ISSN: 2091-2331 (Print) 2091-234X (Online)

Journal of Nobel Medical College

Volume 14, Number 02, Issue 27, July-December 2025, 101-104

Original Article

Study of Normal Ranges of Radial and Ulnar Deviation among Female Medical Students

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Article Received: 12th November, 2025; Accepted: 27th December, 2025; Published: 31st December, 2025

DOI: https://doi.org/10.3126/jonmc.v14i2.88115

Abstract

Background
Assessment of joint mobility is a fundamental component of the physical examination of the upper extremities. Accurate measurement of wrist movement helps clinicians evaluate joint laxity, functional capacity, and subtle variations in musculoskeletal structure. Radial and ulnar deviations, in particular, play an important role in activities requiring precision and dexterity, making their evaluation essential in clinical practice, rehabilitation, and research.

Materials and Methods
This cross-sectional, descriptive study included 100 healthy female undergraduate Medical students of NMCTH, participants aged 18–24 years with normal wrist skeletal structure. Radial and ulnar deviations of both wrists were measured using a standard universal goniometer following established procedures.

Results
The overall range of motion (ROM) across all four movements was comparable, averaging between 39° and 41°. Mean radial deviation was 38.76° ± 11.32° in the right hand and 41.18° ± 10.21° in the left hand. Mean ulnar deviation measured 39.84° ± 11.27° on the right and 40.46° ± 10.86° on the left. ROM values were consistently higher in the left wrist for both movements.

Conclusion
This study demonstrates slightly greater wrist mobility on the left side compared to the right for both radial and ulnar deviations. No significant difference was observed between radial and ulnar deviation ranges themselves. Reduced mobility of the right wrist in predominantly right-handed individuals may reflect early functional strain or mild degenerative changes affecting the joint and surrounding ligaments.

Keywords: *Goniometer, Radial deviation, Ulnar deviation*

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Citation
Jha M, Sah SK, Shah SK, Roy S, Bhattrai S, Study of Normal Ranges of Radial and Ulnar Deviation among Female Medical Students, JoNMC. 14:2 (2025) 101-104. DOI: https://doi.org/10.3126/jonmc.v14i2.88115

Introduction

Range of motion (ROM) refers to the extent, distance, and direction through which a joint can move to its full physiological capacity. It is a key indicator of joint flexibility and functional integrity. ROM is typically measured in degrees from the starting position of a limb segment to its end point during full movement, providing objective documentation of joint function and stability [1]. Wrist mobility varies between individuals and even between the right and left hands of the same person due to anatomical, physiological, and functional factors.

Radioulnar deviation involves movements of the hand toward the radius (radial deviation) and the ulna (ulnar deviation), reflecting the functional capacity of the radiocarpal and midcarpal joints. These movements are routinely used during daily activities, sports, fine motor tasks such as musical instrument use, and manual work. Radioulnar deviation is also affected by trauma, fractures, degenerative changes, and ligamentous injuries; hence, its assessment is clinically relevant for evaluating wrist joint flexibility and detecting abnormalities [2].

Goniometry is a simple, reliable, and widely used clinical method for measuring joint ROM. Although radiological techniques have been used to measure radio ulnar deviation, goniometry remains the preferred method in routine clinical and research settings due to its feasibility and non-invasiveness [1]. Previous studies indicate that females generally exhibit greater ROM in upper limb joints including shoulder, elbow, and wrist due to anatomical and hormonal factors [3, 4].

The present study was conducted to assess and compare the ROM of radial and ulnar deviation in the right and left wrists of healthy female medical students. Establishing normative data may assist clinicians in identifying factors influencing wrist mobility and detecting deviations from expected physiological ranges.

Materials and Methods

A descriptive cross-sectional study was conducted at Nobel Medical College and Teaching Hospital (NMCTH), Nepal, from August 2024 to August 2025. Ethical approval was obtained from the Institutional Ethical Committee on 7 August 2024. A total of 100 healthy female medical students aged 18–28 years were enrolled using simple random sampling. The study purpose and procedures were explained in their native language, and written informed consent was obtained. The study included Female participants aged 18–28 years, normal wrist skeletal structure and no recent pain or functional limitations at the wrist. The study excluded history of wrist surgery, trauma, fractures, or ligament injury, rheumatoid arthritis, gout, or other wrist abnormalities The sample size was calculated using the formula: $N = Z^2PQ / d^2$, where Z = 1.96, P = estimated proportion, Q = (1 – P), and d = 10% allowable error. A universal half-circle goniometer (0–180°) was used to measure radial and ulnar deviation. The stationary arm was aligned with the forearm's dorsal midline, while the movable arm was aligned with the third metacarpal. The fulcrum was placed over the capitate bone.

The participant sat beside a table. Shoulder abducted at 90°, elbow flexed at 90°. Forearm in neutral position (midway between pronation and supination). Forearm rested on the table; the hand remained free to move. Participants were instructed to avoid finger flexion or wrist pronation/supination. Measurements were taken for Radial Deviation and Ulnar Deviation

Data were analyzed using SPSS. Descriptive statistics were presented as mean ± SD. Paired t-tests were used for comparing right and left sides. Pearson's correlation evaluated the relationship between age and wrist deviation. A p-value <0.05 was considered statistically significant.

Results

The mean radial deviation on the right side was 38.76° ± 11.32°, with values ranging from 10° to 68°, indicating substantial variability in individual wrist mobility. The left radial deviation showed a slightly higher mean of 41.18° ± 10.21°, with a minimum of 18° and a maximum of 64°. For ulnar deviation, the right wrist demonstrated a mean ROM of 39.84° ± 11.27°, with recorded values spanning 14° to 70°. The left wrist exhibited a mean of 40.46° ± 10.86°, with a minimum of 20° and a maximum of 74°. The above data are summarized in Table 1.

Paired t-test analysis was performed to compare the range of motion between the right and left wrists for radial and ulnar deviation. The mean radial deviation was 39.76° ± 11.66° on the right side and 40.96° ± 10.22° on the left, with a mean difference of -1.20° (p = 0.351). This difference was not statistically significant, indicating symmetrical radial deviation between the two hands. For ulnar deviation, the mean ROM was 40.18° ± 11.63° on the right and 40.40° ± 11.85° on the left, with a mean difference of -0.22° (p = 0.870). Similarly, this difference was not statistically significant. These results suggest that, in healthy

young females, wrist radial and ulnar deviation are largely symmetrical, with only minor, non-significant variation between the dominant and non-dominant sides (Table 2).

Correlation analysis was conducted to examine the relationship between participants' age and wrist range of motion. A weak but statistically significant negative correlation was observed between age and right radial deviation ($r = -0.243$, $p = 0.015$), indicating that radial deviation on the dominant wrist may slightly decrease with increasing age, even within this young adult cohort (Table 3).

No significant correlations were found for left radial deviation ($r = -0.129$, $p = 0.203$), right ulnar deviation ($r = 0.038$, $p = 0.709$), or left ulnar deviation ($r = 0.038$, $p = 0.712$). These findings suggest that age has minimal effect on wrist ROM in young females, except for a subtle decline in right radial deviation, potentially reflecting early adaptive changes related to functional load or micro strain on the dominant wrist (Table 3).

Table 1: Descriptive Statistics for Wrist Joint ROM (in degrees)

Measurement	N	Mean	SD	Min	Max
Right Radial Deviation	100	38.76	11.32	10	68
Left Radial Deviation	100	41.18	10.21	18	64
Right Ulnar Deviation	100	39.84	11.27	14	70
Left Ulnar Deviation	100	40.46	10.86	20	74

Table 2: Paired Samples t-test (Right vs Left)

Comparison	Mean Right (SD)	Mean Left (SD)	Mean Difference	p-value	Remarks
Radial Deviation	38.76 (11.32)	41.18 (10.21)	–1.20	0.351	Not significant
Ulnar Deviation	39.84 (11.27)	40.46 (10.86)	–0.22	0.870	Not significant

Table 3: Correlation between Age and Wrist ROM

Deviation	Hand	R	p-value	Remarks
Radial	Right	–0.243	0.015	Weak but significant negative correlation
Radial	Left	–0.129	0.203	Not significant
Ulnar	Right	0.038	0.709	Not significant
Ulnar	Left	0.038	0.712	Not significant

Discussion

Goniometric assessment is widely used to evaluate joint positioning and quantify available mobility, serving as an essential component of musculoskeletal evaluation, diagnostic decision-making, and rehabilitation planning [5]. The present study assessed wrist radial and ulnar deviation in 100 healthy young females under standardized testing conditions. Strict exclusion criteria were applied to minimize confounders such as prior trauma, congenital deformity, inflammatory arthritis, or neuromuscular disorders, thereby ensuring that the observed values reflected physiological variability rather than pathological limitation. Wrist mobility is influenced by multiple factors including age, sex, ligamentous laxity, joint geometry, hand dominance, muscular strength, and habitual loading patterns [6–8]. Females generally demonstrate higher joint mobility, attributed to differences in hormonal milieu, collagen structure, and muscle mass [3, 4]. These biological factors may explain the relatively high ROM values observed in our cohort.

The results of the present study revealed higher radial deviation values than those reported by Hetal et al., who demonstrated mean values of 17.20° ± 4.21° (right) and 19.21° ± 4.26° (left) in young females [9]. Our findings, nearly twice as high, may be due to population-specific differences, variation in measurement landmarks, or differences in the angle of goniometer alignment. For ulnar deviation, Hetal et al. reported values of 33.90° ± 6.29° (right) and 36.11° ± 6.10° (left) [9], which were again lower than those observed in our subjects. The consistency in both studies showing higher values on the non-dominant side suggests that reduced functional load on the left wrist may help preserve flexibility. In the study conducted by Katsoulis. P et.al, Radial deviation of wrist joint was 28.5°and Ulnar deviation was 45°.Similarly, Gellman .H et. al, found the value of Radial Deviation to be 15° and Ulnar Deviation was 30° Marshall M.M, et al concluded no significant difference in male and female Range of motion using manual goniometer but they found the gender difference in Range of motion while using electric goniometer. [11,12,13]. The influence of testing posture is well recognized. Spilman and Pinkston noted that ulnar deviation increased when the shoulder was abducted and elbow flexed, emphasizing the need for standardized upper limb positioning [14]. Similar findings were reported by Boone et al., who demonstrated that even minor variations in arm placement can significantly affect wrist ROM measurements [15].

In the present study, left-sided wrist mobility was marginally higher for both movements. This pattern may be explained by: Functional dominance: Dominant hands undergo greater repetitive stress, microtrauma, and muscular tighten-

ing, potentially reducing flexibility over time [6, 7, 10]. Habitual use patterns: Non-dominant wrists are rarely exposed to high-load tasks, preserving ligamentous laxity. Subclinical degenerative tendencies: Early adaptive changes and mild mechanical wear in the dominant wrist may begin even in young adults [7]. The lack of significant difference between radial and ulnar deviation suggests symmetrical biomechanical characteristics in healthy females, which aligns with literature reporting minimal variation in normal wrist coupling motions [16,17]. A weak negative correlation between age and radial deviation on the dominant side, though small, may indicate early onset adaptations associated with occupational, athletic, or daily mechanical load.

Taken together, the findings contribute normative data for wrist deviation in young Nepali females, which may be clinically valuable in diagnosing ligamentous injuries, post-fracture stiffness, and rehabilitative progress. Further multicentric studies with larger sample sizes and comparison across age groups are recommended to strengthen normative datasets.

This study has some limitations. The study design is observational. Causality for differences observed cannot be established, only associated.

Conclusion

This study demonstrated that the ROM of radial and ulnar deviation in healthy young females is similar between both hands, with slightly higher values observed in the left wrist; however, these differences were not statistically significant. For clinical practice, the mean value (~40°) can serve as a reference for “typical” ROM in a young adult population, but the wide standard deviation emphasizes the importance of using the unaffected side as the best baseline for each individual patient. So, Goniometric measurement remains a simple and valuable method for assessing wrist flexibility and establishing normative data for clinical use.

Acknowledgement: None

Conflict of interest

The authors declare that there is no conflict of interest regarding the publication of this study.

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