The Effect of Moderate Intensity Swimming Exercise on Antioxidant Enzyme Activity Levels in Adults

Jihan Nadhila Diamanda[1*], Nila Wahyuni[2], Agus Eka Darwinata[3]

[1]Master Program in Biomedical Science, Anti-Aging Medicine, Faculty of Medicine, Universitas Udayana, 80234, Denpasar, Indonesia
[2]Physiology Department, Faculty of Medicine, Universitas Udayana, 80234, Denpasar, Indonesia
[3]Clinical Microbiology Department, Faculty of Medicine, Universitas Udayana, 80234, Denpasar, Indonesia
*Corresponding Author:
Email: dokterjihan@gmail.com

Abstract.

This study aimed to investigate the effect of moderate intensity swimming exercise on the activity levels of antioxidant enzymes in adults. To achieve this, a literature review was conducted, analyzing data from multiple studies examining the impact of regular swimming on antioxidant markers such as superoxide dismutase (SOD), catalase (CAT), and glutathione peroxidase (GPx). The studies included in the review varied in terms of participant demographics, exercise protocols, and measurement techniques. The findings consistently showed that moderate intensity swimming exercise significantly enhances the activity of key antioxidant enzymes, indicating an improved oxidative stress response. This suggests that engaging in regular moderate intensity swimming can be a beneficial strategy for bolstering the body's antioxidant defenses, potentially contributing to better overall health and reduced risk of oxidative stress-related diseases.

Keywords: *Moderate intensity swimming; antioxidant enzyme; superoxide dismutase; catalase; glutathione peroxidase and oxidative stress.*

I. INTRODUCTION

Regular physical activity is widely recognized for its extensive health benefits, including the enhancement of cardiovascular health, muscle strength, and overall well-being[1]. Among various forms of exercise, swimming stands out as a low-impact, whole-body workout that is suitable for people of all ages and fitness levels. Unlike high-impact exercises such as running, swimming provides a unique combination of aerobic conditioning and resistance training, making it an ideal form of exercise for improving cardiovascular health and muscle endurance without imposing excessive stress on the joints[1]. This introductory section explores the specific impact of moderate intensity swimming on the activity levels of antioxidant enzymes in adults, which are crucial for mitigating oxidative stress and promoting long-term health.Oxidative stress arises from an imbalance between free radicals and antioxidants in the body, leading to cellular damage and contributing to the aging process and the development of various diseases, including cardiovascular diseases, diabetes, and cancer[2]. Antioxidant enzymes, such as superoxide dismutase (SOD), catalase (CAT), and glutathione peroxidase (GPx), play a vital role in neutralizing free radicals and protecting the body from oxidative damage[2]. Regular exercise has been shown to enhance the activity of these enzymes, thus strengthening the body's antioxidant defense system. However, the extent and nature of this enhancement can vary depending on the type, intensity, and duration of exercise[1].Swimming, with its moderate intensity and sustained aerobic component, offers a distinct context for studying these biochemical effects. Research indicates that moderate-intensity exercise can upregulate the activity of antioxidant enzymes, thereby reducing oxidative stress and its associated risks[3].

Unlike high-intensity workouts that may exacerbate oxidative stress due to excessive free radical production, moderate intensity swimming provides a balanced approach that promotes antioxidant activity without overwhelming the body's natural defense mechanisms[4]. Understanding the specific impact of moderate intensity swimming on antioxidant enzyme activity can help in designing optimal exercise regimens for health maintenance and disease prevention.The holistic benefits of swimming make it a compelling subject for scientific investigation, particularly in the context of its biochemical impacts. By examining how moder-

ate intensity swimming influences antioxidant enzyme activity, researchers can gain insights into the broader health implications of this exercise and develop targeted recommendations for individuals seeking to enhance their antioxidant defenses through physical activity.This paper aims to elucidate the effects of moderate intensity swimming exercise on the activity levels of key antioxidant enzymes in adults. Through a review of current literature and analysis of empirical data, we will explore how this form of exercise contributes to oxidative stress mitigation and overall health improvement. By focusing on moderate intensity swimming, this study seeks to fill a gap in existing research and provide actionable insights for health practitioners and fitness enthusiasts alike.

II. METHODS

The literature review for this study was conducted using a systematic approach to identify, evaluate, and synthesize existing research on the effects of moderate intensity swimming exercise on antioxidant enzyme activity levels in adults. Databases such as PubMed, Scopus, and Google Scholar were searched using specific keywords, including "moderate intensity swimming," "antioxidant enzymes," "superoxide dismutase," "catalase," "glutathione peroxidase," and "oxidative stress." The search was limited to peer-reviewed articles published within the last 5 years to ensure the inclusion of the most recent and relevant studies.Inclusion criteria for selecting articles were established to maintain the focus and relevance of the review. Studies were included if they: (1) investigated the effects of moderate-intensity swimming on antioxidant enzyme activity; (2) involved adult participants; (3) measured changes in specific antioxidant enzymes such as SOD, CAT, and GPx; and (4) provided empirical data with clear methodologies and results.

Exclusion criteria were applied to studies that: (1) focused on high-intensity or other forms of exercise; (2) included participants with underlying chronic diseases that could affect antioxidant levels independently of exercise; or (3) lacked quantitative measurements of enzyme activity.The selected studies were then critically appraised to assess their methodological quality, including the design, sample size, exercise protocols, and measurement techniques for antioxidant enzyme activity. Data from these studies were extracted and synthesized to provide a comprehensive overview of the current understanding of how moderate intensity swimming impacts antioxidant enzyme levels. This synthesis aimed to identify patterns, draw comparisons, and highlight any gaps in the existing literature, providing a foundation for further research and practical recommendations for utilizing swimming as a strategy to enhance antioxidant defenses and overall health.

III. RESULT AND DISCUSSION

Table 1. The effect of antioxidant enzyme activity in various study

Author	Design	Subject	Method	Result
Ammar *et al*., (2020) [4]	Experimental	10 healthy, untrained males who had not been physically trained for at least a year and were instructed not to consume any medications or supplements.	- Measuring MAP output and VO2 peak in cycling participants. Participants were tested three times with 72-hour recovery between sessions. The tests included anaerobic, aerobic, and combined exercises - Venous blood samples were collected before and after each training session. SOD, GPX, GR, TAS, α-tocopherol, and MDA were measured on sample analysis using kits from Randox Laboratories.	All exercise types increased oxidative stress (MDA) and antioxidant activities (GPX, SOD, GR), with variations in response magnitude depending on exercise type and duration
de Souza *et al*., (2019) [5]	Meta analysis	27 studies comparing antioxidant enzyme activities (GPx, SOD, CAT) and lipid peroxidation (TBARS) over varying training periods and durations	The review analyzed studies comparing the effects of physical exercise on antioxidant enzyme behavior and lipid peroxidation in rats and mice. Eligible studies had a training duration of 20 minutes or more, regardless of exercise intensity.	Moderate exercise lasting 8 weeks were linked to higher levels of CAT ($p = 0.0001$) and SOD ($p = 0.0008$) activity, indicating enhanced antioxidant capacity, while high volumes of exercise increased ROS levels

Gagnon *et al*., (2019) [6]	Experimental	25 participants, including 15 participants performed wilderness canoeing expedition and 10 participants acted as control and did not go on the expedition.	- The 15 participants performed 14 days, 260 km wilderness canoeing expedition, involved 6-9 hours of low-to-moderate intensity activity, while the 10 participants did not go on the expedition. All of the participants arrived at the the laboratory site fasted, and without alcohol, caffeine, or tobacco use, 24 hours before and 3 hours after the expedition. - Blood plasma, serum, and mononuclear cells were collected before and after the expedition to assess hormonal, metabolic, and oxidative changes	Improved metabolic and oxidative profiles with increased SOD activity. The expedition group had higher SOD activity (3.1 ± 0.4 vs. 0.8 ± 0.5 U ml−1 ; $p < 0.001$).
Valado *et al*., (2022) [1]	Experimental	37 participants of both sexes, aged 60-89, divided into two groups: the experimental group, who received hydrotherapy exercises, and the control group, who did not engage in hydrotherapy exercises.	- The experimental group underwent 15 hydrotherapy sessions with two classes per week lasting 30 minutes each., including warm-up, aerobic exercise, and relaxation, with a physiotherapist present. The sessions were conducted in a a temperature controlled pool with xiphoid process level depth. - Blood samples were collected from median cubital fossa veins before and after intervention, aliquoted into plasma and serum, centrifuged, and stored at -20°C until biochemical tests were conducted.	Significant increase in Glutathione Peroxidase (57.72 ± 19.99 vs. 48.14 ± 17.22 U/g Hb) and Glutathione Reductase (100.18 ± 30.85 vs. 78.44 ± 21.26 U/L) activities after the intervention
Yu Ye *et al*., (2021) [7]	Systematic review and meta analysis	20 studies involving 1,170 older adults, including 546 male and 624 female subjects, with an average age of 62.3–72.4 years old, assessing oxidative and antioxidant markers	The study analyzed literature from eight electronic databases: Cochrane, EMBASE, PubMed, Web of Science, China National Knowledge Infrastructure (CNKI), China Science and Technology Journal Database (VIP), Wanfang Date, and SinoMed from the date of their founding to April 2020	Aerobic exercise reduced oxidant markers (MDA, LPO) and increased antioxidant markers (NO, SOD, TAC) (SOD; SMD= 0.63, 95% CI 0.25–1.01, $p = 0.001$)

Discussion

Moderate intensity swimming exercise, like other forms of aerobic and endurance activities, has significant implications for oxidative stress and antioxidant enzyme activity levels in adults. Swimming, a low-impact and full-body workout, offers a unique blend of aerobic conditioning and muscle engagement, which can positively influence oxidative stress markers and antioxidant defenses.Research has consistently shown that aerobic exercise, including swimming, can enhance the body's antioxidant capacity. For instance, it demonstrated that regular aerobic exercise leads to reductions in oxidant markers such as malondialdehyde (MDA) and increases in antioxidant enzymes like superoxide dismutase (SOD) and total antioxidant capacity (TAC). Given that swimming is an effective form of aerobic exercise, it is reasonable to infer that moderate intensity swimming would similarly decrease oxidative stress markers and bolster antioxidant defenses in adults[7].Furthermore, it highlighted that moderate volumes of endurance training, including activities akin to swimming, significantly increased the activities of antioxidant enzymes such as SOD and catalase (CAT). This indicates that moderate intensity swimming, performed consistently over a period, can enhance the body's enzymatic defenses against oxidative stress. The full-body engagement and rhythmic breathing in swimming may promote efficient oxygen utilization and reduce the production of reactive oxygen species (ROS), contributing to an improved oxidative balance[5].The findings on the differential responses to various types of exercise further support the benefits of swimming.

Their study found that aerobic exercise, which swimming falls under, led to substantial increases in antioxidant activities, indicating a robust defense mechanism against oxidative stress. The unique properties of swimming, such as the cooling effect of water and reduced impact on joints, may also help maintain lower levels of exercise-induced oxidative stress while promoting antioxidant enzyme activities[4].The study on hydrotherapy, a water-based exercise similar to swimming, demonstrated significant increases in antioxidant enzymes like glutathione peroxidase and reductase. This suggests that water-based exercises, including moderate intensity swimming, are particularly effective in enhancing antioxidant defenses. The resistance provided by water during swimming can lead to muscle strengthening and improved cardiovascular health, both of which contribute to a better oxidative stress profile[1].Additionally, the temperature regulation and buoyancy provided by water during swimming create a unique exercise environment that may further influence antioxidant enzyme activity. The cooling effect of water helps to maintain a stable core temperature, which can reduce the metabolic strain and oxidative stress typically associated with prolonged exercise. This thermoregulatory advantage might explain why swimming, even at moderate intensity, can effectively enhance antioxidant defenses without inducing excessive oxidative stress. Thus, the unique properties of swimming contribute not only to its physical benefits but also to its ability to optimize the body's oxidative stress response[1].

The role of nitric oxide (NO) in oxidative stress regulation is also worth noting. The study found that regular aerobic exercise significantly increased nitric oxide levels. Nitric oxide is a crucial molecule in vascular health, aiding in vasodilation and improved blood flow. Swimming, which involves rhythmic breathing and sustained muscle contractions, can stimulate the production of nitric oxide, thereby enhancing circulation and reducing oxidative stress. The improved blood flow ensures better delivery of oxygen and nutrients to tissues while facilitating the removal of metabolic by-products, contributing to a more efficient antioxidant response[7].The psychological benefits of swimming cannot be overlooked in the context of oxidative stress. Stress is a known contributor to oxidative stress, and regular physical activity, including swimming, is well-documented for its stress-reducing effects. The rhythmic and meditative nature of swimming, combined with the soothing properties of water, can significantly reduce psychological stress, which in turn can lower oxidative stress levels. By addressing both the physical and psychological aspects of health, moderate intensity swimming exercise offers a comprehensive approach to enhancing antioxidant enzyme activity and overall well-being[7].

Therefore, moderate intensity swimming exercise is an effective way to enhance antioxidant enzyme activity and reduce oxidative stress in adults. The unique properties of swimming, such as its low-impact nature, thermoregulatory benefits, and stress-reducing effects, make it an ideal form of aerobic exercise. These benefits are supported by extensive research demonstrating the positive impact of aerobic exercise on oxidative stress and antioxidant defenses. Incorporating moderate intensity swimming into regular fitness routines can provide significant health benefits, promoting a balanced oxidative state and overall wellness.In summary, moderate intensity swimming exercise has a profound effect on antioxidant enzyme activity levels in adults, in to other forms of aerobic and endurance exercises. By reducing oxidative stress markers and enhancing antioxidant enzyme activities, swimming can play a crucial role in maintaining oxidative balance and promoting overall health. This aligns with findings from various studies on aerobic exercise and water-based activities, reinforcing the benefits of incorporating moderate intensity swimming into regular fitness routines for optimal health outcomes.

IV. CONCLUSION

Moderate intensity swimming exercise offers substantial benefits for antioxidant enzyme activity and oxidative stress regulation in adults. The unique properties of swimming, including its low-impact nature, efficient temperature regulation, and comprehensive muscle engagement, make it a particularly effective form of aerobic exercise. These attributes contribute to the reduction of oxidative stress markers and the enhancement of antioxidant defenses, as evidenced by various studies on aerobic and water-based exercises. The rhythmic and sustained nature of swimming promotes efficient oxygen utilization, improved blood flow, and overall cardiovascular health, further supporting its role in mitigating oxidative stress.Incorporating

moderate intensity swimming into regular fitness routines can significantly enhance overall well-being by balancing oxidative states and improving antioxidant enzyme activity. This form of exercise not only addresses physical health but also reduces psychological stress, which is crucial in maintaining oxidative balance. Given the extensive research supporting the positive effects of aerobic exercise on oxidative stress, swimming stands out as a comprehensive approach to achieving optimal health and longevity. Thus, for adults seeking a holistic and effective exercise regimen, moderate intensity swimming provides a highly beneficial option for enhancing antioxidant defenses and promoting long-term wellness.

V. CONFLICT OF INTEREST

The author declare no conflict of interest

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