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Elevation training mask (ETM) improves cardiorespiratory fitness and metabolic function

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Abstract
Aims: The study aims to test the effectiveness of an Elevation Training Mask (ETM) on metabolic parameters, such as maximal oxygen consumption (VO_2 max), Hemoglobin level (HB), and heart rate variability (HRV).
Method: In an experimental approach, the participants (N=30) were divided into two (i)an experimental group doing HIIT training use Elevation Training Mask (ETM) and(ii) a control group involved in their ordinary training session. Experimental groups underwent 8 weeks of high-intensity cycle ergometer interval training using Elevation Training Mask (ETM). Pre and two post-test between four weeks of the test included the above parameters.
Results: The finding shows that there is a significant difference in the effect of Elevation Training Mask (ETM) on the (VO_2 max), Heart Rate Variability (HRV) and the Hemoglobin level (HB) on the pre-test and post-test of Kedah Under 17 Footballers. Apart from that, there is also analysis showing that the control group (S) had only improved at a minimum level over the training period while the (HE) group had portrayed excellent improvement throughout training and testing.
Impact: The study is to help the country improve the performance of athletes, this study is expected to inspire and spark ideas in the country's sports activists, especially coaches and national athletes.
Conclusions: The eight-week HIIT+ Elevation Training Mask program improved cardiorespiratory fitness and hematological variables in all participants. Future research would be investigate further about the physiological changes in the use of the Elevation Training Mask in certain games.

Keywords: Elevation training mask (ETM), high-intensity interval training (HIIT), heart rate variability (HRV), hemoglobin (HB), maximal oxygen consumption (VO_2 max), hematology

Introduction
In the realm of sports and fitness, athletes are constantly searching for innovative ways to gain a competitive edge. One such innovation that has gained traction in recent years is the elevation training mask, designed to mimic high-altitude conditions. Elevation training masks have piqued the curiosity of athletes and fitness enthusiasts, promising to elevate their performance to new heights. Imagine taking your workout to new heights, quite literally, by simulating the conditions of high-altitude training without leaving your local gym or home. Elevation training masks are designed to do just that, revolutionizing the way we approach cardiovascular fitness and endurance training. In this article, we will explore the intriguing world of elevation training masks, uncovering what they are, how they work, and the potential benefits they offer to athletes and fitness enthusiasts seeking to elevate their training game. Whether you're an elite athlete aiming to push your limits or an everyday fitness enthusiast looking to add a unique twist to your workouts, elevation training masks might just be the missing piece to your fitness puzzle. Strap in as we embark on a journey to discover how these masks are transforming the way we train, breathe, and ultimately, achieve our fitness goals. In this article, we will delve into the science behind elevation training masks, exploring how they work and examining the potential benefits they offer to athletes. To provide a well-rounded perspective, we will also consider the criticisms and limitations of these masks.

Through this comprehensive exploration, readers will gain a deeper understanding of whether elevation training masks are a worthy addition to their training regimens. (Smolianov *et al*., 2018) [1].

What is elevation training mask?

An elevation training mask is a fitness accessory designed to simulate the conditions of training at high altitudes. These masks are worn over the mouth and nose during exercise and restrict the flow of air, making it harder to breathe. The idea behind using an elevation training mask is to challenge and strengthen the respiratory system, as well as to improve overall cardiovascular fitness and endurance. (Porcari *et al.*, 2016) [2].

Here's how an elevation training mask typically works (Sanchez *et al.*, 2018) [4] (Porcari *et al.*, 2016) [2].

Restriction of Airflow: The mask is equipped with adjustable valves or air resistance settings that limit the amount of air you can inhale during each breath. This restriction forces you to take deeper breaths and work harder to inhale oxygen, mimicking the reduced oxygen levels found at higher altitudes.

Altitude Simulation: As you exercise with the mask on, it creates a sensation similar to training at higher altitudes, where the air contains lower levels of oxygen. This prompts your body to adapt by increasing the production of red blood cells and improving oxygen utilization, which can enhance endurance and cardiovascular performance over time.

Training Intensity: Elevation training masks are often used in interval training or during cardiovascular workouts to increase the intensity and challenge of the workout. Athletes and fitness enthusiasts may incorporate them into running, cycling, or other aerobic exercises.

The potential benefits of using an elevation training mask include

Improved lung capacity and respiratory muscle strength.

Elevation training masks can potentially improve lung capacity and respiratory muscle strength through a mechanism known as inspiratory muscle training (IMT). IMT involves strengthening the muscles responsible for inhalation, and elevation training masks can be used as a tool to facilitate this type of training. Here's how they can contribute to these improvements. In the other hand Regular use of elevation training masks may also contribute to improved lung function. As your respiratory muscles become stronger and more efficient, your lungs may become better at oxygen exchange and ventilation, leading to increased lung capacity. (Porcari *et al.*, 2016) [2].

Enhanced endurance and stamina.

Enhanced Muscle Endurance Just as resistance training with weights can improve the endurance of your skeletal muscles, the resistance provided by elevation training masks can enhance the endurance of your respiratory muscles. This can allow you to sustain longer and more intense bouts of aerobic exercise without experiencing as much fatigue in the respiratory muscles. Better Oxygen Utilization: Training with an elevation mask can also help your body become more efficient at utilizing available oxygen. This adaptation is similar to what occurs when training at higher altitudes, where oxygen levels are lower. Your body learns to make the most of the oxygen it receives, which can lead to improved aerobic and anaerobic performance (Smolianov *et al.*, 2018) [1]. Mental toughness and discipline development due to the challenging breathing conditions. Breathing Technique: Elevation training masks can also encourage athletes and individuals to focus on their breathing technique. Learning to take slow, deep breaths can improve the efficiency of oxygen delivery to muscles and reduce the feeling of breathlessness during intense exercise. (Arabaci *et al.*, 2019) [5].

It's important to note that while elevation training masks can be a valuable tool for certain athletes and fitness enthusiasts, they should be used with caution and under proper guidance. They are not suitable for everyone, especially individuals with certain medical conditions or respiratory issues. Before incorporating an elevation training mask into your workout routine, it's advisable to consult with a fitness professional or healthcare provider to ensure it's appropriate for your specific fitness goals and needs.

Objective and Significance

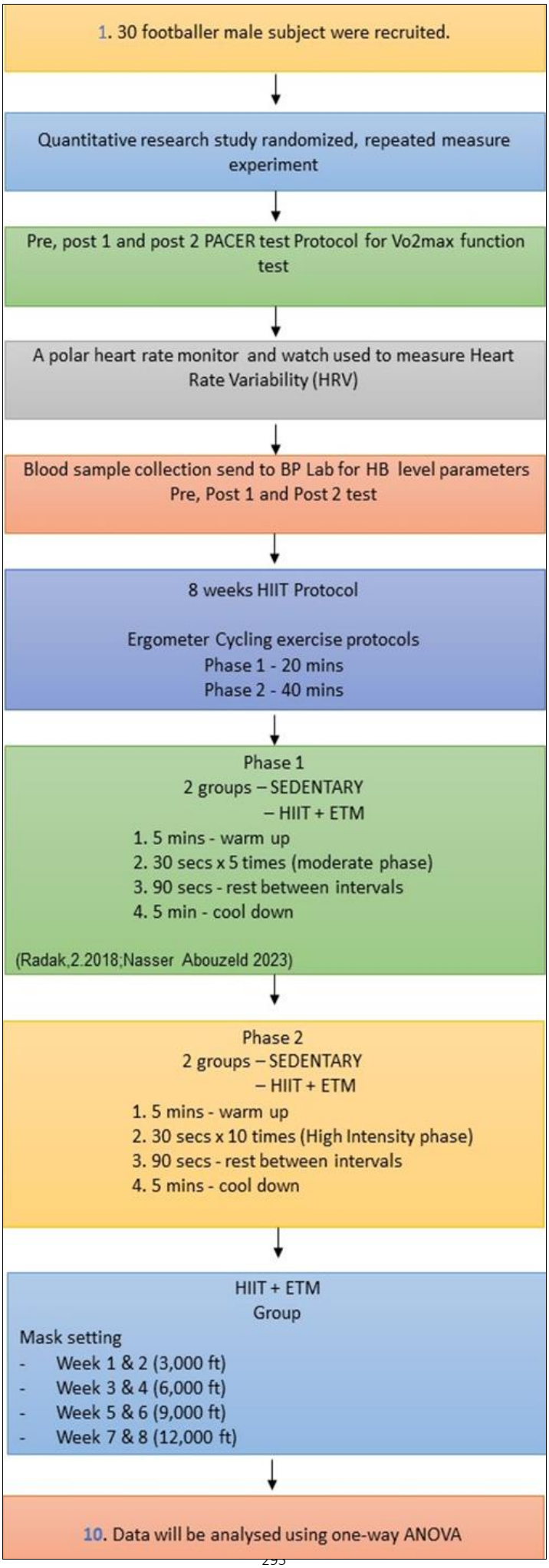
Table 1: Research Objective with Its Significance

Research objective	Research hypotheis
i) To identify the effect of elevation training mask (ETM) on the Maximal Oxygen Consumption (VO_2 max) of Kedah under 17 footballers.	iv) There was no significant difference in the effect of elevation training mask (ETM) on maximal oxygen consumption (VO_2 max) on the pre-test and post-test between the treatment group and the control group.
ii) To identify the effect of elevation training mask (ETM) on the Hemoglobin level (HB) of Kedah under 17 footballers.	v) There was no significant difference in the effect of elevation training mask (ETM) on the Hemoglobin level (HB) on the pre-test and post-test between the treatment group and control group.
iii) To identify the effect of elevation training mask (ETM) on the Heart Rate Variability (HRV) of Kedah under 17 footballers.	Vi) There was no significant difference in the effect of elevation training mask (ETM) on the Heart Rate Variability (HRV) on the pre-test and post-test between the treatment group and control group.

Significance of Research

The significance of this study is to find answers and solutions to the issues and research hypotheses that have been identified. Therefore, the study here is to refer to the expected findings of the study, which in turn can contribute to the improvement of the quality of national sports, besides being a source of reference to sports organizations. To help the country improve the performance of athletes, this study is expected to inspire and spark ideas in the country's sports activists, especially coaches and national athletes. Furthermore, the significance is to test the effectiveness High-Intensity Interval Training (HIIT) and elevation training mask (ETM) on metabolic parameters, such as maximal oxygen consumption (VO_2 max), Hemoglobin level (HB), and heart rate variability (HRV). According to the researcher, these findings will provide additional information on HIIT and ETM efficacy, which can improve cardiopulmonary fitness.

Research Method


1. 30 footballer male subject were recruited.
Quantitative research study randomized, repeated measure experiment
Pre, post 1 and post 2 PACER test Protocol for Vo2max function test
A polar heart rate monitor and watch used to measure Heart Rate Variability (HRV)
Blood sample collection send to BP Lab for HB level parameters Pre, Post 1 and Post 2 test
8 weeks HIIT Protocol
Ergometer Cycling exercise protocols
Phase 1 - 20 mins
Phase 2 - 40 mins
Phase 1
2 groups – SEDENTARY
– HIIT + ETM
1. 5 mins - warm up
2. 30 secs x 5 times (moderate phase)
3. 90 secs - rest between intervals
4. 5 min - cool down
(Radak,2.2018;Nasser Abouzeld 2023)
Phase 2
2 groups – SEDENTARY
– HIIT + ETM
1. 5 mins - warm up
2. 30 secs x 10 times (High Intensity phase)
3. 90 secs - rest between intervals
4. 5 mins - cool down
HIIT + ETM
Group
Mask setting
- Week 1 & 2 (3,000 ft)
- Week 3 & 4 (6,000 ft)
- Week 5 & 6 (9,000 ft)
- Week 7 & 8 (12,000 ft)
10. Data will be analysed using one-way ANOVA

Research finding

Table 2: Comparison of Effect by two groups on the Maximal Oxygen Consumption (VO_2 Max), the Haemoglobin level (HB), and the Heart Rate Variability of Kedah under 17 Footballer

		VO_2 max			HB			HRV		
		N	Mean	Std. D	N	Mean	Std. D	N	Mean	Std. D
Control Group	Pre Test	10	45.4	2.7	10	14.0	0.40	10	89.7	6.7
	Post Test 1	10	46.1	3.3	10	14.1	0.36	10	90.6	6.4
	Post Test 2	10	46.2	4.0	10	14.2	0.57	10	92.7	6.0
	Total	10	45.9	3.3	10	14.1	0.44	10	91.0	6.3
VO_2 Max test HIIT + Mask	Pre Test	10	45.9	4.3	10	14.4	.93	10	89.9	9.2
	Post Test 1	10	51.7	5.2	10	15.1	.72	10	96.6	8.7
	Post Test 2	10	55.9	5.4	10	15.4	.62	10	104.1	8.9
	Total	10	51.2	6.4	10	15.0	.84	10	96.9	10.4

Table 3: Comparison of Effect by two groups on the Maximal Oxygen Consumption (VO_2 Max), the Haemoglobin level (HB), and the Heart Rate Variability of Kedah under 17 Footballer

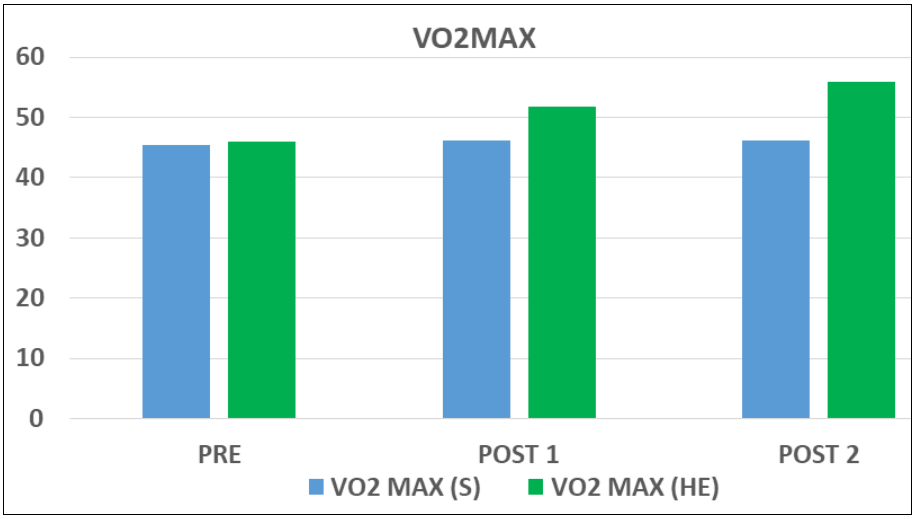
ANOVA										
		VO_2 Max			HB			HRV		
		df	F	Sig.	df	F	Sig.	df	F	Sig.
VO_2 Max test Control Group	Between Groups	2	.180	.836	2	.321	.728	2	.581	.566
	Within Groups	27			27			27		
	Total	29			29			29		
VO_2 Max test HIIT + Mask	Between Groups	2	10.13	.001	2	4.07	.029	2	6.33	.006
	Within Groups	27			27			27		
	Total	29			29			29		

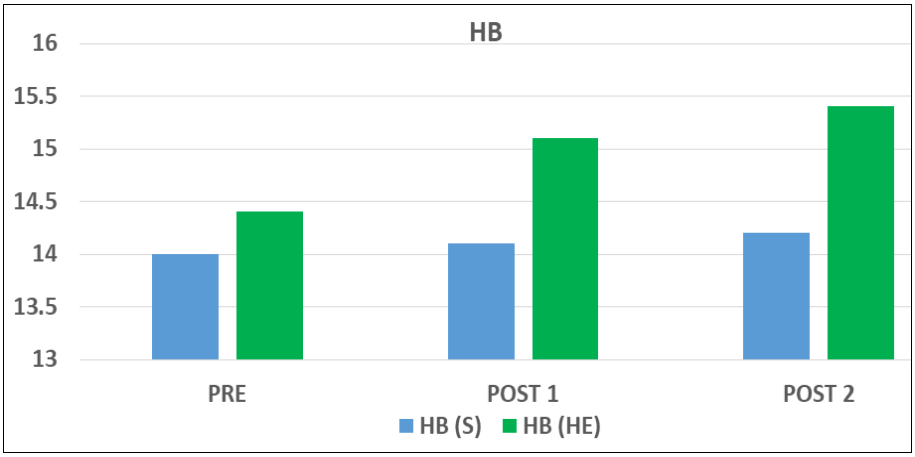
In this part, the focus will be on answering and showing the illustration for three research objectives raised in the study. The table shows the comparison of the effect of high-intensity of interval training (HIIT) between two groups on three parameters of research objectives. The first parameter test was conducted to see if there was a significant difference in VO_2 Max scores between three different tests which were the Pre-test before HIIT+ Elevation training Mask, the Post-test 1 after HIIT + Elevation training, and the Post-test 2. The analysis shows in Table 2 that there is a significant difference at the $p<.05$ level, F (2, 27) = 10.13, p =.001. Post-Hoc comparison using Tukey's test showed that the mean VO_2 Max test score for Post-test 2 (M=55.9, SD =5.4) was significantly different from Post-test 1 (M=51.7, SD = 5.2) and Pre-test (M =45.9, SD = 4.3).

Next, the test was conducted to see if there was a significant difference in Haemoglobin (HB) scores between three different tests which were the Pre-test before HIIT + Elevation training, the Post-test 1 after HIIT + Elevation training, and the Post-test 2. Table 2 shows the analysis that there is a significant difference at the $p<.05$ level, F (2,27) = 4.07, p =.029. Post-Hoc comparison using Tukey's test showed that the mean Haemoglobin (HB) test score for Post-test 2 (M=15.4, SD = 0.62) was significantly different from Post-test 1 (M=15.1, SD = 0.72) and Pre-test (M =14.4, SD = 0.93).

Following up, the test was conducted to see if there was a significant difference in Heart Rate Variability (HRV) scores between three different tests which were the Pre-test before HIIT + Elevation training, the Post-test 1 after HIIT+ Elevation training, and the Post-test 2. Table 2 shows the analysis that there is a significant difference at the $p<.05$ level, F (2,27) = 6.33, p =.006. Post-Hoc comparison using Tukey's test showed that the mean Heart Rate Variability (HRV) test score for Post- test 2 (M=104.1, SD =8.9) was significantly different from Post-test 1 (M=96.6, SD =8.7) and Pre-test (M =89.9, SD =9.2).

The research focuses on the effect of high-intensity interval training (HIIT) with elevation training mask on cardiopulmonary and metabolic function among Kedah under-17 footballers. The finding shows that there is a significant difference in the effect of high-intensity interval training with elevation training mask on the (VO_2 max) on the pre-test and post- test of Kedah Under 17 Footballers but no significant difference in the effect of high-intensity interval training (HIIT) with elevation training mask on the Hemoglobin level (HB). Overall, the finding concludes that there is a significant effect of high-intensity interval training (HIIT) with elevation training mask on cardiopulmonary and metabolic function among Kedah under 17 footballers. Apart from that, there is also analyzed showing that the control group (S) had only improved at a minimum level over the training period while the (HE) group had portrayed excellent improvement throughout training and testing.





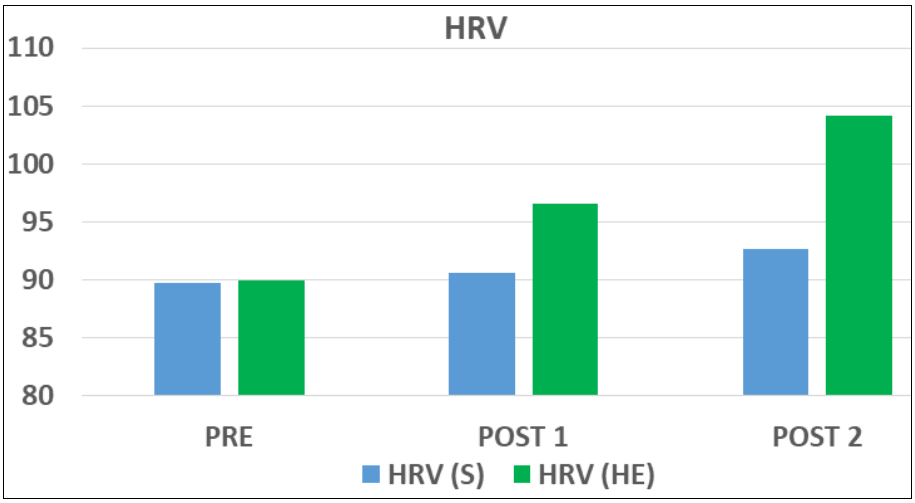


Fig 1: Comparison of Effect by two groups on the Maximal Oxygen Consumption (VO_2 Max), Haemoglobin level (HB), Heart Rate Variability (HRV) of Kedah under 17 Footballers.

Table 4: Hypotheses Analysis

No	Hypotheses	Result
	There was no significant difference in the effect of high-intensity interval training using an elevation training mask on the Maximal Oxygen Consumption (VO_2 max) on the pre-test and post-test of Kedah Under 17 Footballers	Rejected
	There was no significant difference in the effect of high-intensity interval training using an elevation training mask on the Hemoglobin level (HB) on the pre-test and post-test of Kedah Under 17 Footballers	Rejected
	There was no significant difference in the effect of high-intensity interval training using an elevation training mask on the Heart Rate Variability (HRV) on the pre-test and post-test of Kedah Under 17 Footballers.	Rejected

Discussion

The study focused on examining the effect of HIIT+ Elevation Training Mask protocols on Cardiopulmonary And Metabolic Function among Kedah under-17 footballers', on specific parameters like Maximum Rate of Oxygen Consumption (VO_2 max), Hemoglobin (HB), and Heart Rate Variability (HRV) helps to assess the impact of Elevation Training Mask (ETM) on various aspects of the athletes'

physiological and cardiovascular health. The improvements in VO_2 max, HB levels, and HRV in the experimental (HE) group compared to the control group (S) indicate that the implementation of the HIIT+ Elevation Training Mask (ETM) protocol has positive effects on the cardiopulmonary and metabolic function of the under-17 footballers. An increase in VO_2 max reflects improved aerobic capacity, which is crucial for endurance and overall athletic performance. Higher Hemoglobin levels may suggest enhanced oxygen-carrying capacity in the blood, potentially leading to improved oxygen delivery to muscles during exercise, eventually there was a significant difference in the effect of Elevation Training Mask (ETM) on the Haemoglobin level (HB). Additionally, positive changes in Heart Rate Variability indicate better autonomic nervous system regulation, which is associated with improved recovery and overall cardiovascular health. On the other prespective its an important contribution to the field of sports science and athlete training. This specific population of young footballers represents a relevant target group for such research, as their physical fitness and performance can significantly impact their athletic development and future success. The observed improvements in the (HE) group compared to the control group (S) indicates that the implementation of the HIIT+ETM protocol was effective in eliciting positive changes in the footballers' cardiopulmonary and metabolic health. This suggests that incorporating use of ETM into their training routines can be a valuable strategy for enhancing their overall fitness, which may ultimately translate into improved on-field performance.

The fact that the control group (S) showed only minimal improvements over the training period underscores the potential superiority of ETM over more traditional training methods or a lack of structured training altogether. This further emphasizes the importance of structured and scientifically designed training programs, such as use of ETM in trainings, to optimize the physical development of young athletes. The outcome from this study can have practical implications for coaches, trainers, and sports organizations working with young footballers in Kedah or similar contexts. Implementing use of ETM as instrument of their training regimens could be a viable approach to enhance the physical fitness and performance of the athletes. However, it is essential to acknowledge some limitations of the study and potential areas for future research. The study's sample size, duration of the training period, and specific HIIT+ETM protocol used may influence the generalizability of the results. Additionally, the study might benefit from further investigations into other factors that could have influenced the observed improvements, such as nutritional habits, recovery strategies, and other training components. Future research could also consider comparing the effects of ETM to other training methods commonly used in football player development or exploring the long-term effects of sustained training by using ETM on athletes' performance. Moreover, understanding how individual variations in responses to ETM may impact the outcomes could be relevant for personalized training program design. In conclusion, the finding that ETM has a significant effect on cardiopulmonary and metabolic function among Kedah under-17 footballers is valuable for both sports science and athlete development. The study highlights the potential benefits of incorporating structured use of ETM into training programs for young athletes to optimize their physical capabilities. However, ongoing research is needed to further explore the specific mechanisms and potential long-term impacts in the use of ETM training in this population.

Conclusion

In conclusion, elevation training masks have emerged as a unique and polarizing tool in the world of fitness and sports performance. While they hold promise in certain aspects, such as respiratory muscle training and mental toughness development, their effectiveness and safety remain subjects of ongoing debate. Athletes and fitness enthusiasts must carefully consider their training goals and consult with healthcare professionals before incorporating elevation training masks into their routines. Ultimately, the decision to use an elevation training mask should be based on a comprehensive understanding of the potential benefits and risks. Like any fitness or performance-enhancing tool, these masks are not a one-size-fits-all solution, and their impact can vary greatly from person to person. As the science behind elevation training masks continues to evolve, it is essential to stay informed and make informed choices that align with individual fitness objectives and health considerations. Whether you choose to embrace this innovative training tool or explore other avenues of fitness improvement, remember that dedication, consistency, and a holistic approach to training are key factors in achieving your desired athletic goals.

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