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Ergonomic Risk Assessment of Smartphone Users Using the RULA Tool in College-Going Students

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Abstract

Background: Smartphone use has become highly prevalent among college students and is often associated with prolonged static postures and awkward neck, trunk, and upper-limb positions, which may contribute to musculoskeletal discomfort. Assessing ergonomic risk in smartphone users is important for understanding its relationship with musculoskeletal symptoms.

Objective: To assess ergonomic risk among smartphone users using the Rapid Upper Limb Assessment (RULA) tool and to determine its correlation with musculoskeletal disorders in college-going students.

Methods: A correlational study was conducted among **101 college-going students** aged **18–25 years**. Ergonomic risk was assessed using the **RULA tool**, and musculoskeletal symptoms were evaluated using the **Modified Nordic Musculoskeletal Questionnaire**. Statistical analysis was performed to examine the association between RULA score and Nordic musculoskeletal score.

Results: The mean age of participants was **19.93 ± 1.38 years**. The mean **RULA score** was **3.78 ± 0.79**, indicating that most students were in the low to moderate ergonomic risk category. The mean **Nordic score** was **30.77 ± 6.55**. The **neck** was the most commonly affected region (**33.7%**), followed by the **upper back (27.7%)** and **both shoulders (17.8%)**. Spearman's correlation analysis showed a **weak positive, non-significant correlation** between RULA score and Nordic score (**rho = 0.131, p = 0.192**). A weak but statistically significant positive correlation was found between **BMI and RULA score** (**rho = 0.203, p = 0.042**).

Conclusion: Most college-going smartphone users demonstrated low to moderate ergonomic risk, with neck and upper-back symptoms being the most common musculoskeletal complaints. However, no significant correlation was found between overall ergonomic risk and musculoskeletal disorder score. These findings highlight the importance of ergonomic awareness and preventive strategies for smartphone users.

Keywords: Smartphone, RULA, ergonomics, musculoskeletal disorders, college students, posture

Introduction

Smartphones have become an essential part of daily life, especially among young adults. Their portability and accessibility have led to increased use for communication, social networking, entertainment, and academic work. College students form one of the major user groups and often spend prolonged hours on smartphones in a variety of postures.

Extended smartphone use has been associated with musculoskeletal discomfort and disorders due to sustained neck flexion, trunk flexion, shoulder protraction, elbow flexion, and wrist deviation. These postures may place continuous stress on muscles, ligaments, tendons, and joints, particularly in the cervical spine and upper limbs. Previous studies have reported a high prevalence of musculoskeletal complaints among smartphone users, commonly affecting the neck, shoulders, back, and wrists.

Several ergonomic tools are available to assess postural risk in activities involving upper-limb use. The Rapid Upper Limb Assessment (RULA) tool is an observation-based screening method used to evaluate postural loading on the neck, trunk, and upper limbs, along with muscle use and force. It is inexpensive, simple to administer, and suitable for identifying levels of ergonomic risk. Although RULA has been widely used in other occupational and device-related settings, its application to smartphone users remains limited.

Musculoskeletal disorders among smartphone users are increasingly recognized as an important public health concern. Since college students frequently adopt non-neutral postures while using smartphones, it is necessary to assess their ergonomic risk and determine whether this risk is associated with musculoskeletal symptoms. This study therefore aims to evaluate ergonomic risk in smartphone users using the RULA tool and examine its correlation with musculoskeletal disorders in college-going students.

Need for the Study

The rapid rise in smartphone usage has brought increasing concern regarding associated musculoskeletal problems. Smartphone users range from students to working adults and older individuals, but young adults are among the most intensive users. Prolonged use often involves static and awkward postures that may contribute to discomfort and long-term musculoskeletal issues.

Although RULA is a recognized tool for assessing postural risk in users of information technology devices, it has not been widely applied specifically to smartphone users in student populations. In addition, previous studies have not sufficiently explored the correlation between ergonomic risk level and musculoskeletal symptoms in college-going students. Therefore, this study is needed to assess ergonomic risk using RULA and to examine its relationship with musculoskeletal disorders among smartphone users.

Research Question

What is the level of ergonomic risk in smartphone users, and what is its correlation with musculoskeletal disorder in college-going students?

Aim and Objectives

Aim

To assess the level of ergonomic risk in smartphone users and to evaluate its correlation with self-reported musculoskeletal disorders in college-going students.

Objectives

1. To evaluate smartphone users in college-going students using the RULA tool.
2. To evaluate musculoskeletal disorders in smartphone users using the Modified Nordic Musculoskeletal Questionnaire.
3. To determine the correlation between the level of ergonomic risk and musculoskeletal disorders in smartphone users among college-going students.

Hypothesis

Null Hypothesis (H0)

There is no significant correlation between the level of ergonomic risk and musculoskeletal disorder in smartphone users among college-going students.

Alternate Hypothesis (H1)

There is a significant correlation between the level of ergonomic risk and musculoskeletal disorder in smartphone users among college-going students.

Review of Literature

Previous literature suggests that smartphone use is associated with poor posture and musculoskeletal symptoms, particularly in the neck and upper limb regions. Namwongsa et al. reported that ergonomic risk assessment using RULA may provide clinically useful information for practitioners treating smartphone users with neck pain. Their work also emphasized the importance of posture-related educational interventions.

Studies exploring factors associated with neck disorders in university student smartphone users have highlighted prolonged neck flexion and related behavioral factors as important contributors. Kim and colleagues found a relationship between smartphone use and subjective musculoskeletal symptoms among university students, underscoring the need for preventive strategies and improved use habits.

Dennerlein et al. described the ergonomics of mobile computing technology as an evolving area that requires further research. Other studies have shown that RULA can be a useful screening tool even after brief assessor training. The Nordic Musculoskeletal Questionnaire has also been widely used as a standardized method for assessing musculoskeletal symptoms across body regions.

Together, the literature indicates that smartphone-related posture may contribute to musculoskeletal symptoms and that validated tools such as RULA and the Nordic Musculoskeletal Questionnaire can help evaluate these risks. However, more focused research is needed in college-going populations.

Materials and Methods

Study Design

Correlational study.

Study Setting

Uka Tarsadia University, Bardoli-Mahuva Road, District Surat, Gujarat, India.

Study Population

College-going students of Uka Tarsadia University, Gujarat.

Sample Size

More than 100 students.

Sampling Method

Convenient sampling.

Materials Required

- Pen
- Paper
- Smartphone
- Stopwatch
- Desk
- Chair
- RULA scale
- Nordic questionnaire

Eligibility Criteria

Inclusion Criteria

1. Young adults aged 18–25 years.
2. Owners of a smartphone.
3. At least 6 months of experience using smartphones.
4. Daily smartphone use of at least 2 hours per day.

Exclusion Criteria

1. History of traumatic injuries or surgical interventions in relevant regions within the past year, such as whiplash injury.
2. Medical conditions negatively affecting the spine and upper extremities, such as deformity.
3. Chronic musculoskeletal diseases such as rheumatoid arthritis, osteoarthritis, or connective tissue disorders including fibromyalgia.
4. Neurological or orthopedic disorders, as well as sensory deficits.
5. Visual problems not corrected by glasses, dizziness, or vertigo.
6. Consumption of sedative drugs or alcohol within the past 48 hours.

Outcome Measures

1. Rapid Upper Limb Assessment (RULA)

RULA is an ergonomic assessment tool developed to evaluate exposure to risk factors associated with upper extremity musculoskeletal disorders. It assesses posture, muscle use, and force/load requirements affecting the neck, trunk, and upper extremities. A single-page worksheet is used to score body posture, repetition, and force.

Scores are assigned separately for:

- Arm and wrist analysis
- Neck, trunk, and leg analysis

These scores are combined to generate a final score representing the level of musculoskeletal disorder risk.

Interpretation of RULA Score

- **1**: Negligible risk, no action required
- **2–3**: Low risk, change may be needed
- **4–7**: Medium risk, further investigation and change soon
- **8–10**: High risk, investigate and implement change
- **11+**: Very high risk, implement change immediately

2. Modified Nordic Musculoskeletal Questionnaire

The Modified Nordic Musculoskeletal Questionnaire is a standardized instrument used to detect musculoskeletal symptoms in body regions such as the neck, shoulders, elbows, wrists/hands, upper back, lower back, hips/thighs, knees, and ankles/feet.

It includes questions about:

- Symptoms during the last 12 months
- Symptoms during the last 7 days
- Functional impact
- Duration of symptoms
- Professional assessment
- Relevant history of musculoskeletal problems

Scoring

- **A**: No pain = 1 point
- **B**: Moderate pain = 2 points
- **C**: Pain = 3 points
- **D**: Very painful = 4 points

Procedure

Ethical clearance will be obtained from the institutional ethics committee before commencement of the study. Participants meeting the inclusion and exclusion criteria will be selected. The nature and purpose of the study will be explained clearly, and written informed consent will be obtained from each participant.

Participants will then undergo:

1. Assessment of ergonomic risk using the RULA scale.
2. Assessment of musculoskeletal symptoms using the Modified Nordic Musculoskeletal Questionnaire.
3. Statistical analysis to determine the correlation between ergonomic risk level and musculoskeletal disorder scores.

RULA Assessment Procedure

The RULA worksheet will be used to assess:

- Upper arm position
- Lower arm position
- Wrist position and twist
- Neck position
- Trunk position
- Leg position
- Muscle use
- Force/load

The final RULA score will indicate the participant's ergonomic risk level.

Nordic Questionnaire Assessment Procedure

Participants will complete the Modified Nordic Musculoskeletal Questionnaire to identify symptoms in relevant body regions and the severity of musculoskeletal complaints.

Statistical Analysis

Statistical analysis will be performed using IBM SPSS version 20. Based on the normality of the data distribution, an appropriate correlation test will be applied. The level of significance will be set at $p < 0.05$.

Results

A total of **101 college-going smartphone users** were included in the analysis. Among them, **54 (53.5%) were male** and **47 (46.5%) were female**. The mean age of the participants was **19.93 ± 1.38 years**. The mean BMI was **21.99 ± 4.20 kg/m²**. Average daily smartphone screen time was **2.26 ± 1.17 hours**, while the mean total phone-use time was **4.98 ± 1.57 hours**.

The mean **Nordic musculoskeletal score** was **30.77 ± 6.55**, with observed scores ranging from **24 to 56**. The mean **RULA score** was **3.78 ± 0.79**, with scores ranging from **3 to 7**. Distribution of RULA scores showed that **39 participants (38.6%)** had a score of **3**, **50 (49.5%)** had a score of **4**, **8 (7.9%)** had a score of **5**, **3 (3.0%)** had a score of **6**, and **1 (1.0%)** had a score of **7**. Thus, most participants fell within the **low to moderate ergonomic risk range**, indicating that further investigation and postural modification may be needed in a substantial proportion of students.

Analysis of regional musculoskeletal symptoms from the Nordic data showed that the **neck** was the most commonly affected region (**33.7%**), followed by the **upper back (27.7%)**, **right shoulder (17.8%)**, **left shoulder (17.8%)**, **left wrist/hand (13.9%)**, and **lower back (10.9%)**.

Because both RULA and Nordic scores were non-normally distributed, correlation analysis was interpreted using a non-parametric approach. **Spearman's correlation showed a weak positive correlation between RULA score and Nordic score (rho = 0.131), which was not statistically significant (p = 0.192).** Therefore, the study did **not** demonstrate a significant association between overall ergonomic risk level and total musculoskeletal disorder score in this sample.

Gender-wise comparison showed no significant difference between males and females in **Nordic score (p = 0.416)** or **RULA score (p = 0.702)**. However, females had significantly higher total phone-use time than males (**p = 0.002**), and age also differed significantly between the two groups (**p < 0.001**).

A weak but statistically significant positive correlation was observed between **BMI and RULA score** (**rho = 0.203, p = 0.042**). Correlations of screen time, total phone-use time, and age with Nordic or RULA scores were not statistically significant.

Discussion

The present study assessed ergonomic risk among smartphone users using the RULA tool and examined its association with self-reported musculoskeletal symptoms in college-going students. Most participants had **RULA scores of 3 or 4**, indicating that a large proportion of students were exposed to **low to moderate postural risk**, suggesting that further observation and ergonomic correction may be needed. RULA is widely used as a rapid observational method to evaluate postural loading on the neck, trunk, and upper limbs during task performance [5].

In this study, the **neck** was the most commonly affected body region, followed by the **upper back** and **shoulders**. This symptom pattern is consistent with previous studies on smartphone users. Namwongsa et al. reported that neck complaints were highly prevalent among smartphone users and that posture-related factors played an important role in symptom development[1]. Similarly, Kim and Kim found that university students with smartphone use commonly reported musculoskeletal symptoms in the **neck and shoulder regions**, supporting the idea that prolonged smartphone use contributes to discomfort in these body areas[3].

Although the regional symptom pattern in the present study is in agreement with previous literature, the **correlation between total RULA score and total Nordic score was weak and not statistically significant**. This indicates that, in this sample, a higher overall ergonomic risk score did not necessarily correspond to a greater overall musculoskeletal symptom burden. One possible explanation is that musculoskeletal symptoms

related to smartphone use are **multifactorial**. In addition to posture, factors such as duration of use, frequency of breaks, device-handling behavior, physical fitness, stress, and individual pain sensitivity may influence symptom development [3,1].

This result differs from the findings of Namwongsa et al., who observed significant relationships between smartphone-use posture assessed by RULA and neck musculoskeletal disorders, especially for the **neck, trunk, and leg components** of the assessment [Namwongsa et al., 2018a]. A likely reason for this difference is the method of analysis. Their study focused more specifically on posture-related risk in relation to **neck disorders**, whereas the present study examined the relationship between the **overall RULA score** and the **total Nordic musculoskeletal score**. Because the Nordic score includes multiple body regions, a true association with one particular region, especially the neck, may be diluted when summed into a total score.

Another important observation from the present study is that females had significantly greater total phone-use time than males, but there was **no significant gender difference** in RULA or Nordic scores. This suggests that longer duration of phone use alone may not always result in worse posture scores or higher symptom severity. It is possible that posture variability, rest periods, method of holding the device, and individual adaptation affect the development of symptoms more than total use time alone [Dennerlein et al., 2015].

A weak but statistically significant positive correlation was found between **BMI and RULA score**, suggesting that participants with higher BMI tended to demonstrate slightly greater ergonomic risk. Although the association was small, it may indicate that body composition affects posture during smartphone use, possibly through altered trunk alignment or upper-limb positioning. This finding should be interpreted cautiously, but it may be worth exploring further in future studies with larger samples.

Overall, the findings of the present study suggest that while smartphone users commonly experience symptoms in the **neck, upper back, and shoulder regions**, the association between **overall ergonomic risk** and **overall musculoskeletal symptom score** may not be strong in all student populations. Nevertheless, the high frequency of neck and upper-back symptoms remains clinically important. The findings support the need for ergonomic education, posture correction strategies, and awareness about limiting sustained non-neutral postures during smartphone use [Kim & Kim, 2015; Namwongsa et al., 2018b].

In summary, the present study does not support a significant correlation between **total RULA score** and **total Nordic musculoskeletal score** in college-going smartphone users. However, the symptom distribution observed in this sample is consistent with previous evidence showing that smartphone use is associated with discomfort, particularly in the **neck and upper back**. Preventive interventions focusing on posture and safe smartphone-use habits may therefore still be beneficial in this population[7].

Limitation

- The study used a cross-sectional design, which helps identify association but does not establish causality.
- The sample size was relatively limited, which may reduce the wider generalizability of the findings.

- The study evaluated overall ergonomic risk and total musculoskeletal score, so region-specific associations may not have been fully explored.

Future Recommendations

1. Future studies should include a **larger sample size** from multiple colleges or universities to improve generalizability.
2. Further research should analyze **region-wise correlations** such as neck, shoulder, and upper back symptoms with specific RULA components rather than only total scores.
3. Longitudinal or interventional studies should be conducted to evaluate whether **ergonomic training, posture correction, and reduced smartphone exposure** can decrease musculoskeletal symptoms over time.

Clinical Implications

1. The study highlights the need for **early ergonomic screening** in college students who use smartphones for prolonged periods.
2. Physiotherapists and healthcare professionals can use these findings to provide **postural education, ergonomic advice, and preventive exercises** for the neck, shoulder, and upper back.
3. Awareness programs on **safe smartphone use habits**, including frequent breaks and proper posture, may help reduce the risk of developing musculoskeletal discomfort in young adults.

Ethical Considerations

Ethical clearance will be obtained from the institutional committee. Written informed consent will be taken from all participants before data collection. Participant confidentiality and voluntary participation will be maintained throughout the study.

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