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Physical Fitness Leads to Risk of Delayed Onset Muscle Soreness in the Lower Extremities of Sangsekarta Dancers, Malang

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ABSTRACT

Low physical fitness and high dance intensity cause eccentricity, leading to microscopic damage to muscle fibers. That condition leads to an inflammatory response, pain, or Delayed Onset Muscle Soreness (DOMS). It is a condition in which muscle soreness occurs after a high-intensity activity that occurs after 24-48 hours. This study aims to see the relationship between physical fitness and the risk of lower extremity DOMS in dancers registered in KEPK-FKUMM with the ethical number E.5.a/042/LEPK-UMM/II/2024. The research method used an analytical observational design with a cross-sectional study approach. The research respondents consisted of 62 dancers out of a total of 120 based on the purposive sampling technique. Inclusion criteria included traditional and modern dancers who had practiced 2 days before the study. Meanwhile, the exclusion criteria were dancers in the rehabilitation or injury phase. Data testing using correlation analysis with a p-value of <0.001 ($p<0.05$) means a significant relationship exists between physical fitness and the risk of lower extremity DOMS in dancers. The coefficient value of -0.731 indicates a strong relationship. The coefficient value means that the higher a person's physical fitness, the lower the level of DOMS.

Keywords : Dancer injury; delayed onset muscle soreness; lower extremity; VO_2Max; physical fitness

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INTRODUCTION

Indonesia is a country rich in cultural diversity in dance, with structured and expressive movements[1]. Dance art performed with motion, rhythm, and taste (wiraga, wirama, and wirasa)[2]. Similar to athletes, dancers have a high risk of injury. These injuries occur not only during performance but also during the repetitive training process. Physical skills and techniques performed to avoid the risk of injury[3]. Dancer injuries into the upper and lower extremities are at risk levels of up to 25%. The internal and external factors influence these injuries. However, the duration of dance training, which reaches 34 hours a week with high intensity, has more potential to increase the risk of injury. The potential for hamstring injury in the lower extremities is 54%, quadriceps 36%, and gastrocnemius 48%[4]. At the same time, Delayed Onset Muscle Soreness (DOMS) in Sangsekarta dancers arises as a result of dance movement patterns by 19.4%[5].

DOMS is a condition of muscle pain accompanied by stiffness after excessive activity for approximately 24-48 hours[6]. It is a condition of muscle damage in the form of muscle tears that occur due to physical activity involving excessive muscle contraction or inconsistent training. Dancers experience discomfort due to painful sensations in the muscles, causing limitations in movement[6].

Training with intense and dynamic movements can trigger muscle stretching during specific movements that lead to microscopic damage to muscle fibers, especially in the eccentric phase. This damage to muscle fibers causes an inflammatory response in the body, leading to DOMS. Physical fitness is important in maintaining muscle endurance and performance during intense dancing activity. Dancers with better physical fitness levels are expected to adapt to high training loads, thereby reducing the risk of DOMS[7]. However, the relationship between the level of physical fitness and the risk of DOMS in dancers in Sangsekarta, has yet to be widely studied. This study tries to fill this gap by exploring how physical fitness affects the risk of DOMS in dancers. More effective training and recovery strategies can be developed for dancers.

METHODS

This observational research used a cross-sectional study design conducted at Sangsekarta Dancer, Malang. A purposive sampling technique determined as many as 62 out of 120 dancers. The method allows researchers to take samples using the appropriate criteria for the study. The characteristics of the samples involved in this study were dancers who had practiced two days before pain measurement and were included in the category of traditional and or modern dancers. In contrast, the samples not taken in this study were those in the rehabilitation or injury phase[8].

This study includes physical fitness as an independent variable measured using VO_2Max measurement and DOMS as a dependent variable determined using the Visual Analogue Scale (VAS). VO_2Max measurement calculated through the equation;[9]

$$VO_2Max = 15\frac{HR\ Max}{HR\ Rest} \quad \text{.....}^{9}$$

Heart rate max (HRMax) is calculating 220 minus age, while heart rate rest (HRRest) is obtained by calculating the pulse rate in one minute when a dancer is in a state of inactivity or rest[10]. VO_2Max has a validity value of 0.745, and VAS has a validity value of 0.937, which means that both measurement parameters are valid[11].

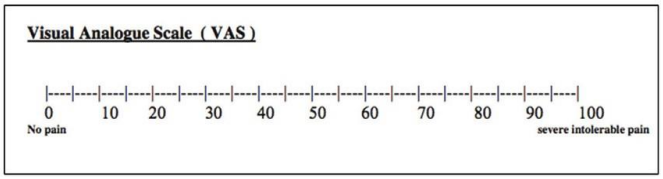

Figure 1. Visual Analogue Scale (VAS)

This study used a data normality test using the Kolmogorov-Smirnov. The normality test results show that the data has a p-value lower than 0.05. Based on this value, continued the non-parametric Spearman correlation test[12].

RESULT

The characteristics of the study respondents are shown in Table 1. The characteristics of respondents were based on age criteria, with the highest percentage reaching 67% in the age group 15-19 years old (middle adolescence). In contrast, the lowest rate was 1% in the age group of 22 years old. Overall, the respondents' gender with the highest percentage reached 97% for female respondents, while male respondents only reached 3%. When viewed from the Body Mass Index (BMI), respondents in the normal category reached 78%, while those in the overweight category amounted to 2%.

The importance of dance type in this study is reflected in the data, where 90% of respondents identified as traditional dancers while only 10% were involved in modern dance. Based on dance experience, 76% of respondents had been dancing for more than 3 years, and there were 3% with two years of dance experience. Duration of dancing was also considered, with 52% of respondents dancing for less than 1 hour and 48% showing more than 1 hour of involvement in each dance session. Overall, this table provides a comprehensive picture of the variations in the characteristics of the respondents who were the focus of this study.

Table 1 Characteristics of Respondents

Characteristics	Distribution n	%
Age		
Middle Adolescene (15-19 years old)	45	67
Late Adolescene (20-24 years old)	17	33
Gender		
Male	2	3
Female	60	97
Body Mass Index (BMI)		
Underweight	12	20
Normal	47	78
Overweight	2	2

Type of Dance		
Traditional	55	90
Modern	6	10
Dancing Period	13	21
≤1 year	2	3
2 year	47	76
>3 year		
Duration of Dancing	30	52
≤1 hour	32	48
>1 hour		
VO_2Max		
Superior	0	0
Excellent	0	0
Good	5	9
Fair	15	25
Poor	16	27
Very Poor	23	39
DOMS		
With pain	38	62
No-pain	23	38

The characteristics of respondents in Table 1 generally show that dancers have a relatively poor fitness level with VO2Max values in the very poor (39%), poor (27%), fair (25%), and good (9%) categories. This condition causes dancers to have more DOMS in the lower extremities. The normality test with Kolmogorov-Smirnov in Table 2 was carried out because the number of samples of more than 50 showed that the data assumption was not normal.

Table 1 Kolmogorov-Smirnov Test

Variabel	**n**	**mean**	**std**	**p-value**
DOMS Physical Fitness	62	0.000	0.618	0.021

The normality analysis in Table 2 shows that both variables show a significance value of p 0.021 <0.05, which means that the data is not normally distributed. A mean of zero indicates the balance in the data, while the standard deviation (std) value of 0.618 shows a relatively slight variation. That means that most of the values in the dataset are consistent and stable in the measurements or results obtained. Hence, the correlation uses the Spearman test[12].

Table 2 Spearman's Correlation Test

Independent Variable	**Dependent Variable**	**n**	**p-value**	***r***
Dancing Intensity	DOMS	62	<0.001	-0.731

Table 3 above shows the relationship between DOMS and fitness <0.001 (p<0.05). This value indicates a relationship between the two variables, namely DOMS pain, and fitness, with each significant

r value of -0.731. The *r* value in this study is a strong category, concluding that the higher the dancer's physical fitness, the lower the risk level for DOMS.

DISCUSSION

DOMS is a condition of muscle soreness that occurs after physical activity, especially unusual or high-intensity exercise. This soreness usually starts between 12 and 24 hours after the workout and can peak within 1 to 3 days. DOMS can be categorized as the effects of muscle damage caused by muscle tears that arise from physical activity, excessive muscle contraction, or inconsistent training. This condition causes discomfort to the dancer due to the sensation of pain located in the muscle, limiting movement[6].

Dancing activities are classified as high intensity, causing eccentric events due to training loads that cause deformity or microscopic damage to muscle fibers. The damage triggers an inflammatory response accompanied by the release of substances such as prostaglandin, bradykinin, and histamine, which can cause a sensation of pain due to muscle inflammation[7]. Then, after the dance activity, there is an increase in blood flow to the muscles, known as the reperfusion ischemia process, which can cause oxidative stress in the muscles. This stress can damage muscle cells and trigger an inflammatory response, which then causes DOMS[13].

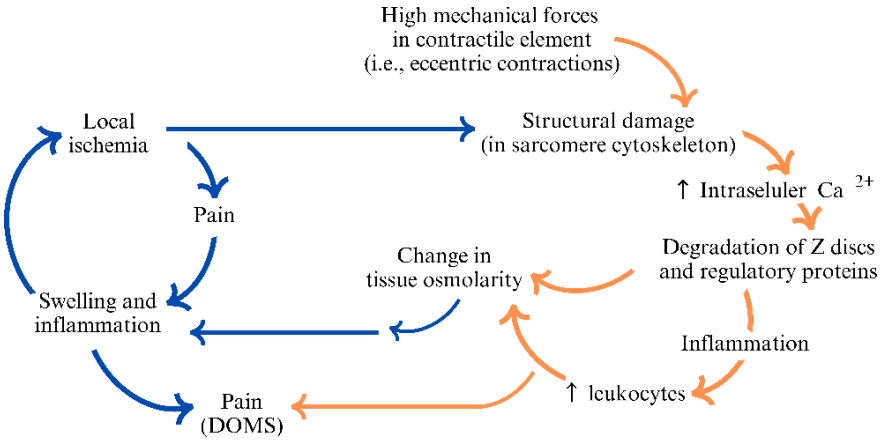

Figure 2. Mechanisms of DOMS

Figure 2 shows the process of the onset of DOMS, which begins with high-intensity dance activities that cause structural damage to the muscles. The damage can result in the release of cellular components, such as enzymes and calcium ions (Ca^{2+}), into the damaged muscle cytoplasm. After that, there is an increase in intracellular Ca^{2+} concentration, which triggers a biochemical response such as Z disk degeneration. This degeneration can disrupt the structural and functional integrity of the muscle, causing osmotic changes in the cell's fluid or triggering inflammation from leukocytes that act as the immune system. These events continually lead to DOMS[14].

The intensity of the Bapang dance requires a good fitness level to minimize excessive fatigue in the muscles[3]. This need is due to eccentric contractions in the muscles. This contraction occurs when

the muscle extends and produces force[15]. When the load is greater than the force produced, then when the muscle extends, a contraction will occur[16]. Muscle contraction requires energy from glycolysis or end metabolism. When accompanied by activity and contraction events in the muscle and coupled with training loads, this final metabolism will create a risk of muscle tears. In addition to physical fitness, several factors may cause DOMS, including age, type of dance, gender, and duration of dance[4].

The VO_2Max value peaks at the age of 18-20 and begins to decline after the age of 28. The progressive decline in VO_2Max can be controlled by regular high-intensity exercise[17]. Previous research explains that most individuals between the ages of 18 and 21 do physical activity with an average light intensity and rarely do sports. If someone who has low physical activity performs an activity with a high intensity of exercise, the risk of DOMS will be higher than that of someone who exercises with low intensity[6]. However, it is not entirely influenced by age. Another factor is gender, because physical characteristics in men, such as muscle mass, are greater than in women. The level of flexibility of female muscles is higher than that of men[18]. Women also have a menstrual cycle, which results in fluctuations in estrogen and progesterone levels, increasing the body's sensitivity to pain[19].

Each individual has their limitations on tolerance and weight. The lower a person's weight, the lower the potential risk of injury[20]. A research study showed that individuals who have a BMI that is less than or exceeds the standard limit have a percentage of injuries that are 15%-48% more vulnerable than individuals whose BMI values are in the normal category. These physical components are very influential on every dance movement[4].

Dance has types based on its categories: traditional, creation, contemporary, and modern. Each type of dance has movement characteristics with different agility and movement patterns. This difference affects the energy needed to dance[21]. Modern dance has a high-intensity value compared to other types of dance. This difference certainly impacts the risk of DOMS. In this study, respondents performed traditional and modern Bapang dance movements[22].

Another study also mentioned that the body can adapt to the habit of dancing. So, DOMS symptoms can depend on these conditions. Dancers with low dance intensity will experience muscle shortening. Conversely, for dancers with high intensity, the level of muscle flexibility increases. Muscle shortening impacts muscle strength and decreases flexibility, causing dancers to easily experience DOMS[23]. In dancing, physiological responses depend on the intensity, duration, and length or frequency of exercise. Previous research states that dancers who exercise for 1-10 hours per week experience increased muscle flexibility. This results in a lower risk of DOMS compared to dancers who exercise 2 hours a week[24].

CONCLUSIONS AND RECOMMENDATIONS

The average intensity of dancing in Sangsekarta dancers is categorized as low, with a training duration of 1-2 hours for 2 days a week. The pain felt appeared 24-48 hours after training with high intensity. Thus, physical fitness in Sangsekarta dancers has a strong relationship with the risk of DOMS in the lower extremities. With these results, there is a need for management efforts to control the

symptoms that arise due to DOMS. However, further research on other factors causing DOMS is highly recommended.

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