

**Risk Factors for Neck Functional Ability in Esports Players****Wahyu Andriawan*, Farid Rahman**

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The public's interest in the world of esports is increasing, both nationally and internationally. The current generation's participation, along with the government's support through prestigious competitions, is producing promising talents. The ambition to compete in esports games has caught the attention of researchers, as the process of engaging the body's functions can lead to physical problems that affect performance. Musculoskeletal disorders that occur involve the accumulation of various factors, which are considered disruptive to players. The highest reported prevalence of complaints is in the neck region, with varying levels of pain. The aim of this study is to determine the relationship and influence of age, gender, player type, duration of play, length of participation, and stress levels on the functional ability of esports players' necks. Through observational analytical research with a cross-sectional approach, researchers analyzed statistically to find the relationship and influence. The results showed that gender and stress level variables have a weak relationship and influence on the occurrence of neck disability. Meanwhile, the player type, age, duration of play, and length of participation variables do not seem to correlate with the functional ability of the neck. Further research is needed on the effect of stress levels experienced by individuals that affect their physical performance in performing functional activities in the field of esports.

INTRODUCTION

Public interest in esports in Indonesia is relatively high. Indonesia ranks 17th in the world gaming market with rapid development. In Southeast Asia, Indonesia accounts for 43% of the total 274.5 million gamers (Hidayah, 2022). The growing number of enthusiasts has reached 40 million gamers, along with the many esports competitions, such as prestigious events like the Pekan Olahraga Nasional (PON), Sea Games, and Asian Games (Kemenpora, 2022). Pengurus Besar Esports Indonesia (PBESI) supports and facilitates esports athletes to optimally achieve "results" according to the progress of the esports ecosystem (Prasatya, 2022). This is evidenced by the achievements of Indonesian esports athletes, one of which is in the IESF 14th World Esports Championship 2022, where they won 3 gold medals in the Dota 2, eFootball, and Mobile Legends games, as well as 1 bronze medal in the CS: GO Women category (Bestari, 2022).

During the process of practicing and competing in esports games, the risk of injury to esports players can occur due to the tendency of non-ergonomic postures and repetitive movements (Palanichamy et al., 2021). Approximately more than 40% of esports athletes complain of musculoskeletal pain. Nintendonitis and Nintendo Neck have been reported in many esports players, as well as tennis elbow, leaguer's shoulder, and gamer's thumb (W. Lam et al., 2022). The prevalence of esports players' physical problems is based on the most common complaints in the neck, with a percentage of 40%, followed by complaints in the fingers (38%) and head (32%) with different pain levels (W. Lam et al., 2022). The cervical spine is able to control the movement of the head region and deliver nerve signals to and from the brain through the spinal cord. However, it is vulnerable to injury if it receives excessive load on the head (King, 2018) Through the spinal cord, the cervical spine transmits and receives nerve impulses to and from the brain, allowing it to control head movement. But if the head is subjected to an extreme load, it could get injured (Ansari-pour et al., 2022) Neck pain conditions are commonly found in musculoskeletal disorders, which are non-specific problems due to specific problems such as trauma, such as whiplash (Jull et al., 2008). Neck pain is classified as pain that did not interfere with daily activities (grade I-II), neurological pain (grade III), and pain due to major structural disorders

(grade IV), including duration of pain and whiplash-associated disorder (Fredin & Lorås, 2017). Neck problems, especially trauma, directly affect the vital structures of the neck, consisting of airways, blood vessels, the innervation system, and the gastrointestinal tract (Salinas & Brennan, 2023).

The sitting posture pattern of esports players with a forward head and rounded shoulder position has implications for physical ailments of the musculoskeletal system. In a study conducted to 50 elite male mobile-gaming athletes who were lineup players from ten professional MOBA Tournament teams held in Shanghai in 2021, it was found that the prevalence of pain locations experienced with the most significant percentage was in the neck and back regions among 42% of respondents (W. K. Lam et al., 2022). Forward head posture measured by the craniovertebral angle method shows an angle below 53 degrees (D. Y. Lee et al., 2017). Malalignment of the head and neck will increase pressure on the posterior cervical aspect, affecting the length of tension of the neck muscles. In addition, there is an increase in neck muscle activity, retraction of neck movement, and disruption of cervical proprioception (Ghamkhar & Kahlaee, 2019). Complications resulting from prolonged activation of the neck and back muscles are strain and fatigue. Muscle fatigue triggers functional weakness of vertebral support and increases mechanical stress on ligaments and intervertebral discs, resulting in pain and musculoskeletal discomfort (W. K. Lam et al., 2022). In addition, the rounded shoulder posture is characterized by the protraction of the acromion in front of the center of gravity (COG) line, which causes changes in scapular kinematics and correlated muscle activity, increasing the pressure that results in shoulder pain and dysfunction (Fathollahnejad et al., 2019).

The prevalence of neck pain is caused by different factors, including inadequate ergonomic positions when using electronic devices, repetitive and fast movements, static positions, and prolonged sitting, as well as individual factors, including age, gender, and history of musculoskeletal pain. It is also supported by psychosocial factors such as stress and depression (Batatolis & Karatrantou, 2023). Neck pain disorders that occur have levels that are considered annoying to disabling. The impact felt by sufferers ranges from ignoring pain to restricting participation in daily activities (Jull et al., 2019). Neck pain conditions vary in severity from mild-

ly bothersome to profoundly disabling. Individuals experience various effects, from enduring the pain to significantly limiting their ability to engage in everyday tasks (Pirnes et al., 2020). Device placement affects neck posture alignment, where computer height determines neck flexion or neck extension, which is associated with musculoskeletal disorders, including the height of the keyboard relative to the elbow, which increases the risk of neck stiffness (Vledder et al., 2015). Muscle stiffness can be disruptive, ranging from discomfort and dull pain to difficulty that has a significant effect on activity (Bailey, 2011). Muscle stiffness can be annoying, ranging from painful and unpleasant to a problem that has a significant impact on activity, especially in activities that require an extensive range of motion (Chino et al., 2018). The level of muscle loading is a factor that affects biomechanical aspects, especially the neck and back. Static biomechanical loading of the neck in a flexi-head posture can increase loading and fatigue in the neck extensor muscles and shoulder neuromusculature (Salk et al., 2018). Continuous overactivation of low-threshold motor units risks overload and damage, with associations at each different loading level. Low levels lead to neck inflammatory pain syndrome, while high levels of association lead to muscle-specific disorders (Nimbarte et al., 2012). Continuous overactivation of low-threshold motor unit causes overload and damage, with associations at various loading levels. Low levels cause neck inflammatory pain syndrome, a musculoskeletal disorder caused by excessive strain in the area (Garosi et al., 2023). The symptom of a neuromuscular disorder that often occurs is weakness in the neck muscles needed to keep the neck upright and not fall to either side. Weakness may occur in the extensor muscles of the neck, but both extensor and flexor muscles are affected. Patients with weakness tend to feel increased difficulty and fatigue when using the affected muscles (Khadilkar et al., 2017).

Devices that are often used are mobile phones and laptops or computers (Visual Display Terminals) with an average usage duration of 1-4 hours per day, which is associated with the appearance of musculoskeletal symptoms such as neck pain, back pain, and shoulder pain (Bogdănici et al., 2017). College esports players practice for 3-10 hours per day before facing competition (Difranco-donoghue et al., 2019). Working with a neck posture that is not ergonomic for a long time can increase muscle loading and fatigue, reducing the

strength and endurance of the neck flexor muscles and triggering pain. The neck extensor muscles will find it difficult to fully relax, and there is an increase in neck flexor muscle activity during flexion, which, if it occurs repeatedly and for a long time, causes pain and injury (Zabihhosseinian et al., 2015). Musculoskeletal injuries, pain, impaired muscle coordination, and poor concentration affect the athlete physically, mentally, and emotionally, impairing decision-making and decreasing performance in play (W. Lam et al., 2022). Performance in terms of cranio-cervical flexion is measured based on the ability of esports players to maintain the level of pressure activated by the number of repetitions on the neck, which is affected due to pressure injuries and repetitive static neck posture (Nintendo neck) when playing esports games (Gallego Izquierdo et al., 2016; W. Lam et al., 2022).

Research on the risk factors that contribute to a decrease in the functional ability of the neck of esports players is important because it forms the basis for building physiotherapy programs to improve performance and prevent injuries in esports players who currently lack a standardized protocol. Previous studies have only observed risk factors with a single variable, not simultaneously reviewing multifactor risk variables. This study objectively observed the risk variables potentially predisposing to decreased neck functional ability in esports players.

METHODS

The type of research conducted was quantitative research with an observational analytic research design, and the data were analyzed statistically without providing intervention to respondents. The approach in this study was a cross-sectional study to describe the correlation and contribution of risk factors (type of player, age, duration of playing esports games, joining period, gender, and stress level) to the functional ability of the neck in esports players. This study was conducted online through a virtual form platform from January to March 2024.

Participants

The research population was made up of esports players in Indonesia. The sample in this study amounted to 284 people who were previously filtered according to the sample criteria determined by the researcher.

Sampling Procedures

The sample was taken using a non-probability sampling technique with incidental sampling, which involved drawing samples based on chance factors and in accordance with the characteristics determined by the researcher. In this study, the sample was taken based on the following inclusion criteria: active professional or amateur esports players, willing to be respondents, professional esports players with an average of 42 hours of play per week, and amateur esports players with an average of 21 hours of play per week. In addition, exclusion criteria were considered, including having a history of neck, hand, and wrist injuries with moderate to severe levels; being in the recovery period after neck, hand, and wrist injuries within ≤ 6 months; and having indications of certain medical conditions.

Materials and Apparatus

The research population was made up of esports players in Indonesia. The sample in this study amounted to 284 people. The questionnaire media used requested demographic data from respondents, including age, gender, type of player, duration of play, joining period, and stress level. The six variables were categorized and then tested to determine their correlation and contribution to neck functional ability. Specifically for stress levels, the questionnaire instrument was taken from the Beck Depression Inventory (BDI) II scale, and the measurement of neck functional ability used the Neck Disability Index (NDI) measurement scale. The questionnaire instrument had an ICC score of 0.86/0.89. ICC interpretation of scores between 0.75-0.90 was considered good. The measurement of neck functional ability used the Neck Disability Index (NDI) measurement scale with an ICC score of 0.92 (95% CI 0.85-0.96) with a testing interval time of 1 week. Measurements were taken for respondents aged ≥ 18 years. ICC interpretation of a score >0.90 was considered very good.

Procedures

The researcher prepared and disseminated the questionnaire to be used in the data collection process online and offline. At the beginning of the questionnaire, informed consent was included as a sign that the filler was willing to become a research respondent. The

questionnaire was filled out independently; the researcher only monitored the filling process and incoming data. The data collected were then filtered according to the criteria determined by the researcher.

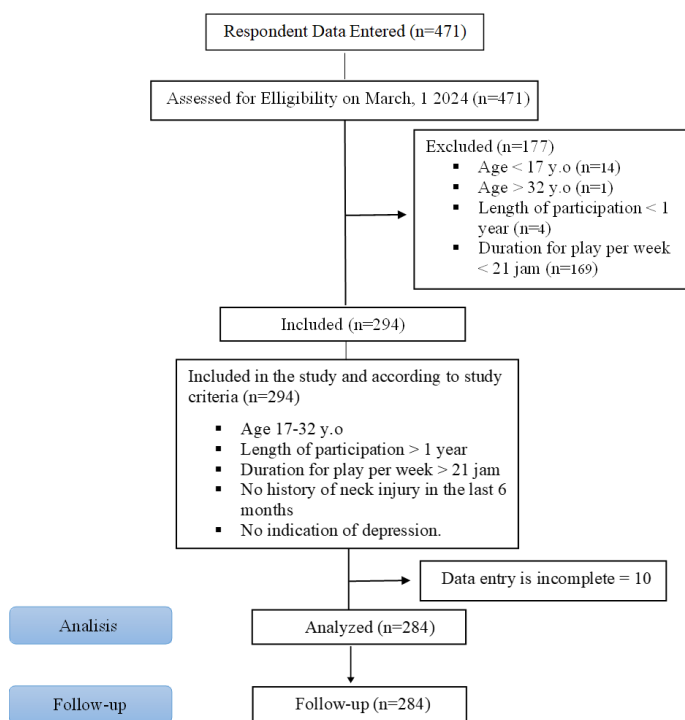


Figure 1. Respondent Screening Flow

Design or Data Analysis

The research was conducted using observational methods and online and offline questionnaire distribution, resulting in 471 people who were willing to become respondents. The data collected provided a deep insight into the state of the esports community on the ground. Of the total respondents, the analyzable data from 284 participants presented a comprehensive picture of their views and experiences on neck functional ability. The data were processed through a normality test to determine whether or not the data distribution was normal. After the test showed the data were not normally distributed, the data were analyzed with the Spearman and Kendall-Tau correlation tests to see whether or not there was a relationship. Moreover, the data were analyzed through ordinal logistic regression and binary regression tests to see the contribution of independent variables to the dependent variable.

RESULT

Table 1. Statistical Analysis Among Variables

Test	Score	Age	Sex	Length of Participation	Stress Levels	Type of Player	Duration for Play
Spearman Correlation and Kendall-tau	Sig (p) r	0,115 -	0,001 1.000	0,097 -	0,000 - 0.001	0,539 -	0,333 -
Logistic Regression and Binary Regression	Sig (p) R ²	1 = 0.000 2 = 0.000 3 = NA 4 = NA 0.036	0,049 0,169	1 = 0,566 2 = 0,490 3 = NA -	1 = 0.007 2 = 0,113 3 = 0,404 4 = NA 0.165	0,405 -	1 = 0,207 2 = 0.035 3 = 0,42 4 = NA 0,040

The variables of gender and type of player through the Kendall-tau test show different results, where gender correlates ($p = 0.001$) with a positive relationship direction. In contrast, the kind of player shows the opposite ($p = 0.539$). Using the Spearman correlation test, other variables show no relationship to functional ability, unlike the stress level ($p=0.000$), which has a negative relationship with the functional ability of the neck. Then, the logistic and binary regression tests, show an influence in the significance values of age, gender, joining period, stress level, and playing duration. Gender has a weak strength of influence ($R^2=0.169$) on neck functional ability, as did stress level in the minimal depression category ($R^2=0.165$).

DISCUSSION

In the previous research conducted by Kazeminasab et al., it was stated that gender demographic characteristics, as a biological risk factor, can affect the prevalence and development of neck pain events (Kazeminasab et al., 2022). However, in a cross-sectional retrospective study by (Koh et al., 2020), women, as they age, have a significant impact on disability due to a decrease in skeletal muscle mass. This contradicts the data obtained, where men are more at risk of neck disability than women due to the unbalanced proportion of respondents in the gender variable.

Stress due to pressure in playing or competing in esports games is linked to the duration of play; the longer the game process is carried out, the longer the stress pressure is felt. Stress also triggers physical problems such as disruption of sleep due to insomnia (Yasin et al., 2022), known based on the reports of respondents who filled out this research questionnaire. Stress also triggers physical problems such as disruption of sleep

due to insomnia, as reported by respondents who filled out this research questionnaire. The incidence of chronic neck pain is double in individuals with mental disorders and is associated with pain severity. This plays a role in altering central pain processes at the vertebral, brainstem, or cortical level, with manifestations being remote hyperalgesia (Kazeminasab et al., 2022). The stress factor in gender differences also needs to be underlined due to the significance that women are twice as at risk as men, but this should not be underestimated so that the risk of increased stress that interferes with function occurs. On the flip side, age is also a predictor of stress incidence. Adolescence is the peak of stress incidence, starting to decrease and stabilize as it enters the adult phase (Salk et al., 2018). The existence of a relationship and influence is in line with previous research. However, there are differences in research (W. K. Lam et al., 2022) where what affects functional abilities, especially the incidence of neck pain, is high-stress levels. Esports players who engage in intense gaming are at risk of mental disorders due to neglect of emotional, social, and psychological situations and conditions that indirectly interfere with physical health. Due to the demands of the esports world, players can be diagnosed with Internet Gaming Disorder, which can accumulate various aspects that affect physical and psychosocial health (Franks et al., 2022).

Based on the research (Kazeminasab et al., 2022), age is the same as gender, which can influence and develop the prevalence of neck pain. The age categorization in this study is adolescence and young adulthood, namely 17-32 years. The age range that contributes to neck disability is 17-24 years old, which, according to the World Health Organization (WHO), falls into the adolescent category. Musculoskeletal disorders in adolescents influenced by factors such as sleep disturbances, mental health, and physical inactivity contribute

to the incidence of neck pain (Jahre et al., 2021). Adolescents have more excellent muscle stability than those of the age above because the prevalence of neck pain incidence is in line with the increasing age of a person (Biomedika & Belakang, 2019). Adolescence is a period of growth and development of strength and muscle mass, which can be maximized if trained with high-intensity exercise that can improve musculoskeletal and metabolic outcomes (Brown et al., 2017). However, in this study, the variation in age levels categorized by researchers was not significantly significant, mainly because the range included adolescents to early adulthood. Hence, the neck musculoskeletal conditions experienced between categories were not much different, and it could not be concluded that there were differences in the relationship and influence that appeared. In contrast, the research conducted by Arif Pristiano et al., 2022 showed that 21-30 years of age was the most common age that reported the incidence of neck pain, and one of the factors that followed was the history of previous neck pain (Pristiano et al., 2022).

Each player has varying activity intensity and is influenced by physical fitness, which affects function (Franks et al., 2022). Physical conditions are related to the strength and muscle power of esports players (Saraya et al., 2018). In this case, there is a discrepancy with previous research (W. K. Lam et al., 2022), where athletes or professional players must maintain full attention for 2-3 sets of play, which triggers fatigue and complaints of neck pain with the highest prevalence (40%). Only the intensity of play between athletes and amateur players is different. However, health status measured through physical activity does not show significant differences where both are active for about 8.8 (± 10.7) hours per week, exceeding the recommendation of 2.5 hours per week by WHO (Rudolf et al., 2022). Player status determines the risk of functional ability problems, focusing on professional athletes who are more at risk of recurrent injury due to the strength and conditioning training performed in preparation for competitions where anti-gravity neck muscles are strengthened and activated. Recreational players, on the other hand, often have an imbalance of trained muscles, so there is a possible risk of functional impairment (Ilsya et al., 2023; Solikah et al., 2023).

The length of time spent playing esports games was initially thought to be the accumulation of years of

playing that may cause neck musculoskeletal problems. However, this contradicts the theory that muscles working for long periods or with heavy loads contribute to adaptation, so muscles will have better endurance capacity and gain greater mass (Hughes et al., 2018). Good physical health management from players supports the adaptation process, such as professional players who are recommended to remain active in exercising at least stretching to maintain their physical performance (Jasmine et al., 2022). Good physical health management from players supports the adaptation process, such as players at least stretching before competing because of the effect that can reduce muscle stiffness and pain by training the flexibility of these muscles (Tunwattanapong & Kongkasuwan, 2016). Exercise with correct and effective methods, along with health checks and implementing an organized diet and rest, can reduce the risk of injury. Physical training education with exercise that involves eccentric contractions can support adaptations in muscle strength associated with functional ability (Setiawan et al., 2024). Added to the knowledge data obtained from respondents, it was revealed that players with diverse joining backgrounds tend to stretch when they start to feel neck pain; this is done to ensure their comfort is maintained. This finding differs from previous research, where the joining period affects amateur players who have just joined, having a higher risk level for musculoskeletal disorders than players who have joined for 10 years (Fathuldeen et al., 2023).

Playing for extended periods of time in the most common position for players, which is sitting, affects the stretching of the spinal ligaments and the tension in the muscles (Baker et al., 2018). The tension of the neck and shoulder muscles due to inadequate body position triggers pain and interferes with daily functional activities (Dharmawan et al., 2021). However, when linked to age, adolescent individuals are still developing good muscle strength (Arovah, 2021). Nonetheless, adolescents continue to build strong muscles in relation to their age (S. Lee et al., 2020). At an age classified as the third decade, isometric and dynamic muscle strengthening has increased (Larsson et al., 1979). In previous research conducted by Bhattacharjya et al., there was a positive correlation between muscle strength and muscle endurance, meaning that the greater the muscle strength, the more durable the muscle (Bhattacharjya et al., 2019). So, with excellent muscle

strength and endurance, esports players with various intensities do not have a neck disability. The data noted that respondents reported various other activities involving gadgets, including participation in educational learning, social media, and work factors that require a static neck position. This is in line with other studies explaining that the duration of playing esports cannot stand alone. However, there is a contribution to the duration of gadget use for activities outside of esports, such as studying or working, as well as a previous history of neck pain (Falah et al., 2023).

The results' implications are expected to add to and develop science, especially in physiotherapy, in terms of factors that affect neck function. In this case, it can add new insights that the level of psychosocial stress indirectly affects the physical health of individuals, including disruption of neck functional abilities, likewise with gender, which in this study relates to higher male interest, thus increasing the prevalence of the incidence of musculoskeletal problems in the context of the male gender. In addition, this study is expected to be used as primary data and developed in further research as comparative data with previous studies so that it becomes the basis for consideration of data collection for educational purposes or health interventions, seeing the differences in research results obtained between references.

Despite the results, the research implementation still faced significant challenges. One of the main obstacles was the respondents' need to understand the questionnaire questions, which resulted in intensive discussions between them, researchers, and fellow esports players. In particular, respondents tended to be more interested in completing the questionnaire via the researcher's smartphone, although this was a time-consuming and complicated process. Furthermore, the significant imbalance between the number of male (96.1%) and female (3.9%) respondents not only poses problems in representing the actual situation but also in understanding the impact on the functional ability of the neck. In addition, the need for more adequate references on the effect of stress levels on neck functional ability also makes it difficult, signaling the need for further research to fill the gap.

Gender has a significant unidirectional relationship with increasing the prevalence of neck pain incidence and a weak relationship with stress levels, where

the lower the stress level, the higher the index of impaired neck functional ability. Meanwhile, the variables of age, playing duration, type of player, and joining period had no relationship with the neck functional ability. However, age and duration of play have a weak contribution to the risk of neck functional ability experienced by esports players.

CONCLUSION

From the results of observational research on esports players, it was found that stress level and gender contributed to neck functional ability. At the same time, other variables, including age, player type, joining period, and playing duration, did not have a significant correlation with neck functional ability. This warrants further investigation, especially on the potential factors that affect the performance and neck function decline of esports players.

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CONFLICT OF INTEREST

The authors declared no conflict of interest.

REFERENCES

- Arovah, N. I. (2021). *Olahraga Terapi Rehabilitasi pada Gangguan Musculoskeletal*. UNY Press.
- Arthamevia, S. M., Bachtiar, F., Prabowo, E., & Purnamadyawati, P. (2022). Hubungan Antara Durasi Penggunaan Smartphone Dan Keluhan Nyeri Leher Pada Tim E-Sport Mobile Legend. *Jurnal Fisioterapi Terapan Indonesia or Indonesian Journal of Applied Physiotherapy*, 1(2), 2.
- Bailey, J. (2011). Muscle spasms and stiffness. *Multiple Sclerosis Society*.
- Batatolis, C., Karatrantou, K., Gymnopoulos, V., & Gerodimos, V. (2023). Functional Capacity Profile of the Cervical Joint in Young Adults: Sex-Related Differences. *Applied Sciences*, 13(20), 11326.
- Bestari, N. P. (2022). *Bangga! Indonesia Juara Ajang Kejuaraan eSport Dunia*. CNBC Indonesia. (Online).

- Di unduh dari <https://www.cnbcindonesia.com/tech/20221212091914-37-395967/bangga-indonesia-juara-ajang-kejuaraan-esport-dunia> [diakses 2023]
- Bhattacharjya, J., Baishya, R., & Dutta, B. (2019). Analysis of muscle strength and endurance in healthy young adults and association of muscle strength with muscle endurance.
- Yustianti, Y. T., & Pusparini, P. (2019). Hubungan intensitas pemakaian gawai dengan neck pain pada usia 15-20 tahun. *Jurnal Biomedika Dan Kesehatan*, 2(2), 71-76.
- Bogdănici, C. M., Săndulache, D. E., & Nechita, C. A. (2017). Eyesight quality and computer vision syndrome. *Romanian journal of ophthalmology*, 61(2), 112.
- Collins, J., & O'Sullivan, L. (2010). Psychosocial risk exposures and musculoskeletal disorders across working-age males and females. *Human Factors and Ergonomics in Manufacturing & Service Industries*, 20(4), 272-286.
- Dharmawan, T. M., Riskia, A. A. C., & Susilo, T. E. (2021, May). Pengaruh Telerehabilitation Berbasis Video Exercise Terhadap Smartphone Addiction dan Nyeri Leher Pada Pelajar di Era Pandemi Covid-19. In *Prosiding University Research Colloquium* (pp. 810-816).
- DiFrancisco-Donoghue, J., Balentine, J., Schmidt, G., & Zwibel, H. (2019). Managing the health of the eSport athlete: an integrated health management model. *BMJ open sport & exercise medicine*, 5(1), e000467.
- Maayah, M. F., Nawasreh, Z. H., Gaowgzeh, R. A. M., Neamatallah, Z., Alfawaz, S. S., & Alabasi, U. M. (2023). Neck pain associated with smartphone usage among university students. *Plos one*, 18(6), e0285451.
- Fathollahnejad, K., Letafatkar, A., & Hadadnezhad, M. (2019). The effect of manual therapy and stabilizing exercises on forward head and rounded shoulder postures: a six-week intervention with a one-month follow-up study. *BMC musculoskeletal disorders*, 20, 1-8.
- Fathuldeen, A., Alshammiri, M. F., & Abdulmohsen, A. (2023). Prevalence and awareness of musculoskeletal injuries associated with competitive video gaming in Saudi Arabia. *Cureus*, 15(4).
- Franks, R. R., King, D., Bodine, W., Chisari, E., Heller, A., Jamal IV, F., ... & Solomon, M. (2022). AOASM position statement on esports, active video gaming, and the role of the sports medicine physician. *Clinical Journal of Sport Medicine*, 32(3), e221-e229.
- Gallego Izquierdo, T., Pecos-Martin, D., Lluch Girbés, E., Plaza-Manzano, G., Rodriguez Caldentey, R., Mayor Melus, R., ... & Falla, D. (2016). Comparison of crano-cervical flexion training versus cervical proprioception training in patients with chronic neck pain: a randomized controlled clinical trial. *J Rehabil Med*, 48(1), 48-55.
- Ghamkhar, L., & Kahlaee, A. H. (2019). Is forward head posture relevant to cervical muscles performance and neck pain? A case-control study. *Brazilian journal of physical therapy*, 23(4), 346-354.
- Heryana, A. (2020). Buku ajar metodologi penelitian pada kesehatan masyarakat. *Bahan Ajar Keperawatan Gigi*, June, 1-187.
- Hendrawan, E. K., & Witarso, L. S. *Atlet E-sport: Main game kok malah stres?*
- Hughes, D. C., Ellefsen, S., & Baar, K. (2018). Adaptations to endurance and strength training. *Cold Spring Harbor perspectives in medicine*, 8(6), a029769.
- Jasmine, N. M. (2021). Gambaran psychological well-being pada pro-player tim e-sport Indonesia. *Buletin Riset Psikologi dan Kesehatan Mental*, 1(2), 1357-1368.
- Jull, G., Falla, D., Treleaven, J., & O'Leary, S. (2018). *Management of neck pain disorders: a research informed approach*. Elsevier Health Sciences.
- Jull, G., Sterling, M., Falla, D., Treleaven, J., & O'Leary, S. (2008). *Whiplash, headache, and neck pain: research-based directions for physical therapies*. Elsevier Health Sciences.
- Kazeminasab, S., Nejadghaderi, S. A., Amiri, P., Pourfathi, H., Araj-Khodaei, M., Sullman, M. J., ... & Safiri, S. (2022). Neck pain: global epidemiology, trends and risk factors. *BMC musculoskeletal disorders*, 23, 1-13.
- Kemenpora. (2022). *Kemenpora RI Dukung Piala Presiden Esport 2022 Menjadi Kuat Dalam Perkembangan Industri Olahraga Indonesia*. Kementerian Pemuda Dan Olahraga Republik Indonesia. (Online). Di unduh dari <https://www.kemenpora.go.id/detail/2425/kemenpora-ri-dukung-piala-presiden-esport-2022-menjadi-kuat-dalam-perkembangan-industri-olahraga-indonesia> [diakses 2023]
- Khadilkar, S. V., Yadav, R. S., & Patel, B. A. (2018). *Neuromuscular disorders*. Singapore: Springer.
- King, A. I. (2018). *The biomechanics of impact injury*. Cham: Springer, 153-175.
- Koh, K., Yamada, K., Enomoto, T., Kawai, A., Hamaoka, S., Chiba, S., & Iseki, M. (2020). Sex-specific impact of pain severity, insomnia, and psychosocial factors on disability due to spinal degenerative disease. *Pain Research and Management*, 2020.
- Lam, W. K., Chen, B., Liu, R. T., Cheung, J. C. W., & Wong, D. W. C. (2022). Spine posture, mobility, and stability of top mobile esports athletes: A case series. *Biology*, 11(5), 737.
- Lam, W. K., Liu, R. T., Chen, B., Huang, X. Z., Yi, J., & Wong, D. W. C. (2022). Health risks and musculoskeletal problems of elite mobile esports players: a cross-sectional descriptive study. *Sports Medicine-Open*, 8(1), 65.

- Larsson, L., Grimby, G., & Karlsson, J. (1979). Muscle strength and speed of movement in relation to age and muscle morphology. *Journal of Applied Physiology*, 46(3), 451-456.
- Do, Y. L., Nam, C. W., Sung, Y. B., Kim, K., & Lee, H. Y. (2017). Changes in rounded shoulder posture and forward head posture according to exercise methods. *Journal of physical therapy science*, 29 (10), 1824-1827.
- Mustafaoglu, R., Yasaci, Z., Zirek, E., Griffiths, M. D., & Ozdincler, A. R. (2021). The relationship between smartphone addiction and musculoskeletal pain prevalence among young population: a cross-sectional study. *The Korean journal of pain*, 34(1), 72.
- Nimbarte, A. D., Al Hassan, M. J., Guffey, S. E., & Myers, W. R. (2012). Influence of psychosocial stress and personality type on the biomechanical loading of neck and shoulder muscles. *International Journal of Industrial Ergonomics*, 42(5), 397-405.
- Palanichamy, T., Sharma, M. K., Sahu, M., & Kanchana, D. M. (2020). Influence of Esports on stress: A systematic review. *Industrial Psychiatry Journal*, 29(2), 191-199.
- Prasatya, R. (2022). Prestasi Timnas Esports Indonesia Masuk Papan Atas Dunia. *Detikcom*. (Online). Di unduh dari <https://sport.detik.com/sport-lain/d-6461941/prestasi-timnas-esports-indonesia-masuk-papan-atas-dunia> [diakses]
- Pristianto, A., Ramadhan, K. K., & Widodo, A. (2022). Kejadian musculoskeletal disorders (msds) selama work from home pada dosen fakultas ilmu kesehatan Universitas Muhammadiyah surakarta. *Jurnal Kesehatan*, 15(1), 93-100.
- Rewasan, R. B. H., Endaryanto, A. H., Priasmoro, D. P., & Abdullah, A. (2022). Hubungan Durasi Bermain Game Online Dengan Tingkat Nyeri Punggung Bawah Pada Komunitas E-Sport. *Jurnal Keperawatan Muhammadiyah*, 7(1).
- Rudolf, K., Soffner, M., Bickmann, P., Froböse, I., Tholl, C., Wechsler, K., & Grieben, C. (2022). Media consumption, stress and wellbeing of video game and eSports players in Germany: the eSports study 2020. *Frontiers in sports and active living*, 4, 665604.
- Brennan, J. A., Holt, G. R., Connor, M. P., Donald, P. J., Eusterman, V. D., & Hayes, D. K. (2012). Resident manual of trauma to the face, head, and neck. Alexandria, VA: American Academy of Otolaryngology—Head and Neck Surgery Foundation.
- Salk, R. H., Hyde, J. S., & Abramson, L. Y. (2017). Gender differences in depression in representative national samples: Meta-analyses of diagnoses and symptoms. *Psychological bulletin*, 143(8), 783.
- Van Vledder, N., & Louw, Q. (2015). The effect of a workstation chair and computer screen height adjustment on neck and upper back musculoskeletal pain and sitting comfort in office workers. *The South African journal of physiotherapy*, 71(1).
- Al Yasin, R., Anjani, R. R. K. A., Salsabil, S., Rahmayanti, T., & Amalia, R. (2022). Pengaruh sosial media terhadap kesehatan mental dan fisik remaja: a systematic review. *Jurnal Kesehatan Tambusai*, 3(2), 83-90.
- Zabihhosseinian, M., Holmes, M. W., Ferguson, B., & Murphy, B. (2015). Neck muscle fatigue alters the cervical flexion relaxation ratio in sub-clinical neck pain patients. *Clinical Biomechanics*, 30(5), 397-404.