

## Serum Dehydroepiandrosterone (DHEA) concentration after aquarobic training in premenopausal women with obesity

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### Abstract:

Background: The prevalence of obesity which is characterized by an increase in excess body weight occurs worldwide, including Indonesia, with 8.1% of obese men and 13.5% of obese women. Dehydroepiandrosterone (DHEA) is a precursor to the hormone DHEA, a sex steroid hormone produced by the adrenal cortex, and its concentration decreases with age have not precisely been decided in obese people regulation by aquarobics training (recommended sport type or obese people). This research aims to investigate the Dehydroepiandrosterone (DHEA) concentration of obese people based on BMI, examine their relationship with obesity-related parameters and how it can be modulated by aquarobic training in premenopausal women with obesity. Methods: The experimental laboratory research design using the design of The Randomized Pretest-Posttest Control Group Design, conducted on 20 healthy volunteers women obese from 45 – 55 years old, was divided into 2 groups where group 1 (n=10) aquarobics training intensity 70-85% HRmax for 8 weeks and control group (n=10). Measurement of the Dehydroepiandrosterone (DHEA) concentration Using enzyme-linked immunosorbent assay (ELISA) methods, measuring other factors like Low Density Lipoprotein and cholesterol level before and after treatment. Result: Aquarobic training group pre-test BMI  $31.32 \pm 0.97 \text{ kg/m}^2$ , DHEA  $66.92 \pm 22.65 \text{ nmol/l}$  and cortisol levels  $9.67 \pm 3.37 \text{ nmol/l}$ ; Post-test BMI  $30.24 \pm 1.18 \text{ kg/m}^2$ , DHEA  $82.25 \pm 21.52 \text{ nmol/l}$  and cortisol levels  $7.60 \pm 3.11 \text{ nmol/l}$  ( $p < 0.05$ ). control group pre-test BMI  $32.48 \pm 1.56 \text{ kg/m}^2$ , DHEA  $63.83 \pm 24.09 \text{ nmol/l}$  and cortisol levels  $7.70 \pm 1.65 \text{ nmol/l}$ ; Post-test BMI  $33.18 \pm 1.56 \text{ kg/m}^2$ , DHEA  $65.53 \pm 22.09 \text{ nmol/l}$  and cortisol levels  $8.23 \pm 1.44 \text{ nmol/l}$  ( $p > 0.05$ ). Conclusion: it was observed that aquarobics training intensity 70-85% HRmax for 8 weeks significantly increased DHEA concentration and decreased cortisol levels, DHEA may play an important role in obesity and can be potentially modulated by aquarobic training.

**Key Words: Inflammation, Waterfitness, Metabolic syndrome, Cortisol.**

### Introduction

The prevalence of the metabolic syndrome increases with age, and is particularly high in premenopausal women, where as the increased risk factors associated with the metabolic syndrome including central obesity and cardiovascular disease are higher in women than men. (Saad, M. A.2014, Kim, S.2015). In general, the sex hormones of premenopausal women show considerable changes in relation to abdominal adiposity, thereby increasing the likelihood of developing metabolic syndrome. There is increasing evidence that changes in sex hormones contribute to the pathophysiology of metabolic syndrome (Kim, C. 2014). Dehydroepiandrosterone (DHEA) and its sulfate ester (DHEA-S), are steroid hormones produced by the adrenal glands that are converted into testosterone and estrogen. Although the physiological function of DHEA-S is right is not fully understood, but the serum levels decline with age, and this decline is associated with increased waist circumference in elderly women. Low levels of sex hormone binding globulin (SHBG), which binds testosterone and estradiol is associated with a high prevalence of metabolic syndrome in premenopausal women. (Labrie, F. 2001) Dehydroepiandrosterone sulfate or DHEAS, is the form of the molecule dehydroepiandrosterone (DHEA) that is naturally modified in the body so it can be stored in the blood. DHEA is synthesized from cholesterol and stored as DHEAS until it is needed to make different steroid sex hormones, including estradiol and testosterone, as well as other sex steroid precursor molecules.(Heaney JLJ.2013) These hormones are crucial in maintaining energy, muscle and bone health, and sexual function in both men and women. Estrogen, testosterone, and other important sex hormones are produced by the gonads—the testes in men and the ovaries in women. In men, the testes continue to release testosterone and the other sex steroids at rates that decline slowly but steadily as they age. In

contrast, when women reach menopause the ovaries completely cease to produce sex hormones such as estrogen. The hormonal fluctuations of menopause thus lead to a variety of physiological changes, and at this time, DHEAS becomes the only source of the essential sex hormones in women (Sato K. 2012, Aldred S. 2013).

DHEAS is produced by the adrenal cortex of the kidney, a set of glands that produce a class of hormones called corticosteroids. Other examples of these corticosteroids include cortisol, which is involved in immunity and responding to stress, and the mineralocorticoids, which are involved in regulating blood pressure. Of the molecules produced by the adrenal cortex, DHEAS is found in highest concentration in blood serum. However, scientists do not yet completely understand how it works or if it has functions aside from being a precursor for the sex steroids. What scientists do know is that in both women and in men, DHEAS levels increase from early childhood until they peak again during age 20-30. After this, DHEAS levels steadily decline with age. Lower of DHEAS levels are associated with higher risk of conditions such as diminished immunity (Quiroga MF.2012) increased risk of cardiovascular disease (Sanders JL.2010) stroke (Jiménez.2013) and unstable blood sugar levels (Liu L.2013)

Lifestyle changes and measurable and regular physical exercise are recommended as an alternative for the prevention of metabolic syndrome. (Yamaoka, K. 2012) Several previous studies have shown that physical exercise has a positive effect on the profile of the metabolic syndrome, thus affecting body composition, cardiorespiratory fitness, insulin resistance and sex hormones. (Ostman, C. et al. 2017, Myers, J.2019, Ennour-Idrissi, K., 2015) Although the effect of physical exercise on sex hormones among elderly women has not been clearly, several studies have shown that estradiol levels, testosterone increased after exercise, change of lifestyle, active and healthy lifestyle (Copeland, JL, 2002, Kim, J.-W.2012). Previous study has shown that the hormone DHEAS is decreased in older adults and DHEAS is significantly increased in women who exercise. Postmenopausal women show an increase in DHEAS after exercise and 2 hours after endurance training and weight training (Kemmler W. 2003) Appropriate exercise instructions are needed according to the dose of exercise according to gender and age, where the effect and response of exercise to DHEAS in men and women associated with and appropriate dose of exercise. As the impact of high intensity exercise on DHEAS is still unclear, this study was done to examine the impacts of 8 short-term aquarobic training on DHEAS levels in women. Aquarobic training is a exercise in water, the effectiveness of aquarobic training considers safety for women, especially premenopausal women with obesity, this can improve fitness related to blood vessels without metabolic syndrome (Mukarromah, SB.2014).

## **Material & methods**

### *Participants*

24 obese women aged  $46.49 \pm 1.41$  years with a body mass index (BMI) of  $32.8 \pm 0.92$  volunteered to participate in this study with obese limit of 30 kg / m<sup>2</sup> in Semarang, based Asia-Pacific Guide (EA Nurad 2003). Participants filled out a questionnaire that included age, last menstrual period, and menopausal status (last menstrual period is 6 months). All participants were aware of the possible risks and read the procedures for conducting the study before signing the informed consent form. This research was approved by the Indonesian Research Ethics Committee, Kaliadi Hospital, Diponegoro University, Semarang (No.519/EC/FK/RSDK/2020).

### *Aquarobics Exercise*

Aquarobics Method: Expanding heart rate amid work out within the water is more hard. Since 65-95% body cells comprise of water, the blood circulation amid work out within the water gets better, meaning that when doing the exercises within the water the heart does not need to pump difficult to circulate oxygen. Heart rate monitors are performed each 5 minutes of the work out period. Aquarobic training given in direct strongly (75% HRmax) such as 15 minutes warming-up and stretching statis and dynamis, 20 minutes aqua jogging and stretching movements, 20 minutes aquarunning and feet continue to perform running motion in the water and 15 minutes of cooling down exercise. During Aquarobics training (Mukarromah SB.2014) supervised by experienced aquarobics instructors, was performed eight week. Each session consisted of a 15-min warm up session, a 40-min session of aquarobics training an intensity of 50-75% HRmax.

### *Blood samples and hormone analysis*

The DHEA-S level test is an examination carried out to measure the level of the hormone dehydroepiandrosterone-sulfate (DHEA-S) in the blood. Blood samples were taken at 06.00 am before exercise and 1 hour after exercise, 6 ml of antecubital venous blood was taken and put into a plain tube. (BD Vacutainer, Plymouth, UK). Serum and plasma were separated and stored at -20°C until examination. DHEA-S examination using the CMA (Chemiluminescent Microparticle Immunoassay) ECLIA method.

### *Statistical analysis*

Data were expressed as mean  $\pm$  standard deviation of baseline for each group, 24 people were divided into two groups: control and aquarobic training. Aquarobics training program takes place at the Semarang State University Swimming Center, Central Java, Indonesia. The analysis used one-way ANOVA followed by post hoc testing to identify significant differences. Statistical analysis was performed using SPSS software version 21 (SPSS Inc, Chicago, Illinois, USA) and  $p < 0.05$  was considered significant.

**Results**

Age and Body Mass Index (BMI) for the aquarobic training group did not differ before treatment, after treatment there was a significant difference between control and aquarobic training, this was a result of weight loss due to exercise. Results obtained from this study showed that eight weeks of training aquarobics lowering body mass index ( $p = 0.00$ ) than the control group. In addition, after 8 weeks of training aquarobic DHEAS concentrations were significantly increased ( $p = 0.00$ ) than before treatment ( $P < 0.05$ ) (Table 1). DHEAS is an essential precursor of important sex steroid hormones, particularly for women, that naturally declines with age. Having DHEAS levels outside of the optimal range for your age is associated with a variety of chronic conditions that can be prevented by making simple changes to your diet and exercise routine.

**Table 1. Comparison of characteristics subject (pre and post intervention)**

Variable	Aquarobics Group (n=12) (Mean ± SD)	Control group (n=12) (Mean ± SD)	p
Age (y.o) pretest	48.74±1.30	48.79±1.35	0.450
Body Mass Index (kg/m <sup>2</sup> ) pre-test	33.32±0.97	34.48± 1.56	0.040
Body Mass Index (kg/m <sup>2</sup> ) post test	31.24± 1.18	33.48± 1.56	0.000*
Cortisol (nmol/l) pre-test	9.67±3.37	7.70±1.65	0.112
Cortisol (nmol) post-test	8.60±3.51	9.79±1.44	0.002*
DHEA-S (nmol/l) pre-test	66.92±22.65	73.83±24.09	0.047
DHEA-S (nmol) post-test	72.25±21.52	80.50±25.34	0.000*

data are expressed as mean and SD, significant difference between groups ( $p < 0.05$ )

Aquarobics classes are a great way to mix up a traditional gym workout with the benefits of water, The driving force of pressure from water on the body has a positive impact, namely reducing stress on joints and muscles, increasing muscle strength (Lim HS.2013, William M. 2010) with a movement against water, will activate the muscles, help improve pulmonary and heart blood flow to the body. whole body. The gravity generated by this water pressure provides a wider range of motion where the increased aquarobic training load does not put excessive stress on joints and muscles and helps prevent overheating. Aquarobics training provides a potent stimulus for muscular adaptation, this process is mediated, at least in part, by acute and cronic hormonal responses to aquarobic training, including changes in DHEAS. Another study reported in older adults demonstrated a DHEAS immediately increase significant in response to post-exercise aerobic submaximal (Giannopoulou L.2003) and after resistance training (Copeland JL.2002) in postmenopausal women. To our information, this is the first study to investigated the impact of short-term aquarobics training on DHEAS concentration in obese participants.

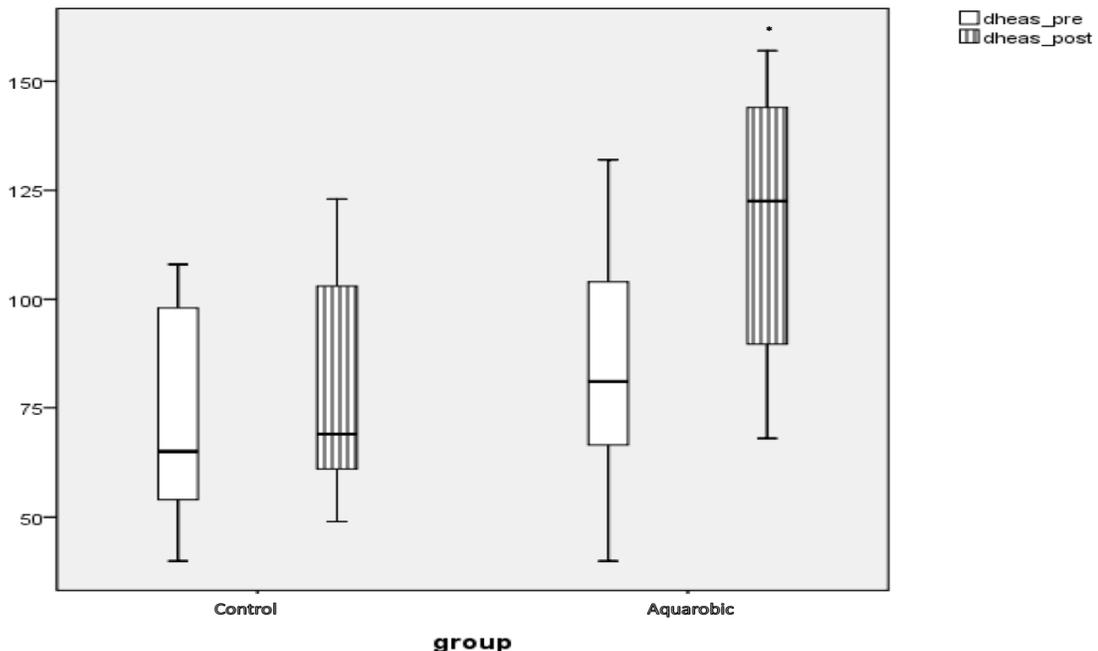


Fig 1. Response shor-term of aquarobics training on DHEAS levels in obes women. \* $p=0.001$ . Significantly different from pre-test values, \* $p < 0.001$ .

## Discussion

DHEAS concentrations increased significantly due to aquarobic training, the largest (15%) occurred during 90 minutes after treatment, and decreased during the recovery period, and increased significantly after 1 hour of exercise. Our previous studies have found that the effect of exercise on DHEAS concentration depends on the intensity and load of the given exercise (Tremblay MS.2005, Bouchard L.2004, Tremblay MS.2004). The results of the study so far show that the increase in response due to aquarobic training depends on the duration of the specified exercise, this result is supported by previous studies that the greater DHEAS concentration in women after running with a duration of more than 60 minutes. The mechanism for increasing DHEAS in this study is not clearly understood; However, the exercise induced in DHEAS is too large to be explained solely by reduced metabolic clearance and suggests that the main mechanism is increased glandular secretion. (Aldred S.2009, Anne E.2007) Aquarobic training increases the production of DHEAS from the adrenal cortex via the hypothalamic-pituitary-adrenal axis. From this research it is clear that after an increase aquarobics exercise significant DHEAS hormone after exercise ( $P=0.001$ ). The increase in DHEAS hormone due to aquarobics exercise is due to the fact that DHEAS hormone has several functions on T cells, which are mediated through the binding of a group of intracellular receptors, or specific receptors that mediate many different pathways. The increase in the percentage of apoptotic lymphocytes is associated with an increase in the hormone DHEAS (Liang.2004)

Differences DHEAS levels are influenced by gender, age, genetic factors, receptors of the hormone androgen. In women, it is influenced by the hormone estrogen, differences in the menstrual cycle, stress factors and free radicals. The estrogen hormone act as antiandrogens, through the barrier effect of androgens on the sebaceous glands, inhibition of androgen production via negative feedback on the pituitary gland, and estrogen regulates genes that inhibit the growth of sebaceous glands and the production of lipids (Krobath.1999) The existence of these factors can also cause levels of the hormone DHEAS results were lower than normal value. Some types of systemic drugs can also affect serum DHEAS hormone levels, such as oral contraceptives, corticosteroids, spironolactone, but these drugs are already included in the exclusion criteria, so that in this study there was no subject who consume these drugs. Similarly, some antibiotics can also affect serum DHEAS hormone levels, such as rifampicin and ampicillin which can lower serum DHEAS hormone levels. This difference in serum DHEAS levels is not only influenced by sex, age, genetic factors, androgen receptors, androgen receptor susceptibility, but estrogens that affect different DHEAS levels, differences in the menstrual cycle, we can also distinguish between androgens, stress and free radical. This research has its limits, so there are many other things that can be associated with exercise and metabolic syndrome (obesity). Aquarobics training can be applied to prevent the increase in metabolic syndrome due to obesity in premenopausal women. This research has its limits, so there are many other things that can be associated with exercise and metabolic syndrome (obesity). Aquarobics training can be applied to prevent the increase in metabolic syndrome due to obesity in premenopausal women (Botelho, 2013). The mechanism for the increase in DHEA-S observed in women is unclear. a larger increase in DHEA-S concentration is required to observe a significant change. (Aldred S.2009) women had a much lower level of DHEA-S before being given aquarobics training this is because the impact of exercise is measurable and regular, so it has a greater potential for significant improvement due to exercise. DHEA-S concentrations during recovery have been shown to be associated with physical activity in women (Heaney J.L.J.2013, Tremblay MS.2015, Anne E.2007). Aquarobics training dose of 75% HRMax increases DHEA-S concentrations in obese premenopausal women, it can be recommended that aquarobics training is an alternative health management exercise with non-pharmacological methods to increase anabolic hormones. Exercise of longer duration and higher intensity is required to increase and maintain DHEA-S levels for a significant recovery period after exercise.

## Conclusions

Aquarobics training is beneficial for health and wellbeing, increasing body fitness which is characterized by a normal heart rate. Aquarobics training is a type of aerobic exercise in the water that can increased fat burning through the mechanism of lipolysis. Aquarobics training can be recommended as a non-pharmacological disease prevention for obesity conditions where water is an excellent medium as an exercise load. Significant increases in DHEAS occurred in obese premenopausal women, with an immediate decrease in cortisol after 1 hour of exercise. Increased DHEAS was positively correlated with Vo2Max and exercise energy expenditure. This mechanism is due to an increase in DHEAS induced by an increase in the rate of adrenocortical secretion stimulated by adreno cortico tropic hormone (ACTH) and a decrease in vascular flow metabolism induced by Aquarobics exercise. The function of ACTH is to make a hormone called cortisol from the adrenal glands, cortisol itself helps regulate the body's metabolism and blood pressure. The results of this study showed that 8 weeks of aquarobic exercise affected the hormonal status of women, but in addition, resting DHEAS levels and response to aquarobic exercise were also affected by exercise intensity. Further research can be done by identifying various variations of physical exercise with the right dose to improve the endocrine system.

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