August 2020 to February 2021. The number of pregnant females recruited for the study were 317 (multiparous women) using non-probability purposive sampling technique. The angle of Q was bilaterally measured with a standard universal goniometer in standing position. The Pregnancy Physical Activity Questionnaire (PPAQ) was used to measure physical activity level. Demographic data such as age, BMI, parity, weight and height were also documented. The data was analysed using SPSS version 21. A chi-square test was used and the correlation was done by the Spearman method with statistical significance set at $p \leq 0.05$.

Results: Among the total of 317 participants, 26.5% had normal Q-angle value and 73.5% showed bilaterally increased Q-angle values ($>20^\circ$). The BMI ($p < 0.001$), age group ($p < 0.001$) and physical activity level, assessed by PPAQ ($p < 0.001$) were found to be significant associations with abnormal Q-angle values. The prevalence of abnormal Q-angle values was greater in the overweight/obese individuals. Females who were not very active had a significantly larger change in the Q-angle than the moderately active females.

Conclusion: Bilateral increased Q-angle values are commonly found in multiparous pregnant females, especially those with greater BMI, older maternal age and lower physical activity. Lower limb biomechanics changes and the risk of musculoskeletal complications during pregnancy can be attributed to lower level of exercise.

Keywords: Multiparous, Multiparous pregnancies, Pregnant females, Q' Angle, Variation

INTRODUCTION

Pregnancy is a dynamic state in which there are changes in the endocrine, cardiovascular, postural and musculoskeletal systems happening systemically. These adaptations are necessary for fetal development and for maternal support, and can lead to postural, gait and joint changes¹.

Weight gain and the anterior shift of the center of gravity during pregnancy, cause compensatory changes in postures including increased lumbar lordosis, anterior pelvic tilt, and lower limb alignment. These changes, and their associated mechanical loading, are significantly different for weight-bearing joints such as the hip, knee, and ankle joints². Evidence indicates that multiparous women experience higher rates of musculoskeletal pain, balance impairments, altered gait mechanics, and falls during pregnancy³.

Hormonal changes during pregnancy, specifically increases in relaxin, estrogen, and progesterone, lead to significant biomechanical alterations. Relaxin affects collagen metabolism and reduces ligament stiffness, resulting in increased joint mobility and instability⁴. There is evidence that multiparous pregnant women are more likely to develop musculoskeletal pain, gait abnormalities and balance impairments than primiparous pregnant women⁵.

The quadriceps angle (Q-angle) is one of the most important biomechanical parameters that are clinically evaluated when assessing the alignment of the lower limb. The angle formed by a line from the anterior superior iliac spine (ASIS) to the middle of the patella and a line from the tibial tuberosity to the patella is the angle of the Q-angle⁶. In females, normal Q-angle lies between 15° and 20°, and is greater than this the more valgus stress at the knee joint⁷.

A change in the Q angle can lead to patellofemoral maltracking, knee instability and greater joint load. Increased values of Q-angle during pregnancy may be due to biomechanical changes, including increased pelvic width, internal rotation of the femur, and ligamentous laxity^[8]. There are however, only a few studies that have focused on the effect of pregnancy on the Q-angle in multiparous patients.

Exercise is a crucial modifiable factor of musculoskeletal health in pregnancy. Pregnancy Physical Activity Questionnaire (PPAQ) is a validated questionnaire that measures physical activity in pregnant women in occupational, household, transportation and recreational areas⁹.

An increasing number of studies have explored musculoskeletal changes during pregnancy, yet there is

limited research on the association between Q-angle variation and physical activity in multiparous pregnant women. Previous studies have focused more on general musculoskeletal symptoms, balance issues, and gait changes instead of biomechanical measures like the Q-angle. Understanding the relationship between Q-angle variation and physical activity during pregnancy could shed light on the link between pregnancy and knee dysfunction, aiding physiotherapists and gynecologists in formulating preventative and rehabilitative strategies. The present study was therefore an attempt to assess the change in Q-angle and its relationship with physical activity level of multiparous pregnant females.

MATERIALS AND METHODS

Study Design: A cross-sectional observational study was conducted to evaluate Q-angle variation and its association with physical activity levels among multiparous pregnant women.

Study Duration: The study was conducted over a period of six months, from August 2020 to February 2021.

Study Setting: Data were collected from the gynecology departments of tertiary care hospitals.

Sample Size: The sample size of 317 participants was calculated using standard formulae for cross-sectional studies with a 95% confidence interval and 5% margin of error.

Inclusion Criteria

Participants were included if they met the following criteria:

- Multiparous pregnant women aged between 20–40 years¹⁰.
- History of at least one previous viable pregnancy.
- Ability to stand independently without support for postural assessment.
- Willingness to participate and provide written informed consent.

Exclusion Criteria:

Participants were excluded if they had:

- Knee osteoarthritis or rheumatoid arthritis affecting lower limb biomechanics.
- History of lower limb fracture or significant trauma within the past six months.
- Congenital deformities of lower extremities such as genu valgum or genu recurvatum.
- Neurological disorders affecting gait, balance, or coordination.
- History of knee surgery or arthroplasty.

- Diagnosed patellofemoral pain syndrome¹¹.
- High-risk pregnancy conditions restricting mobility or physical activity.

Data Collection Tools

Quadriceps Angle (Q-Angle) Measurement

Q-angle is a clinically important parameter that determines the biomechanical alignment of the knee joint; it is the angle between the quadriceps muscle and the patellar tendon and tibial tuberosity.

Measurement Procedure

Participants were evaluated in a standing position with feet shoulder width apart, and equal weight distribution on both lower limbs. The stationary arm of the goniometer was placed from the side of the ASIS to the centre of the patella and the movable arm was placed from the centre of the patella to the centre of the tibial tuberosity. The intersection of these 2 lines was the Q-angle. Good interrater reliability of goniometric measurement of Q-angle has been shown in previous studies, with coefficient of reliability ranging from 0.90 to 0.92¹².

2. Physical Activity Assessment: Pregnancy Physical Activity Questionnaire (PPAQ)

Physical activity levels of participants were assessed using the Pregnancy Physical Activity Questionnaire (PPAQ), a validated and widely used self-administered tool designed specifically for pregnant populations.

The PPAQ evaluates physical activity during pregnancy across five categories: household/caregiving, occupational, transportation, sports/exercise, and inactivity. Participants report time spent in these areas, allowing for the assignment of metabolic equivalent (MET) values. Total energy expenditure is calculated by multiplying duration by MET intensity, classifying activities into low, moderate, and high. The measure's validity and reliability are also noted¹³.

The PPAQ has demonstrated strong validity and reproducibility in pregnant populations and is considered one of the most reliable tools for assessing gestational physical activity behavior¹⁴.

Statistical Analysis

Data were analyzed using SPSS version 21.0. Quantitative variables were expressed as mean $\pm$ standard deviation, while categorical variables were presented as frequencies and percentages. Chi-square test was used to assess associations between categorical variables. Spearman correlation was used to determine the relationship between Q-angle and PPAQ scores. A p-value ≤ 0.05 was considered statistically significant.

RESULTS

In this study 317 multiparous pregnant women participated. The analysis showed that 73.5% (n = 233) of the participants had a bilateral abnormal Q-angle (Q-angle $> 20^\circ$) while 26.5% (n = 84) had a normal Q-angle (Q-angle between 15° and 20°), suggesting that a large proportion of the study population had altered lower limb biomechanics.

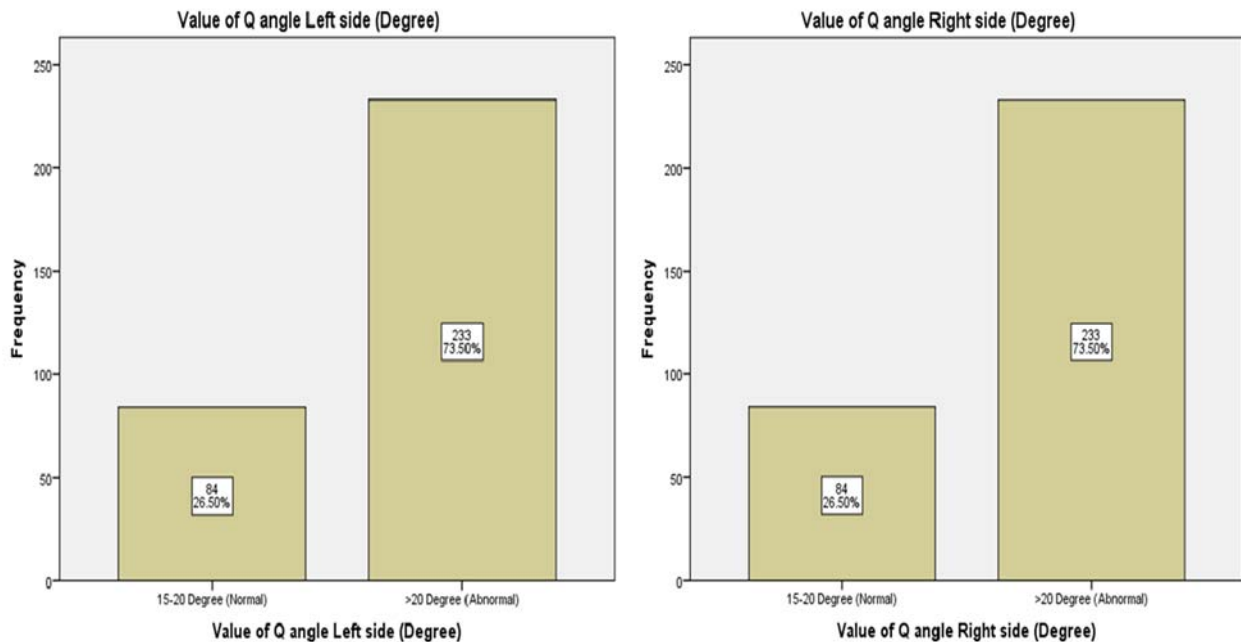
In the table 1 The mean age of participants was 31.22 ± 5.26 years, while the mean body weight and height were 73.42 ± 11.58 kg and 167.35 ± 9.05 cm, respectively. The mean BMI was 26.29 ± 4.12 kg/m², reflecting that most of the participants were in the overweight category. The average number of children per participant was 3 (IQR: 2–4). The mean values of the Q-angles were greater than the normal range of 15° to 20° on both sides (left knee $21.55 \pm 2.48^\circ$ and right knee $21.56 \pm 2.63^\circ$), indicating a trend towards an increased valgus knee alignment in this population overall.

As far as BMI distribution is concerned, 2.8% of the participants were underweight, 36.0% had normal BMI, 43.2% were overweight and 18.0% were obese. Regarding age, the ages of the participants ranged from 20–30 years (47%) and 31–40 years (53%), suggesting a slightly larger number of older pregnant women in the sample (Table 2).

A significant relationship was found between BMI and the Q angles. The left and right Q-angle was tested, both showed a chi-square value of 60.3 with 3 degrees of freedom and p values of < 0.001 , with an effect size of $r = 0.32$. Higher BMI was associated with more abnormal Q-angle values, especially in overweight and obese participants, with a greater prevalence of abnormal Q-angle values in these groups than in those with a normal BMI (Table 3).

Similarly, a significant association was found between age and Q-angle variation. The chi-square value for both left and right side was 32.9 with 1 degree of freedom and p value < 0.001 with an effect size of $r = 0.33$. The age range of the participants showed an increased rate of abnormal Q-angle measurements with age (31–40 years) and parity (20–30 years), indicating that the development or aging process could influence knee alignment over time.

Regarding physical activity, detailed scoring was analyzed separately and findings showed that participants with lower scores of physical activity were more likely to be associated with abnormal Q-angle values, although descriptive data showed this. This implies that possibly there is an inverse relationship between physical activity and knee alignment deviation in multiparous pregnant women.

Figure-1: Frequency of right and left side Q angle values**Table 1:** Demographic and Clinical Characteristics of Participants (n = 317)

Variable	Mean $\pm$ SD	Median (IQR)
Age (years)	31.22 $\pm$ 5.26	32 (27–35)
Weight (kg)	73.42 $\pm$ 11.58	72 (67–80)
Height (cm)	167.35 $\pm$ 9.05	167 (162–170)
BMI (kg/m ²)	26.29 $\pm$ 4.12	—
Number of children	3 $\pm$ 1.44	3 (2–4)
Left Q-angle (°)	21.55 $\pm$ 2.48	22 (20–23)
Right Q-angle (°)	21.56 $\pm$ 2.63	22 (20–23)

Table 2: Frequency Distribution of Participants by BMI and Age Group

Variable	Category	n (%)
BMI	Underweight (<18.5)	9 (2.8)
	Normal (18.5–24.9)	114 (36.0)
	Overweight (25–29.9)	137 (43.2)
	Obese ($\geq$ 30)	57 (18.0)
Age Group	20–30 years	149 (47.0)
	31–40 years	168 (53.0)
Total	—	317 (100)

Table 3: Association of BMI and Age with Q-Angle (Chi-Square Analysis)

Variable	Q-angle Side	χ^2	df	p-value	r (Effect Size)
BMI	Left	60.3	3	<0.001	0.32
BMI	Right	60.3	3	<0.001	0.32
Age group	Left	32.9	1	<0.001	0.33
Age group	Right	32.9	1	<0.001	0.33

DISCUSSION

In the present study, it was found that the prevalence of increased Q-angle was high in multiparous pregnant women with 73.5% of the women having increased Q-angle levels above 20° measurement. This indicates that

there are substantial changes in lower limb biomechanics during pregnancy, especially among women having multiple pregnancies.

There are a number of biomechanical changes that occur during pregnancy which involve posture and gait changes¹⁵. This gradual rise in maternal body weight and

anterior change in the center of gravity results in compensatory changes in the spine, pelvis and lower limb loading¹⁶. Such adaptations may lead to an increased valgus load on the knee joint and are likely to lead to the higher Q-angle values seen in the present study.

These biomechanical changes seem to be further accentuated with multiparity. Hormone swings and mechanical stress are repeated to the musculoskeletal system with repeated pregnancies. This can cause progressive changes in the ligaments of the body, a change in the neural function and control of the body over time. Thus multiparous women may develop chronic postural changes which make them more likely to have knee joint malalignment and dysfunction¹⁷.

In the present study, BMI was also seen to be significantly associated with Q-angle variation. BMI was correlated with Q-angle values, suggesting a correlation between the mechanical loading of the knee joint and the amount of body mass¹⁸. This is in line with the biomechanical principles, that the more the body weighs, the more compression and shear forces are put across the lower extremity joints, resulting in compensatory valgus alignment^{19,20}.

There was a strong negative association between physical activity (as measured by the Pregnancy Physical Activity Questionnaire [PPAQ]) and Q-angle variation. Those who did not have a high level of physical activity had significantly higher abnormal Q-angle values. This indicates that lower levels of physical activity could be associated with lower muscle strength, especially of the quadriceps and stabilizers of the hip joints, which results in a disruption of joint control and a larger biomechanical deviation^{21,22}.

Frequent exercise during pregnancy has been demonstrated to have a beneficial effect on muscle strength, postural stability and neuromuscular coordination. These are very important to keep the lower limbs aligned correctly and not unduly stressed on joints. Thus, the lower levels of activity during pregnancy can make women vulnerable to biomechanical dysfunction and risk of musculoskeletal problems.

This study's results are similar to the previously mentioned studies which suggest that gait and postural adaptations do occur during pregnancy. Stride length, step width and joint kinematics have been reported to change during pregnancy in systematic reviews, which can all lead to changes in lower limb alignment^{23,24}.

As far as the clinical picture is concerned, elevated Q angle is related to anterior knee pain, patellofemoral maltracking and functional instability. The high prevalence of abnormal Q-angle in this study reinforces the need for early screening of musculoskeletal conditions in pregnancy especially for multiparous

women.

Physiotherapy implications of these findings include a focus upon increasing the strength of the quadriceps, hip abductors and core muscles as key interventions to be undertaken during antenatal period to prepare for the birth. Further, safe and controlled exercise could have a beneficial effect on biomechanical stress and therefore functional outcome during pregnancy.

The overall conclusion is that multiparity, higher BMI and lower physical activity are all associated with changes in lower limb biomechanics, which causes an increase in the Q-angle variation during pregnancy.

CONCLUSION

Multiparous pregnant women demonstrate significant Q-angle alterations, particularly those with higher BMI and low physical activity levels. Physical activity plays a protective role in maintaining lower limb biomechanics during pregnancy.

RECOMMENDATIONS

- Implementation of antenatal physiotherapy exercise programs
- Promotion of safe physical activity during pregnancy
- Longitudinal studies across trimesters
- Inclusion of biomechanical gait analysis in future research

DECLARATION

Ethical Approval: Ethical approval was obtained. Informed consent was taken from all participants.

Conflict of Interest: None declared.

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Authors contribution:

Shaher Bano: Conceived idea, Designed Research Methodology, Manuscript writing

Azka Rehan: Literature Review, Thesis writing

Fatima-tul-Zahra: Data collection, Interpretation of Data

Dr. Nadia Anwer: Manuscript final reading, manuscript writing and final approval

Asim Raza: Statistical Analysis of Data, Manuscript final Reading

Dr. Farooq Islam: Final Approval

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