MAJALAH ILMIAH FISIOTERAPI INDONESIA

ORIGINAL ARTICLE

Volume 13, Number 1 (2025), Page 114-120
P-ISSN 2303-1921, E-ISSN 2722-0443

# Forward Head Posture, Musculoskeletal Disorders, and Gaming Habits: A Cross-Sectional Study in Magelang City

**Ana Amaliya Fitri[1], Isnaini Herawati[2*]**
[1,2]Department of Physiotherapy, Faculty of Health Sciences, Universitas Muhammadiyah Surakarta
*Corresponding author: ih166@ums.ac.id

**Submitted: 23 April 2025 | Accepted: 27 April 2025 | Published: 29 April 2025**
**DOI:** https://doi.org/10.24843/mifi.2025.v13.i01.p20

## Abstract

**Introduction:** The rapid growth of esports has increased the risk of postural disorders, notably Forward Head Posture (FHP), due to prolonged video game playing sessions. Playing video games often requires sustained neck flexion to view lower-positioned objects. This leads to poor posture and subsequently the development of FHP, characterized by the head being misaligned with the shoulders. If left unaddressed, FHP can predispose individuals to neck pain and musculoskeletal disorders.
**Methods:** This observational study employed a cross-sectional design and was conducted among esports athletes in Magelang City between August and October 2024. The study population consisted of adolescents and adults actively participating in esports communities in the city. A total of 99 participants met the inclusion and exclusion criteria. Forward Head Posture was assessed using photogrammetry, while neck pain intensity was measured using the Numeric Rating Scale. Data were analyzed using Spearman's Rho correlation test.
**Results:** Spearman's Rho analysis indicated no significant relationship ($p > 0.05$) between FHP, musculoskeletal disorders, duration of playing, and playing time.
**Conclusion:** Forward Head Posture and musculoskeletal disorders among esports athletes in Magelang City were not significantly associated with the duration and frequency of video game playing.

**Keywords:** Forward Head Posture, video games, neck pain, playing duration

## Introduction

The rapid advancement of technology, particularly on the internet, has significantly impacted various aspects of life, including digital entertainment such as video games.[1] Video games have evolved into one of the largest entertainment industries, surpassing the music and film industries.[2] According to the Newzoo Global Games Market Report, approximately 3.3 billion people worldwide engage in gaming activities, with 53% originating from the Asia-Pacific region.[3] In Indonesia, the number of gamers was estimated to have reached 60 million, with projections suggesting an increase to 100 million by 2020.[4] One of the most prominent trends is the emergence and growth of esports, referring to professional video game competitions.[5]

The increasing amount of time spent playing video games has raised concerns regarding players' health, particularly affecting the musculoskeletal system. Playing video games typically involves neck flexion to view lower-positioned objects, requiring players to maintain this posture for extended periods.[6] Such positions may result in poor posture, potentially leading to disorders such as Forward Head Posture (FHP), a condition where the head is not aligned with the shoulders.[6] If unaddressed, FHP can lead to recurrent neck pain, often unnoticed by players.[7] Prolonged gaming activities combined with poor posture may alter head and spinal alignment, increasing the load on the neck and shoulder muscles. Consequently, musculoskeletal issues such as tennis elbow, leaguer's shoulder, and other related disorders may develop.[6] Studies have reported that more than 40% of gamers experience musculoskeletal pain.[8]

Esports has gained immense popularity, particularly among adolescents and young adults. While much of the research on esports has focused on computer-based games, mobile esports, despite having significant impacts on player posture, has received relatively little attention. Mobile gamers often focus on smaller screens, necessitating a forward or downward head posture for better visual focus. Additionally, the absence of a table to support the elbows often forces players to suspend their arms or rest their weight on the olecranon. Maintaining a forward-bent head posture for prolonged periods may contribute to neck pain or other spinal disorders, commonly called Forward Head Posture. Studies indicate that neck pain can emerge after as little as 16 minutes of mobile gaming, and playing for more than two hours per day increases the prevalence of neck, shoulder, and lower back pain among adolescents.[9]

Forward Head Posture (FHP) is one of mobile gamers' most common postural abnormalities. It is characterized by the anterior positioning of the head relative to the vertical body line, leading to shoulder misalignment.[10,11] The prevalence of FHP among gamers is notably high, reaching 45.2% among individuals aged 18–21 years.[12] A study conducted in Malaysia reported an exceptionally high prevalence of FHP (98.3%) among individuals who engaged in gaming for 6 to 10 hours daily.[12] FHP adversely affects neck flexibility and static balance control, even in asymptomatic individuals.[13]

However, research findings on the relationship between FHP and neck pain remain controversial. Some studies have reported no significant association between FHP and neck pain,[14,15] whereas others have found a positive correlation.[16,17]

Esports has been expanding rapidly in Indonesia, including in Magelang City, where local communities and tournaments are emerging. Nonetheless, no studies have specifically investigated the relationship between FHP and musculoskeletal disorders among esports athletes in Magelang City. Therefore, this study examines the relationship between Forward Head Posture and musculoskeletal disorders in esports athletes in Magelang City. The hypothesis proposed in this study is that there is a positive relationship between the severity of FHP and musculoskeletal disorders among esports athletes in Magelang City.

## Methods

This study employed an observational design with a cross-sectional approach. A cross-sectional design was chosen to observe the relationship between Forward Head Posture (FHP) and musculoskeletal disorders simultaneously among esports athletes in Magelang City. The study focused on mobile video game players in the Magelang area, Central Java. Data collection took place offline (face-to-face) from August to October 2024. Observations and measurements of variables for each subject were conducted only once. A total of 112 respondents were initially recorded. After applying the inclusion and exclusion criteria, 99 respondents met the eligibility requirements.

From the 112 registered respondents, an initial screening based on craniovertebral angle (CVA) measurement was performed to ensure that only those with a CVA <50° were included. Sampling was conducted using a purposive sampling technique, where subjects were selected from the available population who met the inclusion criteria until the required sample size was achieved. Purposive sampling ensured that participants met specific criteria, such as age and posture characteristics relevant to the study focus.

The inclusion criteria were participants aged 13–35 years with a baseline craniovertebral angle of less than 50°. Exclusion criteria included the presence of cervical anatomical abnormalities (cervical syndrome) and a history of head or neck injury with a formal medical diagnosis. Dropout criteria included participants who failed to follow instructions correctly; dropouts were not replaced with new subjects.

Forward Head Posture was assessed using a photogrammetry method. Lateral photographs were taken from a distance of 1.5 meters, with the camera height aligned to the participant's shoulder level to ensure an accurate lateral view. The camera focus was adjusted to capture the upper body. Craniovertebral angles (CVA) were then measured using MB Ruler software, with the reference point at C7 [26]. Before data collection, the MB Ruler measurement tool was recalibrated. This tool has demonstrated inter-rater reliability with an ICC of 0.75 (95% CI: 0.65–0.85) and intra-rater reliability with an ICC of 0.85 (95% CI: 0.81–0.91) [27]. Inter-rater reliability was further tested with two observers. A single trained observer performed image measurements to minimize measurement bias.

Additional data were collected through questionnaires and pain assessments using the Numeric Rating Scale (NRS). The questionnaire included demographic data such as name, age, average daily video game playtime, length of gaming experience, complaints experienced during gaming, and NRS pain scores. Participants were instructed to recall their average gaming duration over the past week to minimize recall bias. Written instructions were provided, and participants were guided carefully to optimize recall accuracy.

This study received ethical approval from the Health Research Ethics Committee of Universitas Muhammadiyah Surakarta (Ethical Clearance No. 914/KEKP-FIK/II/2025). All respondents received detailed information regarding the purpose of the study, their rights as participants, and assurances of data confidentiality.

The sample size of 99 subjects was determined based on the minimum required sample size for a correlation study using Spearman's Rho, with a power of 80% and a significance level of 5%. Thus, the sample size was considered adequate for the planned analyses. Data were analyzed using SPSS software version 26.0. Univariate analysis was conducted to describe frequencies and percentages. Bivariate analysis was performed using Spearman's Rho correlation test. Missing data were excluded from the study without imputation.

Multivariate analysis was not conducted, as the cross-sectional design focused on examining the direct relationship between the two primary variables, assuming minimal influence from other variables. Gaming duration was categorized in an exploratory analysis (<2 hours per day vs. ≥2 hours per day). Pain scores on the NRS were analyzed as continuous data and categorized into mild, moderate, and severe levels. Potential confounding variables such as age and gaming duration were explored and considered when interpreting the results.

## Results

The distribution of subject characteristics is detailed in Table 1, which presents the demographic and clinical profiles relevant to the study. Variables assessed include age group, severity of forward head posture (FHP), duration of video game playing in years, average daily video game playing duration, and types of musculoskeletal complaints experienced by the participants. This descriptive information provides important context for understanding the relationship between video game habits, posture abnormalities, and musculoskeletal complaints among the study population.

**Table 1.** Frequency Distribution of Subject Characteristics

| Variable | N | % |
|---|---|---|
| Age | | |
| 15–20 years | 13 | 13.1% |
| 21–25 years | 59 | 59.6% |
| 26–30 years | 24 | 24.2% |
| 31–35 years | 3 | 3.0% |

**Continuation of Table 1.** Frequency Distribution of Subject Characteristics

| Variable | N | % |
|---|---|---|
| Forward Head Posture (FHP) | | |
| Severe | 3 | 3.0% |
| Mild | 96 | 97.0% |
| Duration of Video Game Playing (years) | | |
| <1 year | 29 | 29.3% |
| 1–3 years | 37 | 37.4% |
| >3 years | 33 | 33.3% |
| Daily Video Game Playing Duration | | |
| <1 hour | 6 | 6.1% |
| 1–5 hours | 59 | 59.6% |
| >5 hours | 34 | 34.3% |
| Type of Musculoskeletal Complaints | | |
| No pain | 18 | 18.2% |
| Neck pain | 22 | 22.2% |
| Shoulder pain | 30 | 30.3% |
| Back pain | 15 | 15.2% |
| Elbow pain | 5 | 5.1% |
| Wrist pain | 9 | 9.1% |

The characteristics of the respondents are presented in Table 1. Among the 99 participants aged 15–35, the most common age group was 21–25, comprising 59 respondents (59.6%). The most frequent specific age was 23, with 19 respondents (19.2%). The majority of respondents exhibited mild Forward Head Posture (FHP) (96 participants, 97.0%), while only 3 participants (3.0%) showed severe FHP.

Regarding the duration of video game playing, the largest group was those who had played for 1–3 years (37 participants, 37.4%), followed by those who had played for more than 3 years (33 participants, 33.3%), and less than 1 year (29 participants, 29.3%). In terms of daily gaming duration, most respondents played for 1–5 hours per day (59 participants, 59.6%), followed by more than 5 hours (34 participants, 34.3%), and less than 1 hour (6 participants, 6.1%).

The most frequently reported musculoskeletal complaint was shoulder pain (30 participants, 30.3%), followed by neck pain (22 participants, 22.2%). Shoulder pain was the second most common complaint, while elbow pain was the least reported, with only five respondents (5.1%). All participants who met the inclusion criteria completed the study without missing data.

Table 2 illustrates the relationship between the severity of Forward Head Posture (FHP) and the presence of musculoskeletal complaints. The table presents the distribution of pain in various regions, including the neck, shoulder, back, elbow, and wrist, across individuals with severe and mild FHP. The correlation and corresponding P-value are also included to assess the statistical significance of these associations. This data provides insights into how different degrees of FHP might influence the occurrence of musculoskeletal disorders in the study population.

**Table 2.** Relationship Between Forward Head Posture and Musculoskeletal Disorders

| Complaint | No Pain | Neck Pain | Shoulder Pain | Back Pain | Elbow Pain | Wrist Pain | Total | Correlation | P-value |
|---|---|---|---|---|---|---|---|---|---|
| Severe FHP | 1 | 1 | 1 | 0 | 0 | 0 | 3 | | |
| Mild FHP | 17 | 21 | 29 | 15 | 5 | 9 | 96 | 0.117 | 0.247 |
| Total | 18 | 22 | 30 | 15 | 5 | 9 | 99 | | |

Cross-tabulation analysis showed that among the three respondents with severe FHP, one reported no pain, one reported neck pain, and one reported shoulder pain. Most complaints were observed among respondents with mild FHP. Spearman's correlation test yielded a correlation coefficient of 0.117 and a p-value of 0.247, indicating no significant relationship between FHP and musculoskeletal complaints.

Table 3 presents the relationship between the duration of video game playing, measured in years, and the severity of Forward Head Posture (FHP). The table details the distribution of participants with severe and mild FHP across different categories of gaming duration (<1 year, 1–3 years, and >3 years). Additionally, the correlation coefficient and P-value are provided to evaluate the strength and significance of the association. This analysis aims to explore whether a longer history of video game playing is related to an increased severity of FHP among participants.

**Table 3.** Relationship Between Duration of Video Game Playing (Years) and Forward Head Posture

| Duration | Severe FHP | Mild FHP | Total | Correlation | P-value |
|---|---|---|---|---|---|
| <1 year | 2 | 27 | 29 | | |
| 1–3 years | 1 | 36 | 37 | 0.158 | 0.119 |
| >3 years | 0 | 33 | 33 | | |
| Total | 3 | 96 | 99 | | |

Severe FHP was more frequently found in respondents who had played for less than 1 year. Spearman's correlation test showed a coefficient of 0.158 with a p-value of 0.119, indicating no significant relationship between the duration of video game playing (in years) and FHP.

Table 4 shows the relationship between the duration of video game playing, categorized by years, and the distribution of various musculoskeletal complaints among participants. The table outlines the frequency of different types of pain — including neck, shoulder, back, elbow, and wrist pain — across each gaming duration group. The

correlation coefficient and P-value are also presented to assess the potential association between prolonged video game activity and the occurrence of musculoskeletal disorders. These findings help to further elucidate the possible impact of long-term video game habits on physical health outcomes.

**Table 4.** Relationship Between Duration of Video Game Playing (Years) and Musculoskeletal Disorders

| Duration | No Pain | Neck Pain | Shoulder Pain | Back Pain | Elbow Pain | Wrist Pain | Total | Correlation | P-value |
|---|---|---|---|---|---|---|---|---|---|
| <1 year | 5 | 9 | 9 | 4 | 0 | 2 | 29 | 0.146 | 0.149 |
| 1–3 years | 5 | 12 | 10 | 4 | 5 | 1 | 37 | | |
| >3 years | 8 | 1 | 11 | 7 | 0 | 6 | 33 | | |
| Total | 18 | 22 | 30 | 15 | 5 | 9 | 99 | | |

The highest number of complaints was found among respondents who had played for 1–3 years and more than 3 years, predominantly reporting neck and shoulder pain. Spearman's correlation test yielded a coefficient of 0.146 and a p-value of 0.149, suggesting no significant relationship.

Table 5 presents the relationship between the daily duration of video game playing and the severity of Forward Head Posture (FHP) among participants. The table details the distribution of severe and mild FHP cases across different daily gaming duration categories (<1 hour, 1–5 hours, and >5 hours). The correlation coefficient and P-value are provided to assess the strength and significance of the association. This analysis aims to explore whether longer daily exposure to video gaming activities contributes to worsening postural abnormalities in the study population.

**Table 5.** Relationship Between Daily Duration of Video Game Playing and Forward Head Posture

| Daily Duration | Severe FHP | Mild FHP | Total | Correlation | P-value |
|---|---|---|---|---|---|
| <1 hour | 0 | 6 | 6 | -0.122 | 0.230 |
| 1–5 hours | 1 | 58 | 59 | | |
| >5 hours | 2 | 32 | 34 | | |
| Total | 3 | 96 | 99 | | |

Most respondents who played for 1–5 hours daily exhibited mild FHP. Spearman's correlation test yielded a negative coefficient of -0.122 with a p-value of 0.230, indicating no significant relationship between daily video game playing duration and FHP.

Table 6 illustrates the relationship between the daily duration of video game playing and the occurrence of various musculoskeletal complaints among participants. The table outlines the distribution of pain types — including neck, shoulder, back, elbow, and wrist pain — across groups categorized by daily gaming duration (<1 hour, 1–5 hours, and >5 hours). The correlation coefficient and P-value are provided to determine the strength and statistical significance of the association. These results help in evaluating whether longer daily engagement in video gaming activities is linked to an increased risk of musculoskeletal disorders.

**Table 6.** Relationship Between Daily Duration of Video Game Playing and Musculoskeletal Disorders

| Daily Duration | No Pain | Neck Pain | Shoulder Pain | Back Pain | Elbow Pain | Wrist Pain | Total | Correlation | P-value |
|---|---|---|---|---|---|---|---|---|---|
| <1 hour | 4 | 2 | 0 | 0 | 0 | 0 | 6 | -0.028 | 0.780 |
| 1–5 hours | 6 | 10 | 25 | 5 | 4 | 9 | 59 | | |
| >5 hours | 8 | 10 | 5 | 10 | 1 | 0 | 34 | | |
| Total | 18 | 22 | 30 | 15 | 5 | 9 | 99 | | |

The most common complaints among respondents who played for more than 5 hours daily were neck and back pain. Spearman's correlation test showed a negative coefficient of -0.028 with a p-value of 0.780, indicating no significant relationship between daily video game playing duration and musculoskeletal complaints.

## Discussion

This discussion focuses on the relationship between forward head posture (FHP), the duration and length of video game playing, and musculoskeletal disorders among esports athletes in Magelang City. Based on the study involving 99 respondents, the majority were aged 21–25 years (59 individuals, 59.6%), with mild FHP (<50˚) found in 96 respondents (97%). Most respondents had played video games for 1–3 years (37 individuals, 37.4%), with a daily playing duration of 1–5 hours (59 individuals, 59.6%). The most frequently reported complaint was shoulder pain (30 individuals, 30.3%).

These findings are consistent with previous research conducted among medical students at the Faculty of Medicine, Udayana University, where the most common age was 21 years (48.4%), and the majority exhibited mild FHP (130 respondents, 94.2%).[18] Similarly, a high proportion of students at the Faculty of Health Sciences, Universitas Muhammadiyah Pekajangan Pekalongan reported prolonged game playing (46 individuals, 74.2%) (29). However, among smartphone users, the most prevalent complaint was neck pain, reported by 87 individuals (61.7%).[19]

Correspondingly, a study by Lam Wing (2022) demonstrated that repetitive use over extended periods with poor posture leads to FHP, contributing to reduced muscle strength and endurance, ultimately resulting in musculoskeletal disorders.[20]

### Relationship Between Forward Head Posture and Musculoskeletal Disorders

In this study, among 99 respondents with FHP, the most frequent musculoskeletal complaint was shoulder pain, reported by 29 respondents with mild FHP and one respondent with severe FHP. The Spearman's Rho statistical test yielded a p-value of 0.247 (p>0.05), indicating no significant relationship between FHP and musculoskeletal disorders among esports athletes in Magelang City.

This contrasts with Lau's 2010 study, which reported a strong correlation between FHP and musculoskeletal disorders. Decreased craniovertebral angle (CVA), worsening FHP severity, can lead to neck pain radiating to the shoulders due to the anterior head shift, increasing spinal flexion, and abnormal pressure on cervical structures.[21] Another study found that 60% of video game players with FHP experienced back and neck pain, followed by wrist complaints due to inadequate hand support.[22] Neck pain extending to the shoulders may also be influenced by intensity and duration, affecting sitting posture with neck flexion during gaming.

**Relationship Between Duration of Video Game Playing and Forward Head Posture**

Among 99 respondents, FHP was most prevalent among those playing video games for over 1 year (69 respondents). The Spearman's Rho test produced a p-value of 0.119 ($p>0.05$), indicating no significant relationship between the length of time spent playing video games and FHP among esports athletes in Magelang City.

Previous research similarly found a negative correlation between the length of video game playing and the occurrence of FHP, potentially attributed to internal factors.[23] Another study identified a relationship between computer-based video game players with more than one year of experience and the occurrence of FHP.[24]

**Relationship Between Length of Video Game Playing and Musculoskeletal Disorders**

Of the 99 respondents, the most common musculoskeletal complaint was neck pain after more than 1 year of video game playing (12 respondents), followed by shoulder pain after more than 3 years (11 respondents). The Spearman's Rho test indicated a p-value of 0.149 ($p>0.05$), suggesting no significant relationship between the length of video game playing and musculoskeletal disorders among esports athletes in Magelang City.

Prior studies reported a positive correlation between the length of playing and musculoskeletal complaints, with neck pain commonly reported within less than 3 years (57.5%), attributed to repetitive poor posture during work or recreational activities.[24] Other findings also demonstrated a significant correlation between work duration and neck pain among individuals with over one year of experience, linked to poor ergonomic practices and lack of rest breaks.[25]

**Relationship Between Daily Duration of Video Game Playing and Forward Head Posture**

Results showed that among 99 respondents, mild FHP was most frequently observed in those playing 1–5 hours per day (58 respondents). The Spearman's Rho test revealed a p-value of 0.230 ($p>0.05$), indicating no significant relationship between daily gaming duration and FHP among esports athletes in Magelang City.

Previous studies noted that lower CVA angles indicate greater FHP severity. Subjects playing video games for more than 4 hours daily exhibited lower CVA values.[26] Similarly, higher cervical spine flexion angles were reported among smartphone users engaged in prolonged daily use compared to short-term users.[27]

**Relationship Between Daily Duration of Video Game Playing and Musculoskeletal Disorders**

Among 99 respondents, musculoskeletal complaints were most common among those playing 1–5 hours per day (25 respondents). The Spearman's Rho test yielded a p-value of 0.780 ($p>0.05$), indicating no significant relationship between daily gaming duration and musculoskeletal disorders among esports athletes in Magelang City.

It has been reported that the odds ratio for musculoskeletal disorders increased by up to 5.2 times for those playing video games for more than 3 hours per day (37). Consistent with Joanne's 2019 study, the most frequently reported complaints among individuals playing 3–10 hours per day were eye strain (56%), followed by back pain (42%) (12). Other findings indicated that playing video games for more than 6 hours daily resulted in 46% of students experiencing wrist pain in maximum dorsiflexion.[28] Wrist complaints may result from prolonged flexion or dorsiflexion during gaming, increasing friction resistance and leading to degenerative changes such as de Quervain's disease.[28] This study's lack of significant association may be attributed to respondents taking adequate breaks, minimizing sustained muscle tension.[29]

This study has several limitations. First, the sample was limited to esports athletes in Magelang City, restricting generalizability. Second, most respondents exhibited only mild FHP, limiting severity variation within the sample. Third, the use of self-reported pain data introduces potential subjective bias. Fourth, factors such as gaming ergonomics and game genres were not analyzed. Additionally, the cross-sectional design restricts the ability to infer causal relationships between video game playing duration, FHP, and musculoskeletal disorders.

The findings of this study are limited to esports athletes in Magelang City. They may not be generalizable to the broader population of video game players, such as non-athlete players, younger adolescents, or esports athletes from other regions.

Although no significant relationships were found between FHP, playing duration, and musculoskeletal disorders among esports athletes, the findings still carry important preventive and interventional implications. Despite non-significant statistical results, they open avenues for exploring other contributing factors to musculoskeletal disorders among esports athletes. Factors such as physical fitness levels, proper ergonomic equipment use, and postural habits like the frequency of breaks and stretching may modify the adverse impacts of FHP on musculoskeletal health.

Further research with longitudinal designs and more diverse samples is needed to understand better the long-term relationships between playing duration, FHP, and musculoskeletal disorders. Moreover, interventions focusing on posture correction and ergonomic gaming environments may reduce health risks and enhance long-term performance among esports athletes.

**Conclusion**

Based on the findings of this study, it was determined that video game players in Magelang City had no significant relationship between forward head posture (FHP) and musculoskeletal disorders, the length of time playing

video games, or the daily duration of video game playing. Nevertheless, these findings provide valuable insights into variables that may not exert a direct influence within the context of this study. Future researchers are encouraged to explore other factors that may contribute to the development of FHP, such as postural habits or ergonomic factors.

The results contribute to a broader understanding that variables like postural habits and ergonomic elements may have a greater impact on the development of FHP and musculoskeletal disorders than gaming duration alone. Furthermore, it is recommended that subsequent research employ more precise measurement methods for assessing FHP and for gathering data on gaming duration. Advanced posture assessment tools and longitudinal research designs may offer deeper insights into the long-term effects of video game playing duration on FHP and musculoskeletal disorders.

Additionally, future studies should incorporate ergonomic factors such as sitting angles, chair height, and biomechanical load on the human body during gaming activities, all of which may influence posture and contribute to the onset of musculoskeletal disorders. The measurement methods utilized in this study are acknowledged to have certain limitations that may have affected the accuracy of the findings. Therefore, developing and adopting more valid and reliable measurement instruments, including advanced postural assessment devices and contemporary technological tools, is essential for future investigations.

**References**


1. Rahma A, Habib M. Android dan masa depan: Analisis dampak terhadap pengguna. Center of Knowledge: Jurnal Pendidikan dan Pengabdian Masyarakat. 2021;1(1):12–21.
2. Phong T, Long T, Tuan L, Kristina K. Orthopedic injuries from video games: A literature review and implications for the future. Int Arch Orthop Surg. 2020;3(2):20–2.
3. Rahayu A. Perkembangan industri game dunia, 48% pemainnya berasal dari Asia-Pasifik [Internet]. 2023 [cited 2025 Apr 27]. Available from: https://goodstats.id/article/perkembangan-industri-game-dunia-48-pemainnya-berasal-dari-asia-pasifik-mLVOw
4. Nor K. Game online mengubah kepribadian seseorang [Internet]. 2019 [cited 2025 Apr 27]. Available from: https://www.kompasiana.com/norkhidnaini5340/5d1c12810d823054313e6522/game-online-mengubah-kepribadian-seseorang
5. Jenny SE, Manning RD, Keiper MC, Olrich TW. Virtual(ly) athletes: Where eSports fit within the definition of "sport." Quest. 2017;69(1):1–18.
6. Yunistiana MA, Rosida L, ST S, Kes MKM, Dhari IFW, et al. Narrative review: Hubungan waktu penggunaan smartphone terhadap forward head posture pada remaja. 2020.
7. Sikka I, Chawla C, Seth S, Alghadir AH, Khan M. Effects of deep cervical flexor training on forward head posture, neck pain, and functional status in adolescents using computer regularly. 2020.
8. Lindberg L, Nielsen SB, Damgaard M, Sloth OR, Rathleff MS, Straszek CL. Musculoskeletal pain is common in competitive gaming: A cross-sectional study among Danish esports athletes. BMJ Open Sport Exerc Med. 2020;6(1):7–11.
9. Shan Z, Deng G, Li J, Li Y, Zhang Y, Zhao Q. Correlational analysis of neck/shoulder pain and low back pain with the use of digital products, physical activity, and psychological status among adolescents in Shanghai. PLoS ONE. 2013;8(10):1–9.
10. Swandari MI, Tianing NW, Utama AAGES, Kinandana GP. Forward head posture dengan keseimbangan dinamis pada remaja usia 13-14 tahun di SMPN 12 Denpasar: Cross sectional study. Maj Ilmiah Fisioterapi Indones. 2023;11:169–74.
11. Rachman MAP, Wibawa A, Muliarta IM, Utama AAGES. Risiko forward head posture pada pegawai berbasis komputer di Fakultas Kedokteran Universitas Udayana. Maj Ilmiah Fisioterapi Indones. 2023;11:290–3.
12. Ramalingam V, Subramaniam A. Prevalence and associated risk factors of forward head posture among university students. Indian J Public Health Res Dev. 2019;10(7):775–80.
13. Lee JH. Effects of forward head posture on static and dynamic balance control. J Phys Ther Sci. 2016;28(1):274–7.
14. Harrison AL, Barry-Greb T, Wojtowicz G. Clinical measurement of head and shoulder posture variables. J Orthop Sports Phys Ther. 1996;23(6):353–61.
15. Hanten WP, Olson SL, Russell JL, Lucio RM, Campbell AH. Total head excursion and resting head posture: Normal and patient comparisons. Arch Phys Med Rehabil. 2000;81(1):62–6.
16. Cheung Lau HM, Wing Chiu TT, Lam TH. Clinical measurement of craniovertebral angle by electronic head posture instrument: A test of reliability and validity. Man Ther. 2009;14(4):363–8.
17. Yip CHT, Chiu TTW, Poon ATK. The relationship between head posture and severity and disability of patients with neck pain. Man Ther. 2008;13(2):148–54.
18. Daniel G, Agung A, Angga G, Negara P, Juhanna IV, Daniel G. The relation between smartphone use with forward head posture occurrence in undergraduate physiotherapy students. 2022;3(2):44–8.
19. Zeffira L, Fitriyasti B, Athifah M. Hubungan penggunaan smartphone dengan keluhan nyeri leher pada mahasiswa Fakultas Kedokteran Universitas Baiturrahmah Padang. J Mandalika (JCM). 2023;617–29.
20. Lam WK, Chen B, Liu RT, Cheung JCW, Wong DWC. Spine posture, mobility, and stability of top mobile esports athletes: A case series. Biology. 2022;11(5):1–11.
21. Lau HMC, Chiu TTW, Lam TH. Measurement of craniovertebral angle with electronic head posture instrument: Criterion validity. J Rehabil Res Dev. 2010;47(9):911–8.
22. Difrancisco-Donoghue J, Balentine J, Schmidt G, Zwibel H. Managing the health of the eSport athlete: An integrated health management model. BMJ Open Sport Exerc Med. 2019;5(1).

23. Kocur P, Tomczak M, Wiernicka M, Goliwąs M, Lewandowski J, Łochyński D. Relationship between age, BMI, head posture, and superficial neck muscle stiffness and elasticity in adult women. Sci Rep. 2019;9(1):1–10.
24. Length OOF, Of D, Online P, Pain N, Among C, In S, et al. Gambaran lama, durasi bermain game online dan keluhan neck pain pada mahasiswa Fakultas Kesehatan Masyarakat Universitas Halu Oleo. Overview of length, duration of playing online games and neck pain complaints among students in Faculty of Public Health. 2024;5(3):149–57.
25. Wagachchi DT, Jayamanne MS, Adikari AMLUK, Kodagoda IDL, Mudalige YT, Parera GAD. Prevalence of forward head posture and its relationship with neck pain among sewing machine operators in two selected garment factories in Kaluthara district. Allied Health Sci Sess. 2020;37–43.
26. Jung SI, Lee NK, Kang KW, Kim K, Lee DY. The effect of smartphone usage time on posture and respiratory function. J Phys Ther Sci. 2016;28(1):186–9.
27. Yang-gon K, Min-hyeok K, Ji-won K, Jun-hyeok J, Jae-seop O, Kim YG, Kang MH, Kim JW, Jang JH, Oh JS. Influence of the duration of smartphone usage on flexion angles of the cervical and lumbar spine and on reposition error in the cervical spine. Phys Ther Korea. 2013;20(1):10–7.
28. Ma T, Song L, Ning S, Wang H, Zhang G, Wu Z. Relationship between the incidence of de Quervain's disease among teenagers and mobile gaming. Int Orthop. 2019;43(11):2587–92.
29. Depari RDS, Rambe AS. Hubungan posisi menunduk saat menggunakan telepon seluler dengan nyeri tengkuk. Scripta Score Sci Med J. 2021;3(1):17–22.