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Influence of outdoor education learning models and mental toughness on cardiorespiratory fitness levels

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ABSTRACT

This study aimed to determine the influence of the outdoor education learning models and mental toughness on cardiorespiratory fitness (CRF) levels. A quasi-experimental method was used, employing a 2x2 factorial design. The 2x2 factorial design in this study involved two learning models: the TGT (Team Games Tournament) and STAD (Student Teams Achievement Division), along with two levels of mental toughness: high and low. The sample consisted of 80 students from Jakarta State University, enrolled in recreational sports courses. The subjects in this study were given the TGT and STAD learning models over a period of 9 weeks. The tests administered during the pretest measured cardiorespiratory fitness using the Bleep Test and mental toughness using a questionnaire. The results showed that both the TGT and STAD outdoor education models have a statistically significant impact on students' CRF levels ($p<0.05$). Additionally, an interaction effect was observed between the learning model and the level of mental toughness ($p<0.05$). Specifically, the TGT model showed a greater influence on CRF in students with high mental toughness ($p<0.05$), while the STAD model was more effective in students with low mental toughness ($p<0.05$). Both the outdoor education learning model and mental toughness influence the level of CRF, suggesting that outdoor education can enhance CRF, which may positively affect academic performance and mental health of students.

KEYWORDS

Cardiorespiratory Fitness; Mental Toughness; Outdoor Education; Students

1. INTRODUCTION

Cardiorespiratory fitness (CRF) refers to the capacity of the circulatory and respiratory systems to supply oxygen to skeletal muscle mitochondria to produce the energy required during physical activity. CRF is an essential marker of physical and mental health, as well as academic achievement (Raghuveer et al., 2020; Ross et al., 2016).

Over the past three decades, it has been firmly established that low levels of CRF are associated with a high risk of cardiovascular diseases and death from any cause, as well as higher rates of mortality from various cancers, especially breast and colon cancers (Blair et al., 1989; Laukkanen et al., 2004; Sawada et al., 2014; Sui et al., 2007). Importantly, increased CRF has been associated with a reduced risk of death (Lee et al., 2010). It is undoubtedly essential for individuals to maintain stable CRF levels to preserve their health. Although CRF is now recognized as an essential marker of cardiovascular health, it remains the only significant risk factor not routinely assessed in clinical practice. One way to maintain and increase CRF levels is to engage in physical activity or exercise regularly and consistently.

Case studies conducted by Mygind (2007) show that when indoor and outdoor learning contexts are combined, the level of physical activity is significantly higher. Additionally, outdoor education is generally recommended for improving physical health.

Outdoor education learning provides an excellent opportunity for individuals to carry out physical activities that impact cardiorespiratory fitness levels (Finn et al., 2018; Raghuveer et al., 2020; Ross et al., 2016). Outdoor education also provides opportunities for those who do it to expand their knowledge of academic subject matter. This is based on environmental-based education initiatives that have shown a good impact on improving student academic achievement (Martin & McCullagh, 2011; Nguyen, 2015; Sandell & Öhman, 2013). The outdoor education learning model can use cooperative learning to provide a forum for individuals to interact with others in the group learning process (Fiskum & Jacobsen, 2013). This will impact learning output not only by providing the opportunity for physical activity, which increases the level of cardiorespiratory fitness, but also by increasing the individual's ability to socialize, leadership, and life skills needed in the life process (Beames & Atencio, 2008; Fox & Avramidis, 2003).

The outdoor education program (OEP), when conducted regularly, can enhance social, academic, physical, and psychological abilities (Becker et al., 2017). Various types of outdoor education can be implemented, including the Team Games Tournament (TGT) and the Student Teams Achievement Division (STAD).

The TGT is a cooperative learning approach that engages all participants equally, includes students as peer tutors, and incorporates elements of play (Jahring, 2017). The STAD is another form of cooperative learning based on group activities that emphasize learning as a social exchange of knowledge. In STAD, each student is responsible for their own learning and is encouraged to help others in reaching their goals (Motwani et al., 2022).

Physical activity conducted through outdoor education has a positive impact on mental health. Research by Stamatis et al. (2020) shows the existence of empirically-based interventions designed to train mental toughness in physical activity. Mental toughness is studied as a distinguishing factor between individuals, enabling them to face challenges effectively and endure under pressure (Lin et al., 2017).

The studies described above do not explain the influence of the outdoor education learning models and mental toughness on CRF levels. However, it is supported by findings that suggest the OEP could be used to assess physical abilities and mental health in the future (Becker et al., 2017). Based on this, the current study is the latest to explore the impact of the outdoor education learning models and mental toughness on CRF levels.

2. METHODS

This study aimed to determine the influence of the outdoor education learning models and mental toughness on cardiorespiratory fitness (CRF) levels. A quasi-experimental method was used, employing a 2x2 factorial design. The 2x2 factorial design in this study involved two learning models: the TGT (Team Games Tournament) and STAD (Student Teams Achievement Division), along with two levels of mental toughness: high and low.

The participants were 146 physical education, health, and recreation students from Jakarta State University, enrolled in recreational sports courses. The subjects in this study were given the TGT and STAD learning models over a period of 9 weeks for physical education students. A mental toughness test was administered to all 146 students, and the results were ranked from highest to lowest scores. Based on these rankings, groups were formed for the TGT (Team Games Tournament) and STAD (Student Team Achievement Division) learning models according to the level of mental toughness.

To determine the distribution of mental toughness levels, Verducci (1974) explained that 27% of the sample is classified as the upper (highest) group, and 27% is classified as the lower (lowest) group, while the middle portion is used as the unit of analysis. This concept was used to classify the sample's mental toughness levels. Therefore, the number of samples for each mental toughness level was calculated as follows: the group of students with high mental toughness (B1) represents 27% of 148, which equals 39.96, rounded up to 40 samples, and the group with low mental toughness (B2) also represents 27% of 148, rounded to 40 samples. In total, the sample consisted of 80 students, divided into four groups using the ordinal pairing method, with each group containing 20 samples. The tests administered during the pretest measured cardiorespiratory fitness using the Bleep Test and mental toughness using a questionnaire. The final test measured cardiorespiratory fitness again using the Bleep Test.

The data analysis was conducted using IBM SPSS Statistics. Specifically, a two-way analysis of variance (ANOVA) was performed in SPSS to assess both the main effects of each independent factor and their interaction effects on the dependent variables. Prior to this, analysis requirements such as normality and homogeneity tests were conducted. If the results of the variance analysis indicated a main effect between the independent and dependent variables, and there was an interaction between the independent and dependent variables, the Tukey test was conducted. The significance level for all tests was set at $\alpha = 0.05$.

3. RESULTS

Based on the findings presented in Table 1, the two-way ANOVA analysis revealed a statistically significant effect of the outdoor education learning models (TGT and STAD) on cardiorespiratory fitness (CRF) levels, with a p-value of .000.

Table 1. Effect of outdoor education learning models on CRF levels

Tests of Between-Subjects Effects					
Dependent Variable:	**Cardiorespiratory Fitness (CRF)**				
Source	**Type III Sum of Squares**	**df**	**Mean Square**	**F**	***p***
Corrected Model	946.900[a]	3	315.633	98.807	.000
Model * Mental	864.900	1	864.900	270.751	.000

Note: a. R Squared = .892 (Adjusted R Squared = .883)

Regarding the interaction between the outdoor learning models and the level of mental toughness, a significant p-value of 0.000 (< α = 0.05) was obtained. This indicates that there is an interaction effect between the outdoor learning models and the level of mental toughness on students' cardiorespiratory fitness (Figure 1).

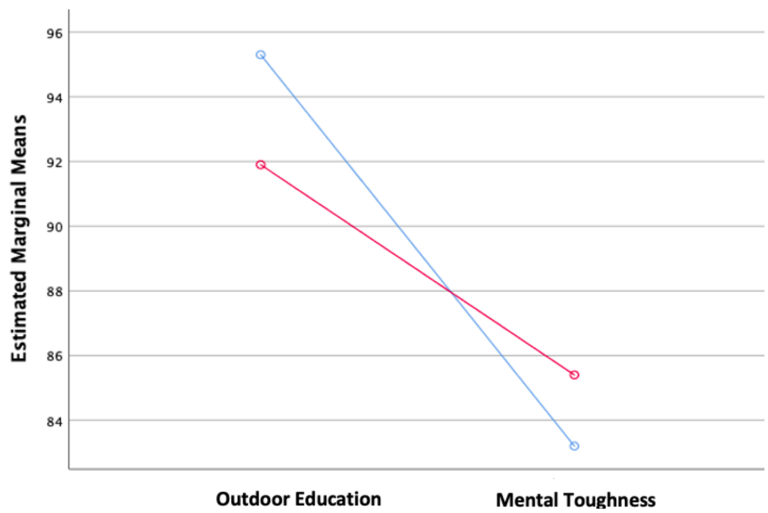

Figure 1. Interaction of outdoor education with mental toughness

Table 2 shows that the outdoor education learning model using TGT has a greater influence on cardiorespiratory fitness levels compared to STAD model in groups of students with high mental toughness ($p < 0.05$).

Table 2. Difference in cardiorespiratory fitness levels between outdoor education learning models in groups of students with high mental toughness

		Tukey test A1B1*A2B1			
Level of Mental Toughness	**Outdoor Education**	**Mean Score**	**Mean Difference (I-J)**	**Std. Error**	***p***
High	STAD	35.7	12.10*	.799	.000
	TGT	39.9	-12.10*	.799	.000

A1B1: Team Games Tournament (TGT) Group with High Mental Toughness
A2B1: Student Teams Achievement Division (STAD) group with High Mental Toughness.
The error term is Mean Square(Error) = 3.194.
**. The mean difference is significant at the 0.05 level.*

Based on Table 3, the outdoor education learning model using Student Teams Achievement Division (STAD) has a statistically significant effect on cardiorespiratory fitness levels compared to the Teams Games Tournament (TGT) model in groups of students with low mental toughness ($p < 0.05$).

Table 3. Difference in cardiorespiratory fitness levels between outdoor education learning models in groups of students with low mental toughness

Tukey test A1B2*A2B2					
Level of Mental Toughness	**Outdoor Education**	**Mean**	**Mean Difference (I-J)**	**Std. Error**	**p**
Low	STAD	37.8	-6.50*	.799	.000
	TGT	33.9	6.50*	.799	.000

A1B2: Team Games Tournament (TGT) Group with Low Mental Toughness
A2B2: Student Teams Achievement Division (STAD) group with Low Mental Toughness.
The error term is Mean Square(Error) = 3.194.
**. The mean difference is significant at the 0.05 level.*

4. DISCUSSION

The results showed that both the Teams Games Tournament (TGT) and Student Teams Achievement Division (STAD) outdoor education models have a significant impact on students' cardiorespiratory fitness (CRF) levels ($p<0.05$). Additionally, an interaction effect was observed between the learning model and the level of mental toughness ($p<0.05$). Specifically, the TGT model showed a greater influence on CRF in students with high mental toughness ($p<0.05$), while the STAD model was more effective in students with low mental toughness ($p<0.05$).

The results of our study align with the studies by Raghuveer et al. (2020) and Ross et al. (2016), which showed that outdoor education influences the increase of CRF. CRF, also known as cardiorespiratory endurance, cardiovascular fitness, aerobic capacity, and aerobic fitness, among others, refers to the capacity of the circulatory and respiratory systems to supply oxygen to skeletal muscle mitochondria for energy production during physical activity (Stodden et al., 2017). Therefore, CRF is significant for individuals because it tremendously impacts our bodies in carrying out and supporting daily activities.

Apart from that, cooperative learning also aims to train students to have a sense of responsibility, increase self-confidence, respect differences in other students' opinions, foster cooperation, and be able to help each other, as well as to train students to think critically about problems with subject matter or assignments. Assigned tasks also hone students' communication skills (Silva et al., 2022). However, cooperative learning-based outdoor education generally impacts the level of CRF.

Based on the research findings, it is known that the outdoor education process can increase the level of cardiorespiratory fitness, an essential marker of physical and mental health and academic achievement (Raghuveer et al., 2020). This provides evidence that when an individual has a high level of cardiorespiratory fitness, it will also positively impact their level of mental toughness. Low or unhealthy cardiorespiratory fitness is a strong independent predictor of cardiovascular disease and death from any cause in adults. CRF predicts several health indicators in adolescents, including cardiometabolic health, academic achievement, and mental health (Lubans et al., 2016; Ortega et al., 2008).

CRF can also be influenced by physical activity, one of which is outdoor education, which is an essential topic in this research. Several other components can also influence the increase in CRF, such as good nutritional intake, an environment that supports physical activity, genes inherited from parents, the individual's age, and the individual's sex (Bouri et al., 2024; Evaristo et al., 2019). Furthermore, CRF also influences cardiometabolic health, which keeps the body's metabolism stable; academic performance, which supports youth during the learning phase; cognitive health, which supports the body in continuing to carry out optimal activities; and mental health, which impacts mental calm and helps people stay focused in carrying out daily activities (Vaux-Bjerke et al., 2023; Juita et al., 2024). Of course, another impact is that when the CRF level is good, which means physical activity is also high, it will significantly reduce obesity (Raghuveer et al., 2020; Ross et al., 2016).

The role of CRF is vital during the learning period for students who are still in their youth, especially its influence on academic performance. CRF has been associated with various cognitive and academic outcomes in youth. Academic performance was generally found to be positively associated with CRF (Santana et al., 2017). Among longitudinal studies, maintaining a healthy CRF or increasing CRF over time has been associated with better academic performance (Sardinha et al., 2016; Wittberg et al., 2012). High CRF can improve school achievement through improving cognitive abilities or psychological factors (Santana et al., 2017). Thus, higher CRF has been associated with better attention allocation and cognition modulation.

5. CONCLUSIONS

In conclusion, both the TGT and STAD outdoor education models have an impact on students' CRF levels. Additionally, an interaction effect was observed between the learning model and the level of mental toughness. Specifically, the TGT model showed a greater influence on CRF in students with high mental toughness, while the STAD model was more effective in students with low mental toughness.

Therefore, it is highly recommended that the outdoor education learning model be used to increase CRF. However, this study has limitations related to CRF testing, academic achievement, and mental health. Further analysis is recommended to explore these areas more coherently.

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CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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