The Effects of Yoga Exercise on Manganese Superoxide Dismutase (MnSOD) Levels and Anthropometric Parameters in Abdominal Obesity Populations

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***Abstract*—The aims of this research was to determine the effect of yoga exercise on MnSOD levels and anthropometric parameters in abdominal obesity populations. Cardiovascular diseases are the main cause of death in the world. Cardiovascular diseases risk factors are abdominal obesity and oxidative stress conditions. Yoga exercise is an effective physical training in correcting these risk factors. Subjects were taken from populations with abdominal obesity in Denpasar Bali Indonesia. Thirty-seven subjects were randomly divided into 2 groups, the yoga group (n = 18) and the control group (n = 19). Yoga exercise was carried out twice a week in 8 weeks. The control group was not given any physical training during the study. We compared the pre-test and post-test results in the two groups. There were significant differences waist/hip ratio (W/H ratio) and MnSOD level (p<0,05). We concluded that yoga exercise has a positive effect on MnSOD levels and W/H ratio in population with abdominal obesity.**

***Index Terms*—physical postures, breathing control, antioxidant enzyme, waist hip ratio, body mass index**

I. Introduction

Abdominal obesity was associated with an increased incidence of cardiovascular diseases risk factors [1]. Over three quarters of CVD deaths take place in low- and middle-income countries. Cardiovascular disease is a cause of mortality and morbidity throughout the world which impacts on clinical and economic aspects globally, so preventive efforts are needed. In addition to genetic factors, modifiable risk factors related to lifestyle also play a role in the pathophysiology of CVD [2]. Many CVD risk factors have been identified but the most important risk factors are hypertension, hyperlipidemia, hyperglycemia, and abdominal obesity approximately 80% of CVD cases are mainly caused by modifiable risk factors [3].

Yoga is an exercise that harmonizes between body and mind. Yoga consists of low-intensity movements that are suitable for individuals at various levels of physical activity. Yoga stimulates the parasympathetic nervous system so that it causes relaxation that can provide a good response for patients with or at risk for cardiovascular disease. Yoga has been studied as physical training to address the psychological and physical risk factors associated with cardiovascular disease [4]. Yoga is effective for reducing obesity through changes in some anthropometric and physical parameters [5].

Oxidative stress is a condition that occurs due to an imbalance between free radicals, namely Reactive Oxygen Species (ROS) and Reactive Nitrogen Species (RNS) with antioxidants. It's happened when free radical levels exceed antioxidant levels. Oxidative stress causes damage to various biomolecular structures such as DNA, proteins and lipids. It is the underlie the pathology process of various diseases such as cancer, cardiovascular diseases, neurodegenerative diseases and the aging process. Three months of yoga in healthy people and individuals with pre-diabetes is effective in increasing levels of Superoxide Dismutase antioxidant enzyme (SOD) [6]. One type of SOD is Manganese SOD (MnSOD). MnSOD is an antioxidant enzyme located in the inner membrane of the mitochondria. This enzyme is the first defense to prevent the formation of excessive free radicals. Atherogenic stimuli occur when the expression of these antioxidant enzymes decreases. Failure of the mitochondrial antioxidant system underlies the occurrence of atherosclerosis [7]. Various studies have proven the effectiveness of yoga exercise in increasing levels of Superoxide Dismutase (SOD), but there are no studies found about evaluating the effectiveness of yoga exercise in specifically increasing one type of SOD, namely MnSOD. Our study investigated the effect of yoga exercise on MnSOD levels as a parameter which is one of the key factors in the pathophysiology of cardiovascular diseases. The purpose of our study was to determine the effect of yoga exercise

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on MnSOD levels and anthropometric parameters in abdominal obesity populations.

II. Methods

A. Participants

Participants in this study were populations with abdominal obesity in Denpasar, Bali, Indonesia. Eligibility criteria in this study were age 40-70 years, waist circumference > 90 cm for men and > 80 cm for women, waist/hip ratio (W/H ratio) > 0,90 for men and > 85 for women, body fat levels > 22% for men and >32% for women, take yoga exercise at least 13 times out of 16 yoga exercise. Subjects who are practicing yoga or regular exercise more than one month in the previous 6 months, have physical disabilities, non-cooperative subjects, currently following a weight-loss diet and taking antioxidant supplements were excluded from this study.

B. Materials

Weight measurements were carried out using anthropometer made in Japan with a decimal number one decimal point in kilograms. Height measurements were carried out using an anthropometer made in America, with a decimal number one decimal point in centimeters. Waist and hip circumference were measured using tape measure dual sided made in Japan. Waist circumference cut of point used guidelines from the American Association of Clinical Endocrinologists and the American College of Endocrinology [8]. W/H ratio cut of point referred to World Health Organization cut-off points. Fat percentage measurement were carried out using body fat monitor HBF-306 made in Japan. MnSOD was examined using human MnSOD ELISA kit BT LAB catalog no: E3827Hu.

C. Procedures

Yoga exercise were carried out for 60 minutes each session, twice a week for 8 weeks intervention. Yoga exercise was under supervision of a yoga therapist and medical team. Yoga exercise began with active stretching as a warming-up for 5 minutes and consisted of 10 postures which each posture was done for 1 minute with 5 repetitions. Yoga postures accompanied with breathing control (Table I). At the end of the session, the subject did relaxation namely shavasana posture for 5 minutes.

Waist circumference, hip circumference, W/H ratio, body fat levels measurements and blood sampling for the MnSOD examination were carried out before (pretest) and after the intervention (posttest).

Waist and hip circumference measured using tape measure dual sided. Waist/hip ratio (W/H ratio) was calculated by dividing the waist circumference with hip circumference. Body fat level measured using body fat monitor HBF-306.

Blood sampling was taken twice, the day before yoga training (pretest) began and the day after it (posttest). Venous blood that had been taken using a syringe was left standing for 1-2 hours, so that serum / plasma and other blood components was separated. After 1-2 hours, a new 300 rpm centrifuge was carried out for 10 minutes. Observed formed supernatant (serum / plasma) were separated from other blood components. The supernatant was put in a 1.5 ml microcentrifuge tube and stored in the freezer -20 / -80˚C.

TABLE I. Details of Yoga Exercise Intervention

Practices	Duration	Repetition	Total duration
Warming up	5 minutes	1	5 minutes
Tadasana	1 minutes	5	5 minutes
Virabhadrasana	1 minutes	5	5 minutes
Dandasana	1 minutes	5	5 minutes
Supta tadasana	1 minutes	5	5 minutes
Supta padangustasana	1 minutes	5	5 minutes
Urdva hastasana	1 minutes	5	5 minutes
Ardha uttanasana	1 minutes	5	5 minutes
Baddha konasana	1 minutes	5	5 minutes
Virasana	1 minutes	5	5 minutes
Swastikasana	1 minutes	5	5 minutes
Shavasana	5 minutes	1	5 minutes

MnSOD measurement by ELISA technique. We used human MnSOD ELISA kit BT LAB catalog no: E3827Hu. Preparation of reagents, samples, standard solutions and assay procedures had been carried out according to standard MnSOD measurement procedures.

Statistical significance was set at $p < 0.05$. All statistical analyses were conducted using IBM SPSS Statistics ver. 24.0 (IBM Co., Armonk, NY, USA).

III. Results

A. Characteristics of Participants

Table II shows shows the characteristics of respondents by age. Mean of age in both groups is 60 years.

TABLE II. Characterisctic of Sujects according Age

Group	No. (%)	Mean (SD)
Yoga	18 (48,65)	60,61 (9,03)
Control	19 (51,35)	60,50 (7,65)

Values are presented as number (%) and mean (SD)

Table III shows the mean of W / H ratio in the yoga group decreased after intervention, while in the control group the W / H ratio showed no change. Fat levels in the yoga group decreased after the intervention while in the control group increased. MnSOD levels in the yoga group increased after intervention while in the control group decreased.

TABLE III. ANTHROPOMETRIC PARAMETERS AND MNSOD LEVELS IN YOGA AND CONTROL GROUP ON PRE AND POST TEST

Variable	Pre test	Post test
Waist circumference (cm)		
Yoga	91,33 (7,79)	89,39 (7,23)
Control	91,28 (7,21)	92,33 (7,25)
Hip circumference (cm)		
Yoga	91,50 (8,56)	92,17 (8,27)
Control	92,33 (8,59)	92,61 (8,66)
W/H ratio		
Yoga	0,99 (0,54)	0,97 (0,53)
Control	0,99 (0,36)	0,99 (0,37)
Fat levels (%)		
Yoga	37,61 (4,27)	34,42 (5,33)
Control	34,66 (3,67)	35,42 (3,50)
MnSOD (ng/L)		
Yoga	6,15 (8,45)	14,22 (21,79)
Control	5,74 (12,85)	2,86 (1,68)

Values are presented as mean (SD)

B. Independent Test Results of Yoga Group and Control Group

Table IV shows waist circumference, hip circumference, W / H ratio, fat levels, MnSOD levels pre-test showed insignificant results (p> 0.05) so that it was eligible to be compared to the results of post-test in the two groups. Independent test after the intervention (post-test) W / H ratio and MnSOD levels showed significant results (p <0.05) while waist and hip circumference, fat levels did not show significant results (p>0,05).

TABLE IV. INDEPENDENT TEST RESULTS OF YOGA GROUP AND CONTROL GROUP

Variable	P value	
	Pre test	Post test
Waist circumference	0,872	0,164
Hip circumference	0,638	0,739
W/H ratio	0,845	0,029*
Fat levels	0,23	0,492
MnSOD levels	0,081	0,000*

*P<0.05, significant difference

IV. DISCUSSION

Our study investigated the effect of yoga exercise on anthropometric parameters and MnSOD levels. The average age of subjects in our study was 60 years (table 2), it supports the recent finding that older age is significantly related to the occurrence of overweight or obesity [9]. The observed increasing of body weight along with age showed that there was more dominant accumulation in the abdominal than the gluteofemoral area. Increasing of visceral fat tissue deposition occurs with increasing age in postmenopausal men and women. Postmenopausal women have up to twice the amount of adipose tissue compared to pre-menopausal women [10]. Abdominal fat deposition in the elderly due to that as we get older, a person will become less active where it contributes to the reduction in total energy expenditure and has an effect on energy balance. During the aging process, fat is redistributed from subcutaneously to the abdomen, liver and muscles. In older age occur changes in adipose tissue phenotype where these changes can affect energy metabolism and insulin resistance [11].

We found that yoga exercise was effective in improving W / H ratio (Table IV). Our result supported the study of V Tundwala, *et al.* (2012) that found pranayama and certain yogic asanas were significantly decrease in waist hip ratio [12]. It was also linier with the study by R Netam, *et al.* (2015) that concluded short-term yoga-based lifestyle intervention yoga reduce the waist hip ratio in overweight/obese individuals [13]. A study by PA Balaji, *et al.* (2011) also showed yoga - pranayama practices is effective to decrease waist hip ratio in type 2 diabetes populations [14].

Central obesity is a far stronger predictor than body weight or BMI in predicting the risk of cardiovascular diseases [15]. One of the anthropometric parameters for central obesity is the wait hip ratio. Various factors contribute to each other in overweight or obese people. Ayurveda and yoga provide the effects of physical training, stress reduction, improvement of the metabolic system and anti-inflammation. It overcomes various etiologies related to overweight and obesity [16]. Relaxation techniques in yoga reduce stress resulting decreased of circulating cortisol through hypothalamus pituitary axis activation which lead to reduced risk of abdominal obesity [17].

Our study also found that yoga exercise was effective in improving MnSOD levels (Table IV). This was in line with the results of research by R Yadav, *et al.* (2019) 12-week yoga-based lifestyle intervention effective to SOD levels in adults with metabolic syndrome [18]. Our result also supported a study that found significant elevation of SOD levels, among healthy male who do yoga regularly [19]. MnSOD is the mitochondrial antioxidant enzyme acting as the chief ROS scavenging enzyme in the cells [20]. SOD2 (mitochondrial antioxidant enzyme) modifies mitochondrial oxidative stress thereby reducing risk factors for cardiovascular diseases [21]. Possible mechanism underlies in our results were that yoga exercise reduce over activation of the hypothalamic pituitary adrenal axis (HPA axis) and the sympathoadrenal axis. Over activation in this system causes an increase in stress hormones such as cortisol. Second, underlying mechanism of the effectiveness of yoga in increasing SOD was yoga increase the activation of the parasympathetic system so that it gives a positive effect on the body [22]. Our research found the effectiveness of yoga exercise in improving various parameters of cardiovascular disease risk factors, so it can be used as a physical training in lifestyle modification for populations with cardiovascular disease risk factors. Our finding about the effectiveness of yoga exercise in improving MnSOD levels can also be scientific evidence that yoga exercise is one of physical exercise that can modify oxidative stress conditions, where oxidative stress is a key factor underlying the pathological process in cardiovascular diseases.

V. CONCLUSION

In conclusion, we conclude that yoga exercise effective to improve antophometric parameter (W/H ratio) and MnSOD levels among abdominal obesity

populations. We conclude that yoga exercise is a lifestyle modification intervention that can reduce coronary heart disease risk factor through modifying the balance between oxidants and antioxidants which is the mechanism underlying the occurrence of coronary heart disease. We recommend yoga exercise as an adjunct therapy to prevent coronary heart disease especially in abdominal obesity populations. The limitation of our study was the small sample size, so we recommend for future research to use larger sample size that are needed to determine whether study results can be generalized to the broader populations.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

AUTHOR CONTRIBUTION

Nila Wahyuni and Adiartha Griadhi conducted the research and wrote this manuscript; Sita Saraswati helps proof reading and analyzed research data. All the authors had approved this final version manuscript.

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