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Original Article

Variation of Carrying Angle among Sedentary and Non-Sedentary Females: A comparative Cross-Sectional Study

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ABSTRACT

Background: The carrying angle is an important anatomical parameter influencing elbow biomechanics. Although gender-based differences are well established, the impact of lifestyle and occupational Physical activity remains insufficiently explored.
Aim: To compare the carrying angle between sedentary and non-sedentary females.
Methodology: A community-based cross-sectional study was conducted among 292 females aged 18–60 years. Participants were classified into sedentary and non-sedentary groups. The sedentary group Included housewifes and students while the non- sedentary group included labourers, cleaners, Nurses and rural women. Their age, height and weight were recorded. Then the Carrying angle was measured bilaterally using a standard universal goniometer. Statistical analysis was performed using independent t-test, ANOVA and Pearson correlation.
Results: Sedentary females exhibited a significantly higher right mean carrying angle (13.21) compared to non-sedentary females (11.8) indicating that lifestyle affects carrying angle. In contrast, the Left Carrying Angle (LCA) remained relatively stable across both groups suggesting that only the dominant hand shows variation. Among sedentary group, age was weakly negative and height was weakly Positive correlated with both RCA and LCA (r= -0.13, p= 0.13 >0.05), (r= 0.04, p= 0.64>0.05) (r= 0.081, p= 0.36 >0.05) While weight showed weak positive correlation with LCA (r= 0.08) and weak Negative with RCA (r= -0.14). However, the relation was not highly significant. Among non-Sedentary females manual occupations (Nurses and Cleaners) showed a higher mean right Carrying angles 12.9 and 13.2 than Rural Area and Construction labourer females may be associated with their occupational upper-limb activities
Conclusion: Lifestyle appears to affect the carrying angle. Sedentary lifestyle may contribute to altered elbow alignment, highlighting the importance of regular physical activity in maintaining

Keywords: Carrying angle, Sedentary lifestyle, non-sedentary females, Occupational physical activity, Elbow biomechanics

INTRODUCTION

The carrying angle is the angle formed between the longitudinal axes of the arm and forearm when the elbow is extended and the forearm is supinated. It facilitates clearance of the forearm from the trunk during walking and contributes to the functional alignment of the upper limb [1,7].

Previous studies have reported sex-related differences in carrying angle, with women generally demonstrating greater values than men [2-5]. The focus on lifestyle-related factors, including exercise, has been largely overlooked. Previous studies have examined carrying angle in relation to sex, age, height, weight that can result in skeletal imbalance, diminished muscle power, and altered joint biomechanics. These biomechanical modifications have the potential to modify anatomical characteristics, including carrying angle. The maintenance of normal anatomical alignment may be linked to increased muscular support and stability in joints achieved through regular exercise. [5,6].

Elbow instability, ulnar nerve irritation, and impaired upper limb function are among the clinically significant conditions that may result from abnormalities in carrying angle. Although previous studies have examined carrying angle in relation to sex, age, height, weight, and other anthropometric characteristics [2,6,10–13], comparatively little attention has been given to differences in carrying angle according to habitual physical activity and occupational activity among women. Therefore, this study aimed to compare bilateral carrying angles between sedentary and non-sedentary women and to examine their relationships with age, height, weight, and occupational activity.

MATERIALS AND METHODS

Study Design

Comparative cross-sectional study

Study Setting

A community-based cross-sectional study was conducted among adult women residing in an urban and rural population in northern India. Participants were recruited from community households and occupational settings, including healthcare facilities, educational settings, construction sites, and rural communities.

Participants

Participants were selected from households, for females with sedentary lifestyle and low physical activity. Schools, colleges, hospitals, construction sites and rural areas provided access to non-sedentary females. A total of 292 subjects were selected out of which 146 were sedentary and 146 were non sedentary females who were invited to take part in the study after receiving thorough explanations. The procedures followed were in accordance with the ethical standards

Inclusion Criteria

- Healthy females aged 18–60 years
- Willing to participate

Exclusion Criteria

- History of upper limb fractures
- Congenital deformities
- Musculoskeletal disorders

Group Classification

Participants were categorized into:

- Sedentary group (n = 146)
- Non-sedentary group (n = 146)

Materials

Electronic universal Goniometer. Electronic scale

Methodology

A record of the participants' age, height, weight, and any previous elbow pain was created in a structured format. The anatomical bony landmarks were indicated with a marker. Based on the criteria for inclusion and exclusion, 292 participants were selected out of which 146 were living sedentary lifestyle and 146 were living non sedentary lifestyle, with age above 18 years. The measurement was taken by placing the goniometer's measurement plate at the fulcrum (biceps brachii tendon) of elbow. The fixed arm is placed on the median axis of the upper arm, the movable arm adjusted on the median axis of forearm. The arrow on the goniometer measurement plate indicates the angle. Measurement of height of the sample was taken using an inch tape.

Females with Non- Sedentary Lifestyle

Non sedentary Females were selected from community and occupational settings, including rural villages, hospital

environments, and construction sites. The study included females engaged in physically active occupations such as cleaning staff, nursing personnel, and construction workers, whose daily routines involved prolonged standing, walking, lifting, carrying loads, and repetitive upper limb movements.

Females with Sedentary Lifestyle

Sedentary females were identified based on their daily activity patterns, which involved prolonged sitting, minimal engagement in regular physical exercise, and limited upper-limb loading [Figure-1]

[Figure-1]: Measurement of Carrying Angle using Goniometer

RESULT

Sedentary females exhibit a significantly higher right mean carrying angle (13.21) compared to non-sedentary females (11.8). The variation is most pronounced in the Right Carrying Angle (RCA). In contrast, the Left Carrying Angle (LCA) remained relatively stable across both groups. Some variations were found among different groups of non-sedentary females including nurses, cleaners, construction workers and rural areas. Variations were also found among females of sedentary group in their relationship with height, weight and age.

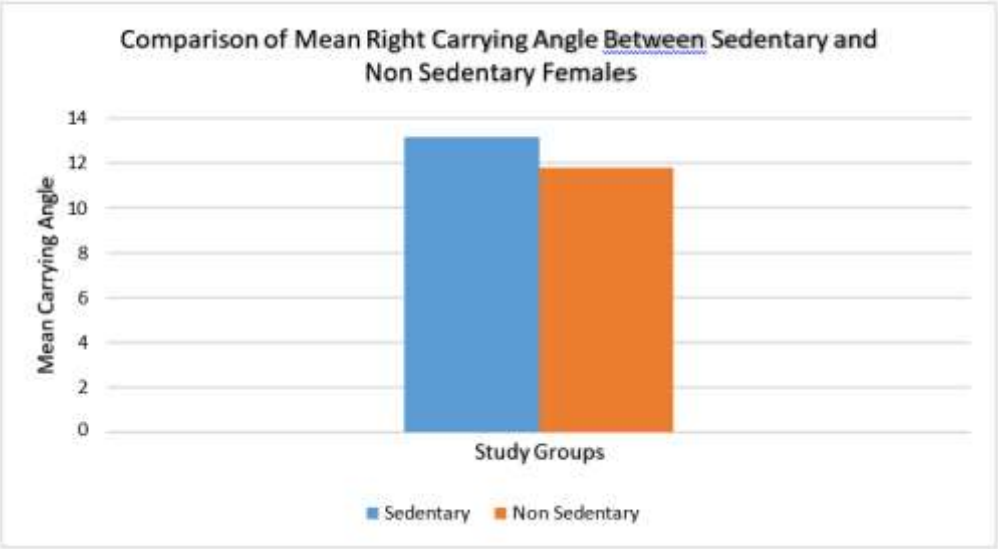
Variation of carrying angle among sedentary and non-sedentary females

The mean right carrying angle was significantly higher among sedentary females (13.21 ± 2.58°) compared to non-sedentary females (11.80 ± 3.17°) ($t = 3.93$, $p < 0.001$) [Figure-2,3]

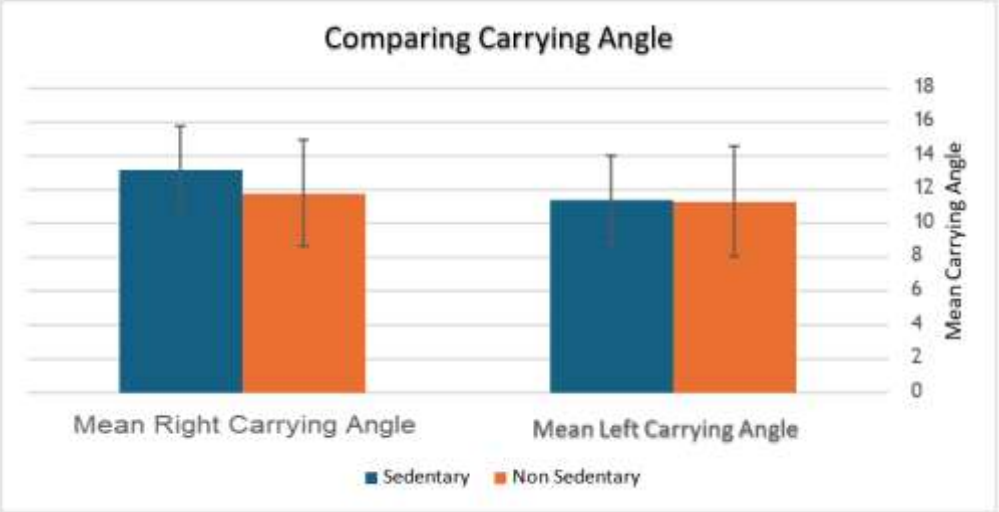
However, no statistically significant difference was observed in left carrying angle between the two groups ($p = 0.975$)

Variable	Sedentary female Mean ± SD	Non-Sedentary female Mean ± SD	t value	p value	Significance
Right carrying angle (RCA)	13.21 ± 2.58	11.80 ± 3.17	3.93	0.0001	Significant
Left carrying angle (LCA)	11.37 ± 2.62	11.38 ± 3.29	-0.03	0.975	Non-Significant

[Table-1]: Different Statistics on sedentary and non-sedentary females, Carrying Angle Left and Carrying Angle Right.



[Figure-2]: Comparison of mean right carrying angle between sedentary and non-sedentary females.



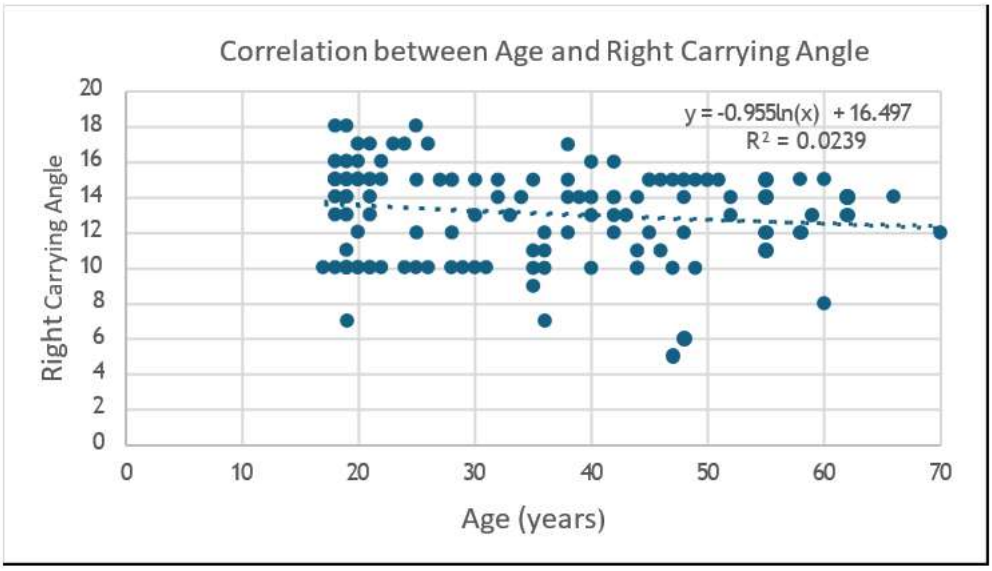
[Figure-3]: Comparison of mean carrying angle between sedentary and non-sedentary females with SD error bars.

Variation of carrying angle among sedentary females

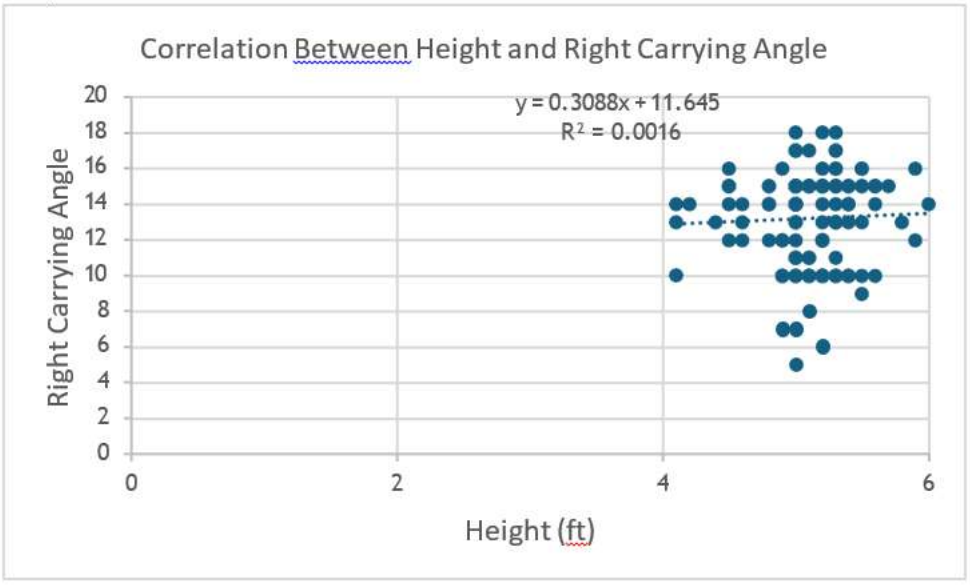
Pearson correlation analysis demonstrated weak negative correlation of both right and left carrying angle with age (r = -0.13) [Figure-4]. Height showed minimal positive correlation with right carrying angle (r = 0.04) and left carrying angle (r = 0.081) [Figure-5] while weight showed minimal negative correlation with right (r = -0.14) and weak positive correlation with left (r = 0.083) among sedentary females [Figure-6] [Table-2]

Variable	Mean ± SD	Pearson Correlation with RCA (r)	Pearson Correlation with LCA (r)
Age (years)	33.6 ± 14	-0.13	-0.13
Height (feet)	5.1 ± 0.33	0.04	0.08
Weight (kg)	53.7 ± 10.7	-0.14	0.08

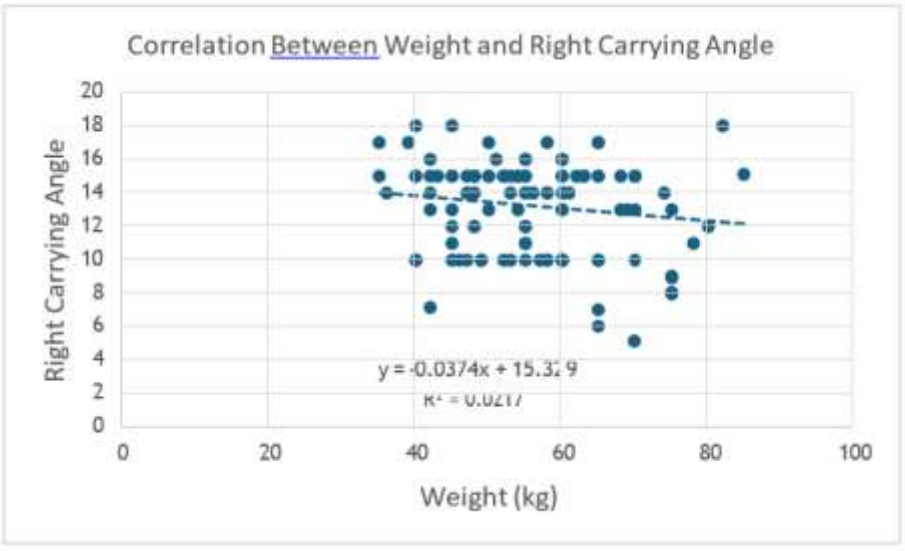
[Table-2]: Different Statistics on sedentary females, Carrying Angle Left and Carrying Angle Right, their relation with age, height and weight



[Figure-4]: Correlation between Age and Right Carrying angle



[Figure-5]: Correlation between Height and Right Carrying angle



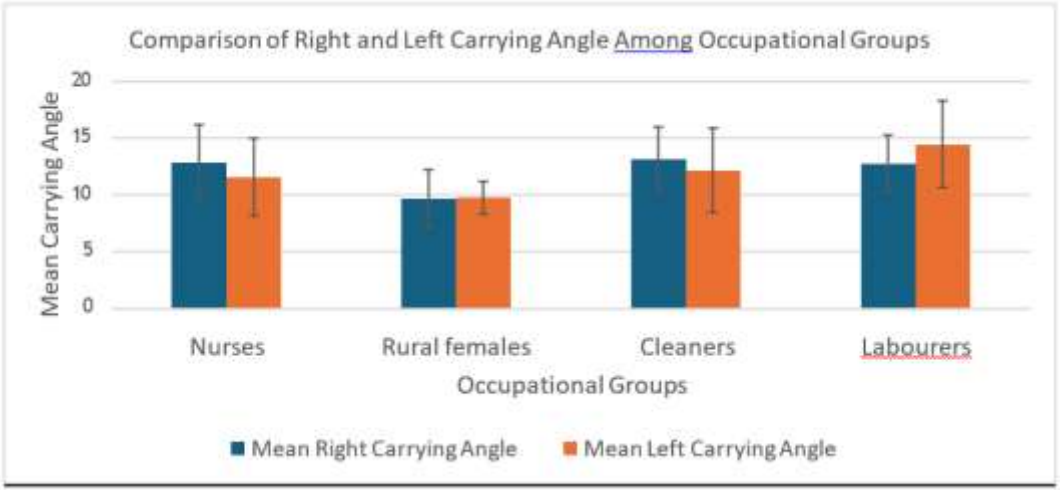
[Figure-6]: Correlation between Weight and Right Carrying angle

Variation of carrying angle among non-sedentary females

Among non-sedentary females, the rural area females showed lowest RCA and LCA values, the nurses and cleaners showed highest RCA value [Figure-8] while the construction labourers showed highest LCA values [Figure-7] [Table-3]

Subgroup	RCA Mean ± SD	LCA Mean ± SD
Nurses	12.9 ± 3.3	11.6 ± 3.4
Rural area females	9.7 ± 2.5	9.8 ± 1.4
Cleaners	13.2 ± 2.8	12.2 ± 3.7
Construction labourers	12.8 ± 2.5	14.5 ± 3.8
ANOVA p- value	<0.001	0.002

[Table-3]: Different Statistics on non-sedentary females, Carrying Angle Left and Carrying Angle Right among different occupational groups n=146



[Figure-7]: Comparison of mean RCA and LCA among different occupational groups of non-sedentary females

[Figure-8]: Image demonstrating increased carrying angle (cubitus valgus) observed among non-sedentary female subjects working as nurses and cleaners

DISCUSSION

The carrying angle is a clinically relevant anatomical parameter influenced by demographic, anthropometric, and

potentially functional factors [2,8,10–13]. In the current study, sedentary females had a significantly higher mean right carrying angle than non-sedentary females. It suggests that the higher right carrying angle observed among sedentary participants may be associated with differences in habitual activity or occupational exposure. The variation in carrying angle caused by functional and biomechanical factors has also been reported previously.

Hand dominance and repeated activities are likely the cause for the increased right carrying angle. The dominant side's increased carrying angle values have been noted in previous anatomical studies due to the impact of differential mechanical stress and functional use of the upper limb. Previous studies have reported side-related variation in carrying angle, including differences according to age and sex [4].

In the current study, sedentary females showed a weak negative correlation between age and both right and left carrying angle. However, the strength of this association was small ($p = 0.13$) and was not statistically significant. The observed age-related pattern should be interpreted cautiously because the correlation was weak and the study design does not allow determination of the underlying mechanism. Similar observations have been made in previous anatomical studies regarding age-related variations in carrying angle. Height and right and left carrying angle were weakly and positively associated in sedentary females. Height may be linked to an increase in humeral and forearm length, which can affect the valgus angulation at the elbow joint and result in slightly elevated carrying angle. Previous studies have indicated that there is a positive correlation between the angle of carrying and its height [2] [10] [11].

The correlation between Weight and both right and left carrying angle was weak. A decrease in the carrying angle may be caused by an increase in soft tissue mass and a change in biomechanical loading around the elbow joint, which could be explained as weakly negative. The correlations between weight and carrying angle were weak, suggesting limited association between body weight and carrying angle in the present sample. Previous studies have similarly examined the relationship between anthropometric variables and carrying angle [2,12,13].

Differences in carrying angle were observed across occupational subgroups, with nurses and cleaners showing higher mean right carrying-angle values, whereas rural participants showed lower mean values. The frequency of carrying angles above 12° in nurses and cleaners may be due to their variation in habitual upper-limb use and occupational demands; however, the specific contribution of individual occupational tasks cannot be established from the present study . The lower mean carrying-angle values observed among rural participants may reflect differences in habitual and occupational activity, although the specific mechanisms underlying this pattern remain uncertain. A decrease in valgus (neck) at the elbow joint may be observed in rural individuals through increased muscular development and habitual use of their upper limbs [11-14].

One-way ANOVA demonstrated significant differences in both right and left carrying-angle measurements among the occupational subgroups of non-sedentary participants ($p < 0.001$ and $p= 0.002$, respectively), there is a statistical significance that occupational activity and lifestyle factors may affect the carrying angle morphology of females [13,12]. This study shows that the multifactorial nature of carrying angle variation is influenced by lifestyle, anthropometric parameters and occupational activity.

The recognition of these differences is essential for clinical purposes in orthopedic diagnosis, physiotherapy evaluation, and management of elbow deformities like cubitus valgus.

Limitations

This study has several limitations. First, its cross-sectional design prevents determination of causal relationships between physical activity and carrying angle. Second, classification of participants according to lifestyle and occupation may not fully capture individual differences in physical activity intensity and duration. Third, potential confounding factors such as hand dominance, duration of occupational exposure, and muscle strength may not have been fully accounted for. Finally, the study population was limited to women from a defined geographic region, which may limit generalizability to other populations.

Ethics Statement

The study was approved by the Institutional Human Ethics Committee of Santosh Medical University.

CONCLUSION

Carrying-angle measurements differed between sedentary and non-sedentary women, with a significant difference observed for the right elbow but not the left. Significant variation was also observed among occupational subgroups of non-sedentary participants. These findings suggest that lifestyle and occupational characteristics may be associated with carrying-angle variation; however, longitudinal studies are required to determine whether habitual physical activity contributes causally to these differences.

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