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Correlation Between The Physical Activities and Physical Fitness Towards The Risk Musculoskeletal Disorder Of E-Sport Athletes

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ABSTRACT (9 pt)

This study aims to determine the relationship between physical activity and physical fitness on the risk of musculoskeletal disorders in E-sport athletes PORDA Yogyakarta City. A quantitative research design with a correlational approach was used, with a population of 29 E-sport athletes who are members of the Yogyakarta City PORDA team. Data collection was carried out using validated instruments, such as the International Physical Activity Questionnaire (IPAQ), Nordic Body Map, and physical fitness tests such as the Back Strength Test, Hand Grip Test, and 12-minute Cooper test. The results showed that physical activity has a significant relationship with musculoskeletal disorder complaints in several parts of the athlete's body, with a Sig.<0.05 value and a negative correlation between -0.314 to -0.551. Physical fitness also had a significant association with musculoskeletal disorder (Sig.<0.05 and r 0.412-0.544). These findings indicate the importance of physical fitness in preventing musculoskeletal disorders and improving athlete performance. Further research is recommended to examine the effectiveness of physical training programs in reducing the risk of injury and improving the performance of E-sport athletes.

INTRODUCTION

E-sports, known as video game-based competitive sports, have grown rapidly, with viewership estimated at 532 million by 2022 and expected to continue to rise (1). Although E-sports do not involve physical contact, E-sport athletes still face the risk of injury from repetitive physical activities, such as rapid hand movements and prolonged use of input devices. Previous research revealed that around 30% to 36% of E-sport athletes reported complaints of hand and wrist pain due to repetitive device use (Zwibel et al., 2019). This problem shows the importance of paying attention to athletes' physical health, especially regarding musculoskeletal disorder (MSD), which can affect their performance.

Research on the physical fitness of E-sport athletes shows that although the sport relies more on mental skills and hand-eye coordination, good physical condition can strengthen the muscles involved in playing activities, such as the wrists, arms and back (Wulandari et al., 2022). Optimal physical fitness plays an important role in preventing injuries from repetitive use of input devices such as keyboards and mice. E-sport athletes who spend long hours in non-ergonomic sitting positions increase the risk of injuries to certain body parts, such as lower back and wrist pain (Difrancisco-Donoghue et al., 2019; Bayrakdar et al., 2020).

Physical fitness, which involves components such as muscle strength and cardiorespiratory endurance, is important for E-sport athletes to prevent MSDs and improve performance (5) Although E-sport is known as a non-physical contact sport, athletes still need good physical fitness, especially in terms of back muscle strength to prevent low back pain syndrome (LBP) due to poor sitting patterns (Y. Chung et al., 2021). Previous research revealed that most E-sport athletes do not meet the physical activity standards recommended by the World Health Organization (WHO), which may increase the risk of injury (T. Chung et al., 2019).

Research on the physical fitness of E-sport athletes shows that good physical fitness is directly related to improved athlete performance (8). Good cardiovascular endurance or VO2max allows players to stay focused during long matches and speeds up recovery after intense gaming sessions (Le Meur et al., 2013). In addition, sufficient hand muscle strength is important in reducing the risk of musculoskeletal disorder injuries, such as carpal tunnel syndrome caused by repetitive hand movements (Loughnan, 2016). Therefore, physical fitness training, including hand muscle strengthening and cardiovascular endurance, can help E-sport athletes to improve physical health and prevent injuries.

This study aims to investigate the relationship between physical activity and physical fitness with the risk of musculoskeletal disorders in E-sport athletes at PORDA Yogyakarta City. With athletes spending an increasing amount of time in static seated positions, understanding the role of physical fitness in preventing injury is crucial to maintaining their physical health and supporting long-term performance. This study fills an existing research gap, focusing on physical fitness components such as cardiovascular endurance and hand muscle strength, which are rarely discussed in the context of E-sports. The findings from this study are expected to provide new insights for the development of more effective training programs for E-sport athletes, and help improve their quality of life and performance in competition.

RESEARCH METHOD

This study uses a non-experimental design with a correlational approach and cross-sectional design, which aims to connect the independent variable with the dependent variable. This research was conducted at Yogyakarta State University in January 2025. The population in this study were 29 E-sport athletes who were members of the Yogyakarta City PORDA E-sport Team. The sampling technique used total sampling, which involved all members of the population who met the criteria as research subjects due to the limited population.

To collect data, several instruments were used that have been proven valid and reliable. Physical activity was measured by the International Physical Activity Questionnaire (IPAQ) short form, with a validity of 0.442 and reliability of 0.713. Musculoskeletal disorders were measured with the Nordic Body Map (NBM) questionnaire, which has a validity of r = 0.387 and a reliability of 0.919. Physical fitness tests included the 12-minute Cooper test for VO2Max with a validity of 0.997, hand muscle strength test using a hand grip dynamometer (validity 0.880, reliability 0.938), and back muscle strength test using a back and leg dynamometer (validity 0.745, reliability 0.960). Data analysis procedures were carried out using appropriate statistical tests to test the relationship between the variables studied

RESULTS AND DISCUSSION

This study was used to determine the relationship of physical activity and physical fitness to musculoskeletal disorders and the level of achievement of Yogyakarta City E-sport PORDA athletes. This research was conducted on Saturday, January 26, 2025 with 29

male subjects. This research was conducted at the Yogyakarta State University Community Sports Park. Based on the results of data collection that has been done, the following results can be obtained.

Table 1. Subject Characteristics.

Variabel		**Mean ± SD**	**f**	%
Age	16-19	20.96 ± 4.20	10	34.48
	20-29		19	65.51
Length of time playing E-sport	≤5 years	6.14 ± 2.81	15	51.72
	6-10 years		12	41.37
	> 10 years		2	6.89

In the table above, it can be seen that the characteristics of the subject can be described, namely from the overall data of 29 athletes, the average age of the subject is 20.96 ± 4.20 years with an age category of 16-19 years as many as 10 subjects, ages 20-29 as many as 19 subjects. Then the subject has an average length of play of 6.14 ± 2.81 years with a category of less than 5 years as many as 15 subjects, 6-10 years as many as 12 subjects and more than 10 years as many as 2 subjects.

Table 2. Physical Fitness

Test	**Mean ± SD**	**Category**					
		Very Poor %(n)	**Poor %(n)**	**Fair %(n)**	**Good %(n)**		
Back Strengh	79.24 ± 15.66	41.4 (12)	44.8 (13)	13.8 (4)	-		
Hand Grip (right)	33.91 ± 3.67	3.4 (1)	72.4 (21)	24.1 (7)	-		
Hand Grip (left)	32.32 ± 4.03	-	62.1(18)	34.5 (10)	3.4 (1)		
VO2Max	29.65 ± 11.88	65.5 (19)	20.7(6)	12.8 (4)	-		

Based on the table 2, the average value of the back strength test is 79.24 ± 15.66 with the results of the frequency distribution in the "very less" category of 41.4% (12 subjects), "less" by 44.8% (13 subjects), and "enough" by 13.8% (4 subjects). Then for the results of the right hand grip test, an average of 33.91 ± 3.67 was obtained with the results of the frequency distribution in the "very less" category of 3.4 (1 subject), "less" by 72.4% (21 subjects), and "sufficient" by 24.1% (7 subjects). Furthermore, the left hand grip test obtained an average of 32.32 ± 4.03 with the results of the frequency distribution in the "less" category of 62.1% (18 subjects), "sufficient" of 34.5% (10 subjects), and "good" of 3.4% (1 subject). Furthermore, the VO2Max test results obtained an average of 29.65 ± 11.88 with the results of the frequency distribution of the "very poor" category of 65.5% (19 subjects), "poor" by 20.7% (6 subjects), and "sufficient" by 12.8% (4 subjects).

Table 3. Physical Activity

	Mean ± SD	Kategori		
		Low %(n)	Moderate %(n)	High%(n)
Total Physical Activity (MET- Minute/Week)	1175.53 ± 1513.87	40 (12)	50 (15)	10(2)

From the table above, the average physical activity of the subjects was 1175.53 ± 1513.87 with the results of the frequency distribution in the "low" category of 40% (12 subjects), "moderate" of 50% (15 subjects), and "sufficient" of 13.8% (4 subjects).

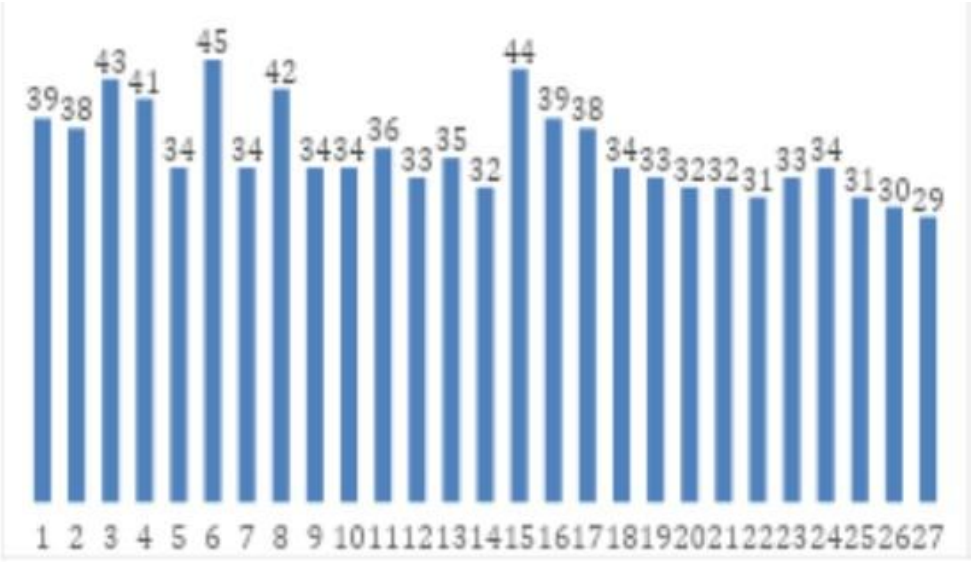

Figure 1. Musculoskeletal Disorder Questionnaire Chart

Pain/stifness in part:

1. Upper neck
2. Lower neck
3. Left Shoulder
4. Right Shoulder
5. Left upper arm
6. Back
7. Right upper arm
8. Waist
9. Ass
10. Left Elbow
11. Right Elbow
12. Left forearm
13. Right forearm
14. Left wrist
15 Right wrist
16. Left hand
17. Right hand
18. Left thigh
19. Right thigh
20. Left knee
21. Right knee
22. Left calf
23. Right calf
24. Left ankle
25. Right ankle
26. Left foot
27. Right foot

Based on the graph above, it can be seen that the highest score refers to the aspect of the back with a score of 45. Then the second highest aspect is the right wrist with a score of 44, and the third highest is the left shoulder with a score of 43.

Table 4. Correlation Test Between Physical Activity, Physical Fitness Forwards The Risk of Musculoskeletal Disorder

Pain / Stiffness in part	**Spearman Test**	**Physical Activity**	***Back Strengh Test***	***Hand Grip Test* (right)**	***Hand Grip Test* (left)**	**VO2Max**
Upper neck	*r*	-0.167	-0.276	-0.188	-0.411*	-0.215
	Sig. (2-tailed)	0.385	0.148	0.328	0.027	0.263
Lower neck	*r*	-0.441*	0.066	0.096	-0.172	-0.101
	Sig. (2-tailed)	0.035	0.732	0.622	0.372	0.604
Left Shoulder	*r*	-0.445*	-0.075	-0.232	-0.316	-0.424*
	Sig. (2-tailed)	0.045	0.700	0.226	0.095	0.022
Right Shoulder	*r*	-0.314*	-0.241	-0.449*	-0.484**	-0.361
	Sig. (2-tailed)	0.028	0.208	0.004	0.008	0.054
Left upper arm	*r*	-0.281	-0.203	-0.188	-0.235	-0.146
	Sig. (2-tailed)	0.140	0.292	0.330	0.219	0.448
Back	*r*	-0.469*	-0.568*	-0.155	-0.194	-0.198
	Sig. (2-tailed)	0.023	0.038	0.422	0.312	0.303
Right upper arm	*r*	-0.080	-0.300	-0.202	-0.207	-0.404*
	Sig. (2-tailed)	0.681	0.113	0.293	0.281	0.030
waist	*r*	-0.414*	-0.511**	-0.101	-0.320	-0.224
	Sig. (2-tailed)	0.035	0.005	0.602	0.091	0.242
ass	*r*	-0.086	-0.693*	-0.104	-0.246	-0.153
	Sig. (2-tailed)	0.658	0.032	0.592	0.199	0.429
Left elbow	*r*	-0.281	0.052	-0.052	-0.411**	-0.087
	Sig. (2-tailed)	0.140	0.789	0.789	0.010	0.653
Right elbow	*r*	-0.284	-0.269	-0.343*	-0.484*	-0.164
	Sig. (2-tailed)	0.135	0.159	0.029	0.036	0.394
Left forearm	*r*	-0.457*	-0.233	-0.472**	-0.514**	-0.251
	Sig. (2-tailed)	0.013	0.233	0.010	0.004	0.189
Right forearm	*r*	-0.332	-0.208	-0.482*	-0.343	-0.145
	Sig. (2-tailed)	0.079	0.208	0.038	0.069	0.454
Left wrist	*r*	-0.413*	-0.068	-0.081	-0.530*	-0.203
	Sig. (2-tailed)	0.034	0.727	0.675	0.023	0.291
Right wrist	*r*	-0.449*	-0.202	-0.653*	-0.383*	-0.270
	Sig. (2-tailed)	0.033	0.294	0.018	0.040	0.156
Left hand	*r*	-0.551*	-0.009	-0.256	-0.494**	-0.217
	Sig. (2-tailed)	0.022	0.964	0.180	0.006	0.259
Right hand	*r*	-0.405*	-0.076	-0.713*	-0.134	-0.178
	Sig. (2-tailed)	0.037	0.696	0.013	0.489	0.355
Left thigh	*r*	-0.190	-0.180	-0.366	-0.595*	-0.431*
	Sig. (2-tailed)	0.323	0.350	0.051	0.012	0.049
Right thigh	*r*	0.087	-0.239	-0.060	0.024	-0.203
	Sig. (2-tailed)	0.652	0.211	0.758	0.902	0.290
Left knee	*r*	-0.388*	-0.481*	-0.433	-0.359	-0.068

	Sig. (2-tailed)	0.038	0.038	0.199	0.056	0.727
Right knee	*r*	-0.183	-0.576*	-0.176	-0.298	-0.393*
	Sig. (2-tailed)	0.343	0.036	0.361	0.117	0.035
Left calf	*r*	0.183	-0.195	0.073	0.114	0.016
	Sig. (2-tailed)	0.342	0.310	0.706	0.556	0.933
Right calf	*r*	0.202	-0.203	0.036	0.084	-0.072
	Sig. (2-tailed)	0.294	0.290	0.853	0.666	0.712
Left ankle	*r*	0.080	-0.060	-0.082	0.104	0.022
	Sig. (2-tailed)	0.681	0.757	0.673	0.593	0.911
Right ankle	*r*	-0.064	-0.204	-0.293	-0.024	-0.033
	Sig. (2-tailed)	0.742	0.290	0.123	-0.900	0.867
Left foot	*r*	0.343	-0.113	0.045	0.158	-0.068
	Sig. (2-tailed)	0.069	0.559	0.816	0.143	0.727
Right foot	*r*	-	-	-	-	-
	Sig. (2-tailed)	-	-	-	-	-

Based on the table of data processing results above, it can be seen that the results of musculoskeletal disorder 11 out of 27 components, namely complaints of pain / stiffness in the lower neck, right shoulder, left shoulder, back, waist, left forearm, left wrist, right wrist, left hand, right hand and left knee have a significant relationship with musculoskeletal disorder in Yogyakarta City PORDA E-sport athletes. The Correlation Coefficient (r) value of - 0.314 to - 0.551 indicates a moderate to moderately strong negative relationship between the two variables. The existence of a negative relationship is when one variable increases, the other variable tends to decrease.

Back strength test data with a sign (*) or (**) means that there is a significant relationship between the physical fitness component, namely back muscle strength with complaints of pain / stiffness in the back, waist, buttocks, left knee and right left because it has a Sig value. (2-tailed) <0.05. With a Correlation Coefficient (r) value of -0.481 to -0.693 indicating a moderate to strong negative relationship.

The hand grip test data (right) shows a correlation between the grip strength of the right hand muscles and complaints of pain / stiffness in the right shoulder, right elbow, left elbow, right forearm, right wrist, and right hand with a Sig value. (2-tailed) <0.05. Correlation Coefficient (r) values of -0.343 to -0.713 indicate a moderate to strong negative relationship. Furthermore, the hand grip test data (left) shows a correlation between the grip strength of the left hand muscles and complaints of pain / stiffness in the upper neck, right shoulder, left elbow, right elbow, left forearm, left and right wrists, left hand, and left thigh with a Sig value. (2-tailed) <0.05. Correlation Coefficient (r) values of -0.411 to -0.595 indicate a moderate to strong negative relationship.

The VO2max test results show a correlation between cardiovascular endurance and complaints of pain / stiffness in the left shoulder, right upper arm, left thigh, right knee with a Sig value. (2-tailed) <0.05. Correlation Coefficient (r) values of -0.393 to -0.431 indicate a moderate to strong negative relationship. This negative relationship indicates

that the more one variable increases, the other variable tends to decrease and the closer to -1, the stronger the negative relationship.

The results of this study indicate that there is a significant relationship between physical activity and musculoskeletal disorder in several components of pain / stiffness complaints in the lower neck, right shoulder, left shoulder, back, waist, left forearm, left wrist, right wrist, left hand, right hand and left knee with a moderate to strong negative relationship. So it can be interpreted that the higher the level of physical activity, the lower the value of musculoskeletal disorder for E-sport athletes.

In line with previous research, it has been shown that E-sport athletes experience an increase in eye, back, wrist, finger, neck and foot health problems. The study reported that most E-Sport athletes had intense training patterns of more than 100 hours per week (9). Grabara (2023), also found that higher physical activity was associated with a reduced risk of musculoskeletal injuries in a poulation of athletes, including athletes involved in computer-based sports.

Musculoskeletal disorders (MsDs) are defined as disorders involving skeletal muscles related to biomechanical factors where muscles receive static loads in a repetitive and persistent frequency (11). Research also shows that around 40% of respondents have low levels of physical activity, which also affects their musculoskeletal health (Seo & Jung, 2016).

In addition, the results of this study also show that physical fitness, especially in terms of back muscle strength, handgrip strength, and cardiovascular endurance, has a significant influence on reducing musculoskeletal disorder (MSDs) complaints in E-sport athletes. The observed negative relationship indicates that the better the physical fitness, the lower the complaints of pain or stiffness. Therefore, a physical fitness training program that focuses on muscular strength and endurance is essential to reduce the risk of musculoskeletal disorders in E-sport athletes.

According to Difrancisco-Donoghue et al., (2019b) a survey conducted on 65 E-sport players in the US and Canada revealed that they practiced between 3 to 10 hours per day and experienced various musculoskeletal complaints, such as eyestrain, neck, back, and hand and wrist pain. However, many players did not participate in physical exercise and only a few sought medical attention. This highlights the importance of physical fitness in preventing or reducing physical complaints often experienced by E-sport players, such as neck, back, hand and wrist pain. Although these E-sport athletes train for long periods of time, most of them do not pay attention to their overall fitness, leading to an increased risk of MSDs (2).

Therefore, implementing a physical training program that focuses on muscular strength and endurance is necessary to prevent injuries and support optimal performance for both local and professional E-sport athletes. A structured and focused physical training program can help improve flexibility and muscle strength, which are needed to support healthy posture during long training sessions or competitions. Research by Choi et al. (2021) showed that muscle strengthening and stretching exercises can significantly reduce muscle tension and improve athletes' physical health, which in turn contributes to their improved performance in E-sport competitions.

CONCLUSION

The results showed a significant between the level physical activity and musculoskeletal disorder (MSDs) in E-sport athletes. The higher level of physical activity and physical fitness, such as back muscle strength, hand grip, and cardiovascular endurance, the lower the complaints of pain or stiffness in various parts of the body such as the neck, shoulders, back, hanfs, and knee. This suggest that physical activity plays an important role in preventing and reducing the risk of musculoskeletal disorder that are often experienced due to long duration of E-sport training and static, repetitive postures. Previous research also support these fidings highlighting the lack of attention to physical exercise and overall fitness among E-sport athletes as one of the main causes of increased injury risk.
Based on this research, it is recommended that E-sport athletes have a structured and routine physical training program, focusing on muscle strengthening, increase endurance, and muscle and joint flexibility for E-sport athletes. This program should be an integral part of their daily training routine to maintain physical health and support optimal performance in competition. Education about importance of physical fitness and supervision from a healthcare professional or fitness trainer is also highly recommended, to ensure the exercise are perfomed safely and effectively. With the right preventive approach, E-sport athletes can minimize their risk of injury and prolong thier professional carees in this field.

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