



# Education for Mothers: Effect of Otaria Exercise on Superoxide Dismutase (SOD) Levels

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**Abstract:** The postpartum period is a critical period susceptible to oxidative stress due to physiological, hormonal, and metabolic changes. One of the main antioxidant enzymes involved in combating oxidative stress is Superoxide Dismutase (SOD). Otaria gymnastics, a form of light physical exercise combining movement, breathing, and relaxation, is believed to increase the body's antioxidant capacity. This study aimed to determine the effect of Otaria gymnastics on SOD levels in postpartum mothers. The study used a quasi-experimental design with a pretest-posttest control group approach. The sample consisted of 30 postpartum mothers divided into an intervention group (n = 15) who performed Otaria gymnastics for 7 days and a control group (n = 15) without intervention. SOD levels were measured using spectrophotometry. The study showed a significant increase in SOD levels in the intervention group of 0.44 U/mL (p = 0.001), while the control group experienced a decrease of 0.16 U/mL (p = 0.021). The intergroup test showed a significant difference (p = 0.000). These findings indicate that Otaria Exercise is effective in increasing SOD levels and strengthening the body's antioxidant defenses in postpartum mothers. Otaria Exercise can be recommended as a simple non-pharmacological intervention in postpartum recovery programs to support maternal health holistically.

**Keywords:** Postpartum; Otaria gymnastics; Oxidative stress; Superoxide Dismutase (SOD)

## Introduction

The postpartum period is a crucial phase that requires attention to a woman's physical and mental health, due to increased oxidative stress resulting from hormonal and metabolic changes after childbirth. Oxidative stress can cause cell damage through the production of free radicals (Parraguez et al., 2020). Studies have shown that antioxidant supplementation, such as vitamins E and C, can help improve placental efficiency and fetal growth, as well as improve immune responses during the peripartum period in animals (Parraguez et al., 2020; Zhang et al., 2024). Additionally, compounds such as spirulina show potential in reducing oxidative stress and increasing antioxidant

capacity, which may be beneficial for women after childbirth (Ferreira et al., 2021; Oz & Gökbel, 2023). Therefore, nutritional interventions that focus on antioxidant supplementation are essential to minimize the negative impact of oxidative stress in the postpartum period (Ardiana et al., 2020; Kruk et al., 2021; Wang et al., 2022).

One promising approach is through physical activity, such as Otaria gymnastics. This physical activity has been shown to enhance the body's antioxidant defenses. Previous research has shown that Otaria gymnastics is effective in reducing levels of malondialdehyde (GoM), an indicator of oxidative stress, in postpartum maternal plasma (Barkinah et al., 2023). Further studies have also shown that moderate

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exercise can increase the activity of SOD, an important enzyme that plays a role in overcoming oxidative stress by converting superoxide radicals into hydrogen peroxide (Ammar et al., 2020; Januarsih et al., 2024; Qiu et al., 2025).

Superoxide Dismutase (SOD) is a vital enzyme in the cellular antioxidant defense system, playing an essential role in mitigating oxidative stress, particularly in response to aerobic exercise. Numerous studies indicate that regular aerobic training can increase SOD activity, suggesting a beneficial adaptation to the oxidative stress associated with physical activity (Cho & Roh, 2022; Ku et al., 2021; Yun et al., 2023). For postpartum women, incorporating aerobic exercises may elevate SOD levels, which could help lower oxidative stress and its related complications (Manfio et al., 2021; Yun et al., 2023). The increase in SOD activity may help reduce the oxidative damage commonly observed in postpartum conditions, highlighting the importance of exercise-based interventions to boost antioxidant defenses during this critical period (Wang et al., 2022; Santoyo et al., 2022). Thus, promoting aerobic exercise regimens for new mothers might lead to positive effects on their oxidative stress markers, enhancing overall health and well-being (Aygün & Atabek, 2023; Santoyo et al., 2022).

Furthermore, there is evidence to suggest that regular exercise not only improves physical health but also contributes to the mental well-being of mothers (Qiu et al., 2025). The application of 'Otaria' exercises as part of a postpartum rehabilitation program can have a dual function; not only does it accelerate the process of uterine involution, but it also serves as a way to improve the body's antioxidant status, thus creating a better health reserve for the future (Dewi & Shofiyah, 2022; Susanti et al., 2023).

This study aims to explore the effectiveness of 'Otaria' exercise in increasing SOD levels in postpartum mothers and provide a scientific basis for developing better postpartum health programs. With increasing awareness of the importance of maternal and child health, this study is also expected to contribute to educational programs for mothers on maintaining health through regular and beneficial physical activity (Rachmah et al., 2020).

The novelty of the research investigating the effect of Otaria exercise on superoxide dismutase (SOD) levels presents a unique intersection between maternal health, physical exercise, and antioxidant defense mechanisms. Otaria exercise, which is characterized by specific physical movements inspired by sea lions, has not been widely studied in relation to maternal populations. This provides a fresh avenue for exploring alternative forms of maternal exercise that may offer benefits for both physical and biochemical health.

The importance of this research is underscored by several logical reasons. Firstly, SOD is a critical enzyme involved in the detoxification of superoxide radicals, thus playing an essential role in mitigating oxidative stress, which is particularly relevant during the perinatal period. Given that oxidative stress is linked to various maternal and fetal complications, understanding how targeted physical exercise can enhance SOD levels can have significant implications for maternal-infant health. Moreover, establishing effective exercise interventions can empower mothers, improve their overall well-being, and potentially reduce healthcare costs associated with complications arising from oxidative stress. Overall, this research can contribute to the development of specialized exercise programs aimed at optimizing health outcomes for mothers and their offspring.

## Method

### *Research Design*

This study used a pretest-posttest methodology, a control group, and a quasi-experimental design. This approach was selected because it makes it possible to compare two distinct groups while accounting for variations that arise both before and after the intervention. Superoxide Dismutase (SOD) enzyme levels in postpartum moms were the variable examined in this study, and Otaria exercise served as the intervention. It is anticipated that using this strategy will yield more precise information about how Otaria Exercise affects SOD levels.

### *Place and Time of Research*

The study was conducted in the Karang Intan 2 Community Health Center (Puskesmas Karang Intan 2) in Banjar Regency, South Kalimantan. This location was selected based on the availability of health facilities for postpartum maternal care and the presence of a population of mothers who met the inclusion criteria. The study lasted for three months, from July to August 2025, to allow sufficient time for data collection and intervention implementation.

### *Population and Sample*

The population in this study were postpartum mothers aged 7-14 days who underwent a check-up at the Karang Intan 2 Community Health Center, Karang Intan District, Banjar Regency. The sample was taken using a purposive sampling technique, which allows researchers to select individuals based on certain criteria relevant to the research objectives. The present study delineates specific inclusion criteria aimed at ensuring the homogeneity and relevance of the participant pool. Firstly, participants were postpartum

mothers aged between 20 and 40 years, specifically recruited between 7 to 14 days postpartum following a normal delivery. This time frame was chosen to assess the immediate impact of Otaria Exercises on recovery post-delivery. Secondly, participants demonstrated a willingness to engage fully in the Otaria Exercises, emphasizing the importance of commitment to the regimen for measuring outcomes. Thirdly, participants were excluded if they were concurrently taking antioxidant supplements, including vitamins C, E, or selenium, to mitigate confounding variables that might influence the study's findings. This rigorous selection process aimed to establish a valid cohort for evaluating the efficacy and safety of the intervention in the specified demographic. On the other hand, exclusion criteria stipulated that participants should not experience postpartum complications, such as bleeding or infection, and should not suffer from chronic diseases, such as diabetes, hypertension, or thyroid disorders. In addition, participants who were unwilling to complete the program were also excluded from the sample. The use of these criteria aims to ensure the homogeneity and validity of the data obtained in the study. The total number of respondents was 30 people, consisting of 15 people in the intervention group (Otaria Gymnastics) and 15 people in the control group (without gymnastics).

*Research Variables*

**Table 1.** Research variables

Variable Types	Variable Name	Scale
Independent variables	Otaria Gymnastics	Nominal
Dependent variable	Superoxide Dismutase (SOD) Levels	Ratio
Control variables	Age, nutritional status, other activities, diet	Nominal / Ratio

*Research Procedures*

In this study, the research procedure was divided into several stages to ensure high integrity and ethics. The preparation stage began with obtaining ethics approval from the research committee and concluded with outreach to postpartum mothers and their families regarding the research. This process included explaining the purpose, benefits, and procedures to be followed. Participants were required to provide informed consent after receiving relevant information about the study.

After the preparation phase, the study continued with initial data collection (pretest), which included blood sampling to measure superoxide dismutase (SOD) levels before the intervention. The intervention consisted of Otaria Gymnastics, which was carried out

twice a week for four weeks under the guidance of a certified instructor. After the intervention, final data collection (posttest) was conducted by repeating blood draws to measure SOD levels in both groups, using the same procedure as the pretest, to evaluate the effects of the intervention.

*Research Instruments*

Superoxide Dismutase (SOD) levels were measured using the WST-1 (Water Soluble Tetrazolium Salt) method through a spectrophotometric biochemical test conducted in a standardized laboratory. This method allows for quantitative measurement of SOD enzyme activity, which is essential for analyzing oxidative stress in the body.

Additionally, observation sheets were used to record factors related to participant attendance, exercise intensity, and any complaints experienced during the exercise sessions. This data collection provided a comprehensive overview of the participants' condition and response to the intervention program. Furthermore, a supporting questionnaire was designed to collect demographic information and respondent characteristics, such as age, physical activity, and dietary patterns. The use of these instruments aims to gain a deeper understanding of factors that may influence the study results. The combination of all these instruments will support in-depth analysis and valid interpretation of the study results.

*Data Analysis*

Data analysis was conducted using a series of systematic steps to evaluate differences in Superoxide Dismutase (SOD) levels between the intervention and control groups. Normality testing was performed using the Shapiro-Wilk test, which aims to assess data distribution. If the data are declared normal, further analysis can be carried out. To evaluate the homogeneity of variance between groups, Levene's Test was used. After ensuring that these assumptions are met, statistical analysis was performed. Paired t-tests were used to analyze differences in SOD levels within the same group before and after the intervention, while Independent t-tests were used to compare changes in SOD levels between the intervention and control groups. All statistical tests were performed with a significance level set at  $p < 0.05$ . This is important to ensure that the results obtained can be considered statistically significant and provide reliable data to support the study's conclusions.

## Result and Discussion

The characteristics of participants in a study with two groups—the intervention group (n = 15) and the control group (n = 15)—are shown in Table 2. The control group's mean age was 28.8 years, with a standard deviation of 3.7, whereas the intervention group's mean age was 29.2 years, with a standard deviation of 3.4. According to the data, the percentage of primiparous parity (mothers giving birth for the first time) was 53.3% in the intervention group and 46.7% in the control group. In comparison, the percentage of multiparous parity (mothers who had given birth more than once) was 53.3% in the control group and 46.7% in the intervention group.

In terms of Body Mass Index (BMI), the average in the intervention group was 24.5 kg/m<sup>2</sup> (± 1.8), while the control group was slightly lower, at 24.3 kg/m<sup>2</sup> (± 2.1). All respondents were postpartum mothers on day 7, in good health, and not taking additional antioxidant supplements. These characteristics were important to ensure equality between the two groups in the study.

**Table 2.** Respondent characteristics

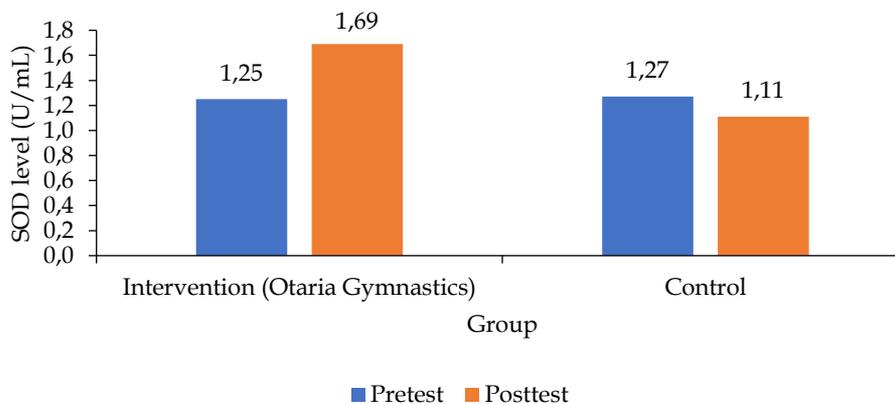
Characteristics	Intervention (n = 15)	Control (n = 15)
Age (average)	29.2 ± 3.4 years	28.8 ± 3.7 years
Primiparous parity	8 (53.3%)	7 (46.7%)
Multiparous parity	7 (46.7%)	8 (53.3%)
BMI (average)	24.5 ± 1.8 kg/m <sup>2</sup>	24.3 ± 2.1 kg/m <sup>2</sup>

Table 3 shows the results of Superoxide Dismutase (SOD) levels before and after the intervention in two groups: intervention and control. The intervention group showed a significant increase in mean SOD levels, from 1.25 ± 0.11 U/mL to 1.69 ± 0.14 U/mL, with a difference of +0.44 (p = 0.001), indicating the effectiveness of the intervention in the form of education for mothers about Otaria exercises. In contrast, the control group experienced a significant decrease in SOD levels, from 1.27 ± 0.12 U/mL to 1.11 ± 0.10 U/mL, with a difference of -0.16 (p = 0.021). Comparison between the two groups using the Independent t-test showed a significant difference in changes in SOD levels (Δ), with p = 0.000. These results strengthen the hypothesis that the intervention has a positive impact on increasing SOD levels in the group that received education about physical exercise. This success emphasizes the importance of an educational approach to improving health through targeted physical activity.

**Table 3.** SOD level test table before and after intervention

Group	Mean Pretest SOD (U/mL)	Mean Posttest SOD (U/mL)	Δ (Difference)	Information	p-value
Intervention	1.25 ± 0.11	1.69 ± 0.14	+0.44	Significant increase	Paired t-test: p = 0.001
Control	1.27 ± 0.12	1.11 ± 0.10	-0.16	Significant decrease	Paired t-test: p = 0.021
					Independent t-test (Δ SOD): p = 0.000

A total of 30 postpartum mothers from day 7 to 14 became research respondents, divided into an intervention group (n = 15) who did Otaria Exercises regularly for 4 weeks and a control group (n = 15) without intervention.



**Figure 1.** Graph of changes in Superoxide Dismutase (SOD) levels between the intervention group (Otaria Gymnastics) and the control group

The intervention group (Otaria Exercises): experienced an average increase in SOD levels of 0.44 U/mL ( $p = 0.001$ ). The control group: actually showed a decrease in average SOD levels of 0.16 U/mL ( $p = 0.021$ ). The difference test between groups resulted in a significant difference ( $p = 0.000$ ). The results showed a significant increase in Superoxide Dismutase (SOD) levels in the group of postpartum mothers who did Otaria Exercises compared to the control group. The average SOD level increased by 0.44 U/mL in the intervention group, while the control group actually experienced a decrease of 0.16 U/mL. This difference was statistically significant ( $p = 0.000$ ), so it can be concluded that Otaria Exercises plays a role in increasing antioxidant enzyme activity. This finding is in line with previous studies which state that physical exercise with light to moderate intensity can trigger physiological adaptations in the form of increased endogenous antioxidant enzyme activity, including SOD. The underlying mechanism for this increase is mild oxidative stress caused by exercise, which then triggers the body to increase antioxidant enzyme expression as a form of adaptation. In the postpartum period, oxidative stress increases due to metabolic stress, hormonal changes, and postpartum inflammation. This condition can weaken the body's defense against free radicals and potentially lead to complications. Therefore, interventions that can increase the body's antioxidant capacity are crucial for postpartum mothers.

The research presented in Tables 2 and 3 provides an in-depth overview of the effectiveness of physical exercise interventions in increasing Superoxide Dismutase (SOD) levels in postpartum mothers. The characteristics of respondents in both groups showed significant demographic equality, with mean age and proportion of parity not significantly different, where the intervention group had a mean age of 29.2 years and 53.3% were primiparous (Gervais et al., 2025). Physical exercise, including aerobic and strength programs, has been shown to increase SOD activity and reduce oxidative stress, indicative of improved metabolic and inflammatory health (Ye et al., 2021). These findings are consistent with the results of other studies showing that structured exercise interventions during the postpartum period can produce positive changes in biomarkers of oxidative stress (Abedi et al., 2023; Tolba et al., 2022). Therefore, physical exercise is not only important for physical fitness, but also for modifying biochemical parameters related to postpartum maternal health.

Data from Table 3 shows that the intervention group experienced a significant increase in SOD levels after undergoing the physical exercise program, while the control group actually experienced a decrease

(Wibawa et al., 2021). The increase in SOD levels in the intervention group from  $1.25 \pm 0.11$  U/mL to  $1.69 \pm 0.14$  U/mL ( $p = 0.001$ ) indicates the effectiveness of the education and exercise program. On the other hand, the decrease in SOD levels in the control group indicates the negative impact of not doing physical activity in the postpartum period, which is in line with other studies that show the importance of postpartum physical therapy to improve overall health (Lewis et al., 2021). Other studies have shown that physical exercise plays an important role in improving antioxidant status, including SOD, which functions to protect cells from oxidative damage (Militello et al., 2024; So et al., 2022).

On the other hand, decreased SOD levels in the control group indicate a negative effect of postpartum physical inactivity. Previous research has shown that postpartum physical inactivity can contribute to increased long-term health risks, including metabolic disorders and inflammation (Bø et al., 2023; Gervais et al., 2025). This is in line with the findings of Gervais et al. (2025), who emphasized the importance of physical activity in the postpartum period to support maternal health recovery. In addition, research by Haferanke et al. (2025) shows that structured physical activity can positively influence the adaptation of the body's antioxidant system, which is important during recovery.

Furthermore, Souissi et al. (2020) showed that variations in exercise modes, such as different running workouts, can affect levels of oxidative stress and antioxidant defense enzymes. These results suggest that the type and intensity of physical exercise may contribute to changes in SOD levels in the context of exercise-based interventions. This provides a more comprehensive view of how physical training, through increasing SOD levels, may serve as a preventive strategy for postpartum health problems.

The mechanism behind increased SOD levels resulting from physical activity may be linked to the antioxidant effects of exercise itself. Exercise provides benefits by increasing the body's antioxidant capacity, which contributes to reducing oxidative stress (Deprato et al., 2024). Physical activity has been known to stimulate the production of antioxidant enzymes in the body, including SOD, which function to reduce oxidative damage and improve tissue health (Wibawa et al., 2021). In fact, several studies show that postpartum physical activity contributes to better recovery and a reduced risk of adverse health conditions (Özkan et al., 2020).

In research on the impact of physical exercise on pregnant women, the respondent's parity plays a crucial role in interpreting the results. Parity refers to the number of births a woman has had, and studies have shown that mothers experiencing their first birth

(primiparas) may adapt differently to exercise programs than mothers with previous birth experience (multiparas). Research by Rahayu et al. (2021) suggests that primiparas may be at higher risk for conditions such as preeclampsia. However, other research has shown that preeclampsia can occur in both groups, necessitating a training approach that can be applied to both groups.

Furthermore, several studies have also shown that parity can influence maternal cardiovascular responses to exercise. Meah et al. (2020) found that pregnant women of varying parity showed differences in cardiovascular adaptations during physical activity, although results may not always be significant between trimesters. This suggests that adjustments to exercise programs may be necessary to address the specific needs of primiparas and multiparas.

In designing future exercise interventions, it is important to consider other factors such as education, knowledge, and socioeconomic status that may influence motivation and access to exercise programs for pregnant women (Sun et al., 2023). A study by Garnæs et al. (2021) noted that participation in exercise programs is often higher among women with better education. Therefore, interventions need to be tailored to the mother's social and educational background to achieve the best results.

Overall, the influence of parity on exercise adaptations among pregnant women is an area worthy of further research. By considering these differences in intervention design, we can improve the effectiveness of exercise programs and provide better support for pregnant women. Further research in this area can also aid in the development of better guidelines and policies to improve maternal and infant health (Santos-Rocha et al., 2022).

The results of the independent t-test showed a significant difference in changes in SOD levels ( $\Delta$ ), with  $p = 0.000$ , supporting the hypothesis that physical exercise intervention through education has a positive impact in increasing SOD levels (Lewis et al., 2021). This is in line with literature that underscores the importance of mental and physical health in postpartum recovery supported by physical activity (Onaade et al., 2021). Research shows that participation in a fitness program can improve not only physiological outcomes, but also psychological ones, by reducing symptoms of postpartum depression and improving overall well-being (Yadeta et al., 2025).

Overall, this study adds evidence to the growing literature regarding the benefits of exercise for postpartum mothers, particularly in terms of increasing SOD levels (Martin-Arias et al., 2025; Silva et al., 2024). The importance of educating mothers about physical activity not only helps improve their physical health

but can also contribute to their mental health and overall quality of life. Therefore, policies that support the provision of information and access to postpartum exercise programs should be considered to improve maternal well-being after childbirth.

## Conclusions

It has been demonstrated that otaria exercise considerably raises postpartum mothers' levels of Superoxide Dismutase (SOD). According to the data, SOD levels increased by 0.44 U/mL in the intervention group that engaged in Otaria exercise for seven days, while they decreased by 0.16 U/mL in the control group. These results suggest that by boosting the body's production of endogenous antioxidant enzymes, especially SOD, light physical activity, like Otaria exercise, can effectively stimulate the body's adaptive response to oxidative stress. Furthermore, the decrease in SOD levels in the control group indicates that without physical stimulation, the postpartum mother's antioxidant system tends to decline in response to physiological and hormonal stress, as well as lack of activity. Overall, this study strengthens the argument that Otaria exercise can be included as an important element in a postpartum maternal recovery program, providing benefits not only physically and psychologically, but also biochemically through increasing the body's antioxidant capacity.

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## Author Contributions

Conceptualization, methodology, formal analysis, investigation, resources, writing—reviewing and editing, visualization, supervision, project administration, obtaining funding, R., J., E.Y., and A.K.; writing—preparation of original draft, R. and J. All authors have read and approved the published version of the manuscript.

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## Conflicts of Interest

The authors declare no conflict of interest.

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