DOI: 10.7860/JCDR/2026/82858.22365

Original Article

Physiotherapy Section

Comparative Analysis of Mobile versus Personal Computer Gaming on Neck Posture and Pain: A Cross-sectional Study

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ABSTRACT

Introduction: Increased screen time, especially for gaming, causes postural alterations such as rounded shoulders and Forward Head Posture (FHP) which can lead to neck pain. Altogether, this poor posture and screen time raise concerns about musculoskeletal issues. Mobiles and Personal Computers (PCs) are the main gaming devices; hence research into their different effects on posture and musculoskeletal health is necessary.

Aim: To observe the difference between neck pain and Craniovertebral (CV) angle among PC and mobile gamers.

Materials and Methods: The present cross-sectional study conducted at Galgotias University, Greater Noida, Uttar Pradesh, India, included 45 right-handed participants residing in hostels from September 2023 to December 2024. Based on primary gaming modality and screen usage frequency, participants were divided into three groups: group A (n=15) comprised PC gamers and group C (n=15) comprised mobile gamers and group B (n=15) comprised non-gamers. Participants in group A and group C underwent 30-minute gaming sessions daily for one week with a 6-day habituation period to minimise adaptation effects. Final data collection was performed on the 7th day to obtain stable postural responses. During the 30-minute gaming session on 7th day, lateral photographs were captured every five minutes to assess CV and thoracic angles using MB RULER software. Markers for anatomical reference were placed at the tragus, C7, and thoracic vertebrae. The Numeric Pain Rating Scale (NPRS) was used to assess neck pain. Statistical Package for Social Sciences (SPSS) version 27.0 was utilised for data analysis. groups were compared using One-way Analysis of Variance (ANOVA), and correlations were assessed with Pearson correlation, considering a p-value <0.05 as statistically significant.

Results: The average age of the participants were 20.78±0.72 years and a Body Mass Index (BMI) of 24.87±4.61. Non-gamers had the most favourable CV angle (47.46°±1.63), compared to PC gamers (44.70°±1.13) and mobile gamers (42.76°±0.75), with the differences being statistically significant (p<0.001**). Similarly, non-gamers reported the lowest neck pain score (1.5±0.45), compared to 6.87±0.77 in PC gamers and 7.01±0.63 in mobile gamers (p<0.001**). No statistically significant difference in pain was observed between the two gaming groups (p=0.74) There was a positive correlation between the gaming duration and the deviation in the CV angle (r=0.72, p<0.001**) and with the level of pain experienced (r=0.65, p<0.001**) which were statistically significant.

Conclusion: According to the present study results,Mobile devices are not suitable for gaming because they put more strain on the cervical spine and enhance the risk of neck pain and FHP.

Keywords: Craniovertebral angle, Digital gaming, Ergonomics, Musculoskeletal pain

INTRODUCTION

Maintaining musculoskeletal health requires proper posture, as it minimises pain, discomfort, and functional limitations. Proper Posture is achieved through coordinated muscular activity that ensures proper spinal alignment during both dynamic movements and static positions. In maintaining spinal curvatures- cervical lordosis, thoracic kyphosis, and lumbar lordosis- promotes optimal alignment of the head, shoulders, and hips, ensuring functional efficiency and even load distribution across the skeletal system [1,2]. However, increasingly sedentary lifestyles and excessive screen use, particularly for digital gaming, make maintaining good posture more challenging. Prolonged screen time, especially among adolescents and young adults, is associated with sustained poor posture and muscular imbalance, most commonly affecting the cervical and thoracic spine [1,2].

One of the most prevalent postural issues linked to gaming is FHP, characterised by anterior displacement of the head relative to the body's vertical axis, which increases mechanical strain on the cervical spine and associated musculature [1,2]. This posture can lead to muscle imbalances, joint dysfunction, and neck pain. Corrective strategies, such as cervical mobilisation and exercises targeting deep cervical flexors, have demonstrated effectiveness in improving postural alignment and reducing discomfort [3-5]. Long gaming durations, particularly when performed while seated in slouched positions, contribute to muscle fatigue, neck pain, and sensory dysfunction [6-8]. Evidence suggests that early intervention through structured programs involving strengthening, flexibility, and motor control exercises can mitigate these issues [9].

With the rising use of mobile and computer devices, postural problems and associated discomfort are becoming increasingly prevalent, especially in youth populations [10]. Habits formed during this developmental stage may persist into adulthood, reinforcing postural deviations. Emerging technologies, such as virtual reality and posture-correction tools, have shown promise in addressing these musculoskeletal issues [11,12].

In addition to physical effects, gaming has been linked to psychological concerns, including anxiety and depression, which may be interlinked with physical discomfort [13,14]. Adolescents are particularly vulnerable due to the combined influence of screen time, poor posture, and ongoing physical development [15]. Evidence highlights the need for integrated behavioural, ergonomic, and psychological interventions to mitigate the adverse health impacts of gaming [16,17]. Postural deviations associated with gaming, such as "tech neck," may affect daily functioning and academic performance [18,19], although real-time feedback technologies have demonstrated potential for correction [20].

While previous studies [1,2,13-15] have examined posture and screen time, none have directly compared PC and mobile gaming regarding text neck or FHP. Therefore, The present study addresses this gap by assessing neck pain and CV angle across both platforms to identify device-specific postural concerns in young gamers.

MATERIALS AND METHODS

The present cross sectional Study included 45 right-handed participants residing in Delhi-NCR hostels, India. Ethical clearance was obtained from the Institutional Ethics Committee prior to the commencement of the study (IEC NO- 5/BPT 2019-2023). The study was conducted in Galgotias University, Greater Noida, India, from September 2023 to December 2024. Sample size was calculated from G*Power considering an alpha level of 0.05 and a power (1-β) of 0.80. with effect size of 0.40 [21].

All the participants provided informed consent prior to participation. Demographic and musculoskeletal assessments - including age, weight, height, BMI were conducted before participants were categorised into one of three groups based on predefined inclusion and exclusion criteria.

Based on primary gaming modality and screen usage frequency, participants were divided into three groups: group A (n=15) comprised of PC gamers and group C (n=15) comprised of mobile gamers and group B (n=15) comprised of non-gamers.

Inclusion criteria: Participants were required to be right-handed, aged 18-25 years, and self-report at least four hours of daily screen time on either PC or mobile devices, with the majority of this time dedicated to gaming. Only hostellers were selected to ensure uniformity in environmental and lifestyle factors. Participants must not have received physiotherapy or postural correction exercises and should not have experienced a musculoskeletal injury in the last six months. An equal number of non-gamers were included which served as the control group.

Exclusion criteria: Participants with congenital or acquired postural deficits (e.g., scoliosis or torticollis), musculoskeletal or neurological conditions (e.g., cerebral palsy or cervical spondylosis), day scholars, those who had taken painkillers or muscle relaxants in the past three months, or individuals using posture-related assistive devices (e.g., cervical collars, neck-mounted VR headsets, or spinal braces) were excluded.

Study Procedure

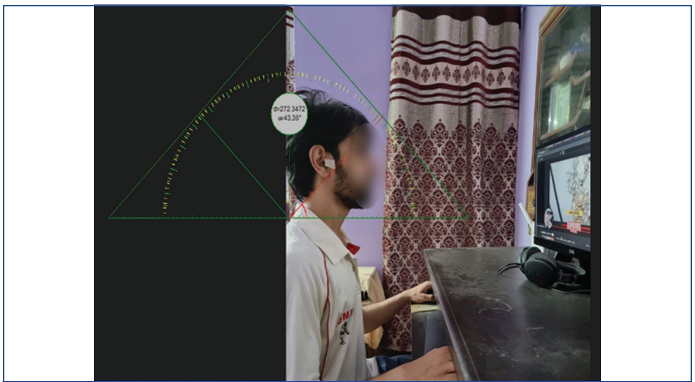
Participants were seated on a standardised stool without armrests or back support. group A used 21-inch Full High Definition (HD) monitors positioned at eye level, 60 cm from the eyes; group C used identical 6.5-inch smartphones provided by the investigator; group B remained seated without device use. Each session lasted 30 minutes, representing a typical uninterrupted duration sufficient to detect postural changes without fatigue interference. Participants followed this protocol daily for one session of 30 minutes in a day for seven days, with a 6-day habituation period to minimise adaptation effects. Final data collection was performed on the 7th day to obtain stable postural responses.

During 30 min session of 7th day, lateral photographs were captured at 5-minute intervals using a high-resolution (24.2 MP DSLR) camera mounted on a tripod positioned 1.5 meters from the participant's side. The camera focused on the acromion process to ensure consistent posture capture. CV angle was assessed by using validated photographic methods by two qualified Physiotherapists, with inter-and intra-rater reliability (ICC > 0.85).

The CV angle was defined as the angle formed between a line connecting C7 (seventh cervical vertebrae) to the tragus of the ear and a horizontal line passing through the spinous process of C7" [21].

For postural assessment, three anatomical markers were placed at the tragus of the ear, the C7 spinous process, and a thoracic vertebra, following established photographic protocols for CV angle measurement [22]. These landmarks enabled the calculation of CV angle using MB Ruler software (Markus Bader, Iffezheim, Germany), a validated digital tool allowing precise angular measurement on images (ICC>0.85) [Table/Fig-1,2] [23]. This setup ensured standardised, repeatable assessment of postural deviations.

[Table/Fig-1]: Craniovertebral (CV) angle and thoracic angle using MB Ruler software; Showing Angle during mobile usage.



[Table/Fig-2]: Craniovertebral (CV) angle and thoracic angle using MB Ruler software; Showing Angle during PC usage.

Neck pain intensity was assessed using the Numerical Pain Rating Scale (NPRS), an 11-point scale ranging from 0 ('no pain') to 10 ('worst imaginable pain'), where participants select the number best represents their pain. The NPRS is widely used in clinical and research settings and has demonstrated good reliability and validity [24].

STATISTICAL ANALYSIS

Data were analysed using SPSS 27.0. Normality was tested with the Shapiro-Wilk test, and as assumptions were met, One-way ANOVA with post-hoc analysis was applied. Pearson correlation assessed relationships between gaming duration, posture, and pain. Significance was set at p<0.05.

RESULT

Baseline variables (age, weight, height, and BMI) were comparable across groups, indicating baseline homogeneity [Table/Fig-3]. Average daily gaming duration was 4.65±0.60 hours for PC gamers, 5.20±0.70 hours for mobile gamers and 0.85±0.30 hours for non-gamers p<0.001**.

Significant differences were found for CV angle and neck pain (p<0.001**) among the three groups. Non-gamers had the most favourable posture (47.46±1.63°), and lowest pain scores (1.5±0.45), followed by PC gamers (44.70±1.13°, pain: 6.87±0.77), while mobile gamers showed the greatest postural deviation (42.76±0.75°) and highest pain (7.01±0.63) [Table/Fig-4].

Post-hoc analysis confirmed significant differences in CV angle across all groups (p<0.001). Also, mobile gamers had significantly poorer posture than both PC gamers and non-gamers (p<0.001). PC and mobile gamers both played significantly longer than non-gamers, though no difference was found between PC and mobile gamers in gaming duration (p=0.072) or pain (p=0.74) [Table/Fig-5].

Variables	Group A (PC Gamers) (Mean±SD, n=15)	Group B (Non-Gamers) (Mean±SD, n=15)	Group C (Mobile Gamers) (Mean±SD, n=15)	p-value
Age (Years)	20.78±0.72	20.75±0.70	20.80±0.75	0.97
Weight (Kg)	71.83±0.93	71.50±1.00	72.00±1.10	0.85
Height (m)	1.71±0.82	1.71±0.03	1.72± 0.025	0.89
BMI (kg/m²)	24.82±4.76	24.70±4.50	25.10±4.60	0.92
Gaming Duration (hours/day)	4.65±0.60	0.85±0.30	5.20±0.70	<0.001*

[Table/Fig-3]: Demographic data.
Shapiro-Wilk test was used for normality; *Significant Difference; Kg: Kilograms; m: meter; N: Number of participants; SD: Standard Deviation

Variables	Group A (PC Gamers) (Mean±SD, n=15)	Group B (Non-Gamers) (Mean±SD, n=15)	Group C (Mobile Gamers) (Mean±SD, n=15)	p-value
Craniovertebral (CV) Angle (Mb Rular)	44.70±1.13	47.46±1.63	42.76±0.755	<0.001*
Numeric Pain Rating Scale (NPRS)	6.87±0.77	1.5±0.45	7.01±0.63	<0.001*

[Table/Fig-4]: Craniovertebral (CV) angle and NPRS Scores: One-way ANOVA results across groups.
*Significant Difference; Kg: Kilograms; m: meter; N: Number of participants; S.D: Standard Deviation; p-values obtained using One-way ANOVA.

Variables	Group Comparison	Mean difference (MD)	p-value
Gaming duration (hours/day)	Group A vs Group B	3.80	<0.001*
	Group A vs Group C	-0.55	0.072
	Group B vs Group C	-4.35	<0.001*
CV angle	Group A vs Group B	-2.76	<0.001*
	Group A vs Group C	1.94	<0.001*
	Group B vs Group C	4.70	<0.001*
NPRS	Group A vs Group B	5.37	<0.001*
	Group A vs Group C	-0.14	0.74
	Group B vs Group C	-5.51	<0.001*

[Table/Fig-5]: Post-hoc analysis for gaming duration, CV angle and NPRS.
*Significant Difference

Pearson's correlation analysis showed positive correlations between gaming duration and CV angle deviation (r=0.728) as well as pain intensity (r=0.657) [Table/Fig-6], suggesting prolonged gaming especially mobile negatively impacts posture and increases discomfort.

Variables Correlated	Pearson's r	r^2 (Variance Explained)	p-value
GD vs CV	0.728	0.530 (53.0%)	<0.001*
GD vs NP	0.657	0.432 (43.2%)	<0.001*

[Table/Fig-6]: Correlation between daily gaming duration, Craniovertebral (CV) angle, and pain scores.
GD: Gaming duration; CV: CV Angle deviation; NP: Neck pain intensity (NPRS Score)

DISCUSSION

The present study aimed to investigate prolonged gaming effect on posture and neck pain by evaluating the CV angle and pain intensity in mobile gamers, PC gamers, and non-gamers. The findings revealed significantly reduced CV angles and higher neck pain scores among gamers compared to non-gamers. Mobile gamers exhibited the most pronounced postural deviation (42.76±0.76°) and highest pain scores (7.01±0.63), followed by PC gamers, whereas non-gamers maintained better cervical alignment (47.46±1.63°) and minimal pain (1.5±0.45). These findings suggest that prolonged screen exposure, particularly on mobile devices, is a key factor contributing to FHP and increased musculoskeletal discomfort.

Post-hoc analysis further indicated that mobile gamers had the lowest CV angle compared to PC gamers (p<0.001**) and non-gamers (p<0.001**). Both gaming groups exhibited significant higher pain scores than non-gamers (p<0.001**). Moreover, gaming duration showed positive correlations with neck pain (r=0.657, p<0.001**) and CV angle deviation (r=0.728, p<0.001**).

These findings are consistent with previous research. Jaroenrungsup Y et al., concluded that posture is a proportionally related to smartphone usage, while Cankurtaran F et al., found that gaming addiction increases musculoskeletal issues in youth [1,7]. Collectively, these studies support the notion that extended device usage contributes to cervical malalignment and pain. Lee S et al., concluded that using a smartphone in a downward gaze position enhances cervical flexion and leads to increase muscle fatigue and pain in the neck and shoulder muscles, specifically in the cervical erector spinae and upper trapezius, compared to more neutral postures [25]. Torkamani MH et al., reported that regular mobile device use with neck flexion increases habitual FHP and imposes greater load on cervical articulators [26]. Additionally, research has shown that gaming sessions of around 16 minutes lead to neck and trunk pain; however, these issues have been encountered lately in PC gamers [27].

Beyond musculoskeletal loading, recent studies indicate that device handling and screen positioning directly affect neuromuscular control and proprioception. Song D et al., reported that prolonged cervical flexion impairs cervical joint position perception, predisposing people to unstable posture [28]. These findings provide a mechanistic explanation for the early onset of musculoskeletal issues in gamers, particularly mobile users. Prolonged exposure to handheld devices has also been shown to alter thoracic curvature and scapular kinematics, further exacerbating neck strain [29]. These broader biomechanical adaptations reveal that the effects of gaming transcend the cervical spine alone.

Another contributing factor to higher pain and lower CV angles observed in mobile gammers is habitual use: Gamers use mobile devices for shorter duration but with high frequency compared to PC devices, which are typically used in a seated, semi-ergonomic position. This frequent usage of mobile devices may exacerbate postural abnormalities, resulting in cumulative musculoskeletal strain without adequate recovery [30-33]. Previous researches have similarly highlighted this behavioural pattern, reporting that mobile gaming is significantly associated with physical complaints than PC gaming [30-33]. Together, these findings align with the study results and highlight how both biomechanical and behavioural factors influence musculoskeletal health in gamers.

Limitation(s)

The present study is limited by narrow demographics, small sample size, and generalisability (individual gaming duration information). Only daily gaming duration was considered, while total screen time was not accounted for, which could have acted as a potential confounder influencing posture and pain outcomes. Moreover, the limited 30-minute game duration can understate long-duration usage of gaming device on postural consequences. Future studies can use longitudinal designs with larger and more heterogeneous population, and apply objective measures like time-tracking apps and tools that measure the changes more precisely.

CONCLUSION(S)

The study concluded significant differences in CV angle and neck pain between PC gamers, mobile gamers, and non-gamers. Mobile gaming has a greater impact on postural deviation and associated pain; however, relative to mobile gamers, PC gaming moderately affects FHP and pain levels. Thus, gamers should prefer PC devices for gaming over mobile devices while maintaining good posture and undergoing regular assessments.

Authors' contribution: MF and H: Contributed to data collection, subject recruitment, and literature review; SA and SZ: Supervised the research methodology and statistical analysis; NM and NH:

Contributed to clinical interpretation and occupational health perspectives; KA: Conceptualised the study, supervised the entire research process, interpreted results, and finalised the manuscript.

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PLAGIARISM CHECKING METHODS: [Jain H et al.]
- Plagiarism X-checker: Aug 25, 2025
- Manual Googling: Oct 18, 2025
- iThenticate Software: Oct 21, 2025 (4%)

ETYMOLOGY: Author Origin

EMENDATIONS: 7

AUTHOR DECLARATION:
- Financial or Other Competing Interests: None
- Was Ethics Committee Approval obtained for this study? Yes
- Was informed consent obtained from the subjects involved in the study? Yes
- For any images presented appropriate consent has been obtained from the subjects. Yes

Date of Submission: **Aug 20, 2025**
Date of Peer Review: **Sep 04, 2025**
Date of Acceptance: **Oct 23, 2025**
Date of Publishing: **Feb 01, 2026**