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Effect of Short-Term Weight Loss on Cardiopulmonary Function, Anaerobics Power and Immune Related Factors in Weight Class Athletes

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ABSTRACT: *Weight class athletes competing require technique, physical fitness, mental and intellectual management to perform well, but scientific weight loss is being used as a new technology or an important strategic point. In weight class competitions, the importance of the period and method of weight control is greatly emphasized because a certain recovery time is given after the limit weight weigh-in to ensure good performance.This study aimed to determine how short-term weight loss affects cardiopulmonary circulatory function, anaerobic power, and immune factors in weight class athletes. The dependent variables were measured, compared and analyzed by losing 5% of body weight over 7 days through exercise and dietary restrictions.After losing 5% of one's body weight for 7 days, there were significant changes in cardiopulmonary circulatory function (lung capacity, maximum oxygen intake), anaerobic power, and immune variables (immunoglobin-IgA, IgB, IgM, IgE, active oxygen, antioxidant substances).Short-term weight loss through intense exercise and dietary restrictions is found to be highly likely to have a negative impact on athletic performance and health. Therefore, there is an urgent need for education on effective weight loss methods that can maintain lean body mass while maximizing body fat reduction.*

KEYWORDS: *Short-term weight loss, cardiopulmonary function, anaerobics power, immune related factors.*

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I. INTRODUCTION

Weight is an objective measure of the body, an indicator of health, and is considered one of the very important physique conditions in all sports. Weight loss used to be done only when people were obese or had a pathological need for weight control, but recently, there are many cases where weight loss is done for a specific purpose. In particular, athletes participating in competitions in each weight class are putting a lot of effort into the degree of weight loss, the period of weight loss, and methods of weight loss in order to lose weight ahead of the game(Fogelholm, 1994; Lakicevic et al., 2020).

However, athletes participating in weight class competitions try to participate in more favorable conditions through misconceptions, habits, or excessive weight loss(Steen et al., 1988). In other words, weight class athletes repeatedly try to lose weight before the weigh-in because it is advantageous to compete against physically inferior athletes by being recognized as a lower weight class, therefore, it is practically difficult for weight class athletes to stop losing weight(Reale et al., 2017). In fact, it is reported that 80.6% of weight class athletes lose weight before competition(Flavia et al., 2021; McKenna & Gillum, 2017; Morales et al., 2018). In particular, they use a method of quickly losing weight, measuring the weight limit for competition, and then quickly gaining weight again(Štangar et al., 2022).

According to ACSM(1996), gradual weight loss over a long period of time is recommended as a relatively desirable weight control method as it is nutritionally sound, minimizes loss of lean body mass, and maximizes the effect of reducing fat mass. However, weight class athletes who require weight control tend to prefer short-term weight loss, which is causing many health problems(Brook et al., 2015).

It has been reported that excessive weight loss has adverse effects on exercise performance(Gutierrez et al., 2003), body temperature regulation(Torranin et al., 1979), kidney function(Forgellholm, 1994), heart function(Palmer, 1968), hormonal balance(Straus et al., 1985), resting metabolic rate(Steen et al., 1988), and nutritional status(Short et al., 1983). In particular, it has been reported that inadequate nutritional supply for artificial weight loss of growing athletes may have a negative impact on their growth and development.

Additionally, many athletes who regularly lose excessive weight in a short period of time before a game in order to gain a physical advantage experience the phenomenon of gaining weight again after the weight loss is over(Alderman et al., 2004). If this weight cycling phenomenon is repeated, a vicious cycle of abnormal hormone secretion, damage to the body heat production mechanism, nutritional deficiencies, decreased immune function, obesity, and changes in body composition is repeated. Repeated weight loss and weight gain not only redu

ces the resting metabolic rate, making weight loss more difficult, but also shows a decline in health-related physi cal strength such as healthy lifespan, metabolic syndrome, cardiovascular disease, and decreased immunity(Kna pik et al., 2019). In particular, because repeated weight loss during the competition season can lead to injuries, e motional disharmony such as anxiety and depression, and memory decline, there is an urgent need for thorough education on effective methods of weight loss for growing weight class athletes.

Despite warnings about health problems, psychological problems, and growth and development proble ms that may be caused by short-term weight loss among athletes in each weight class, athletes who want to main tain lower weight classes continue to lose weight. Therefore, this study aims to provide awareness and a new dir ection for weight loss by identifying how short-term weight loss affects cardiopulmonary circulatory function, e xercise performance, and immune variables.

II. METHODOLOGY

1. Subject

The subjects of this study were male weight class athletes (Taekwondo, Judo, Wrestling, Weightlifting, Boxing) with more than 3 years of experience and the total number of cases was 25. Among these subjects, 21 c linically healthy students without musculoskeletal diseases or metabolic diseases who did not smoke or take dru gs were selected for the second round. During this experiment, subjects were educated to understand and practic e behavioral patterns that could affect the results. The consent form regarding the purpose of this study and the c ontents of the experiment was received from all subjects, and the subjects who did not faithfully follow the weig ht loss program during the experiment period were excluded from this experiment, therefore, the final number of subjects was 19(19.63±0.58yrs, 4.17±0.83yrs-carrer, 170.76±6,81cm, 71.46±8.73kg).

2.Experimental procedure & Design

Weight loss was carried out for 7 days based on the short-term weight loss period recommended by Bro wnell et al,(1987) and Fogelholm(1994), with the goal of losing 5% of one's body weight. There are methods for short-term weight loss such as dehydration, exercise and diet control, and medication, however, in this study, w eight class athletes used methods such as restricting their diet through fasting and caloric restriction and sweatin g through training to lose 5% of body weight.

3. Evaluation items & method

Drugs such as diuretics or laxatives were never taken, and the dependent variables were cardiopulmona ry circulatory function (lung capacity, maximum oxygen intake), anaerobic function, and immune-related factor s, measured twice in total, before and after weight loss. These measurements were conducted at 10 am before we ight loss and after 7 days of weight loss. To ensure that laboratory conditions were the same, the room temperatu re was maintained at 20 ± 2°C.

For cardiopulmonary circulatory function, maximum oxygen intake and lung capacity were measured b ased on ACSM(2006) measurement guidelines. Cardiorespiratory endurance was measured using an aero-bike meter, and lung capacity was measured using SH-9600C. Measurements were made three times, and the average value was used. Anaerobic power was measured using the Wingate test, with a reliability coefficient of ≥.93 bet ween repeated tests, based on the guidelines of Marsh et al.(1999). The measurement of anaerobic power was co nducted using a bicycle ergometer, adjusting the height of the saddle and handle before placing the subject on th e bicycle, and having the subject assume a perfect posture to perform maximum exercise. The load during exerci se was an individual exercise load determined by multiplying each subject's body weight by 0.075kp, and the tot al power was tested for 10 seconds to determine the degree of mobilization of the ATP-PC metabolic process du ring anaerobic exercise, repeating 5 consecutive sets with 10 seconds of exercise → 30 seconds of rest.

For blood collection, 10 ml of blood was aseptically collected from the antecubital vein of the upper ar m using a disposable syringe into a vacuum container treated with EDTA anticoagulant and into an SST contain er for immunoglobulin analysis. As a result of the antigen-antibody reaction, IgG, IgA, and IgM were quantified using the test principle of measuring the change in light scattering intensity of immunopreception particles usin g a nephelometer. For each test item, IgG, IgA, and IgM were analyzed using the Beckman Array Protein Syste m Analyzer using the Immunoneperometry test method using more than 0.1 ml of serum refrigerated at 4°C on t he same day. Active oxygen items were measured using d-ROMs, and antioxidant capacity analysis was measur ed using BAP.

4. Statistical analysis

The measured values obtained in this experiment were calculated using the SPSS Package Ver. 21.0 statistical processing program to calculate the mean and standard deviation for each measurement item. All data were subjected to error verification to maintain the accuracy of data analysis. Compariso n of related variables before and after short-term weight loss was verified by paired t-test. All statistica

l significance levels were set to .05.

III. FINDINGS

This study aimed to determine the effect of short-term weight loss on cardiopulmonary circulat ory function, anaerobic power, and immune factors in weight class athletes. As shown in Table-1, signi ficant changes were observed in lung capacity, maximum oxygen intake, anaerobic power, immunoglob in factor, reactive oxygen species, and antioxidant substances after 7 days of weight loss.

Table 1. Change of related variables after short-term weight loss **M ± S.D**

	HRrest	VC (ml/min)	VO_2max (ml/kg/min)	Apmax (w)	IgA (mg/dl)	IgM (mg/dl)	IgG (mg/dl)	IgE (mg/dl)	d-ROMS	BAP
BWL	66.37 ±7.76	3952.50 ±586.02	71.75 ±20.87	879.25 ±85.80	228.37 ±39.15	126.84 ±28.79	1486.75 ±208.63	95.68 ±19.25	209.62 ±86.33	1659.00 ±192.33
AWL	71.87 ±7.62	3338.75 ±659.51	55.33 ±11.85	862.87 ±80.12	197.61 ±42.86	98.93 ±30.12	1405.92 ±219.65	89.76 ±20.73	467.62 ±92.72	1408.75 ±219.05
t-value		1.993*	2.055*	2.253*	2.009*	2.158*	2.9152*	1.8965	4.505**	2.991*

Values are means ± SEM, BWL; Before weight loss, AWL; After weight loss, HRrest; rest heart rate, VC(ml); Vital capacity, VO2max(ml/kg/min); latin capital v with dot above, APmax(w); Maximal anaerobic power; d-ROMS(ucarr); Free Radical, BAP(uMol/L): Antioxidant, IgA(mg/dl);immunoglobinA, IgE(mg/dl);immunoglobinE, IgG(mg/dl);immunoglobinG, IgM(mg/dl);immunoglobinM.

IV. DISCUSSION

In weight class competitions, weight limits are set for each weight class to exclude advantages due to b ody weight and to ensure fair competition between athletes with similar physical conditions. Weight loss is also reported to be one of the most important factors that determine the performance of weight class athletes(Brechne y et al., 2022). In some weight classes, the importance of weight loss method and period is greatly emphasized b ecause athletes are allowed to perform better after a certain recovery time after weigh-in. The weight loss recom mended in many studies is to reduce body fat as much as possible and maintain lean body mass, but most athlete s prefer rapid loss in a short period of time(Artioli et al., 2016; Joseph et al., 2019; Roklicer et al., 2022).

Weight class athletes try to recover nutritionally before competition by eating and drinking immediatel y after the weigh-in to officially confirm which weight class they will belong to(Steen & Brownell, 1990).. This cycle of losing weight and regaining it again occurs repeatedly in weight class athletes. After competing, athlete s often gain weight at or above their previous weight due to excessive overeating, and this type of weight cyclin g, which involves repeated weight loss and weight gain, poses a great threat to the health of athletes. The repetiti ve phenomenon of weight loss and gain (weight cycling) has negative effects on health-related areas such as deh ydration, decreased glycogen storage, decreased muscle mass, cardiovascular system, immune function, bone de nsity, cognitive ability, and hormonal status, increasing the risk of injury(Mohammad et al., 2017; Logan et al., 2020).. In this context, it would be desirable to overcome the pain of weight loss during training or competition by controlling one's weight or diet well on a daily basis.

Pulmonary function is important in evaluating the efficiency of breathing in most exercises related to o xygen consumption and in understanding the adaptation process of the respiratory system to various exercises. T he lungs are part of the functional elements of the respiratory and circulatory systems and are responsible for the beginning and end of energy metabolism in the human body, therefore, accurately understanding its characterist ics and functions so that its abilities can be utilized to the maximum is an important indicator in identifying the e ffectiveness and limitations of exercise(Rankinen et al., 2000). In particular, as lung capacity has been reported t o be useful in estimating mortality due not only to the cardiovascular system but also to diseases other than the c ardiovascular system, the measurement of lung function is accepted as the same as the measurement of survival ability(Rankinen et al., 2000).

In addition, indirectly measuring the function of the heart and lungs is important in evaluating an indivi dual's physical exercise capacity, and maximum oxygen intake is widely used as a main indicator of cardiopulm onary function evaluation. Maximal oxygen intake, which is used as an indicator of endurance ability, is also wi dely used as a measure of the development of motor skills(Mondal & Mishra, 2017). In particular, maximum ox ygen intake is closely related to lifestyle-related diseases and is highly related to the ability to sustain aerobic act ivity and mortality, so it is important to maintain a high maximum oxygen intake to maintain a healthy state(Oji ambo et al., 2012).

According to reports by Trivic et al,(2023) rapid weight loss can lead to an acute decline in renal functi on, and according to reports by Esben et al.(2016), dietary restrictions and dehydration processes mainly used du

ring weight loss can lead to a decrease in energy source storage and plasma volume, as well as muscle function a nd circulatory function. Cengiz(2015) reported the risk of decreased maximum oxygen intake after rapid weight loss, and Grace et al(2004) reported that repetitive weight cycling could increase the risk of cardiopulmonary cir culatory diseases. Brook et al.(2015) reported that short-term weight loss can increase the risk of metabolic imba lance and cardiopulmonary circulatory diseases. Additionally, it has been reported that artificial dehydration usi ng diuretics and laxatives reduces not only body moisture but also electrolytes, which reduces muscle strength a nd coordination and may cause cardiac arrhythmia(Fogelholm, 1994). This study showed significant changes in lung capacity and maximum oxygen intake after 7 days of rapid weight loss, showing a trend consistent with pre vious studies, although there were differences in subjects and ages. These results are thought to be because rapid weight loss had adverse physiological effects on the body and caused functional changes in the heart.

Anaerobic power is the ability to generate and mobilize energy in a short period of time while oxygen i s limited, and it can represent high-intensity exercise capacity in a short period of time. In other words, anaerobi c power is a concept that reflects both strength and speed at the maximum work speed that the human body can perform, and it is one of the important factors related to athletic performance in competitions by weight class(M ayhew et al., 1994). In particular, they are important elements in relatively short-term sports that require instanta neous explosive force or continuous great force(Cullen et al., 2015).

Weight class athletes such as judo, boxing, weightlifting, taekwondo, wrestling, and ssireum compete a t a certain weight limit. In some weight classes, the importance of weight loss method and period is greatly emp hasized because athletes are allowed to perform well using a certain recovery time after losing weight. In this co ntext, weight class athletes try to compete from a psychological and physiological advantage by losing weight fo r lower wight class because the weight class goes up, players with stronger strength and power enter the game(G rant et al., 2022). However, excessive weight loss over a short period of time may cause a decrease in muscle str ength and coordination, as well as a decrease in aerobic and anaerobic capacity(Fogelholm, 1994). Cengiz(2015) reported that fatigue occurred after rapid weight loss, and maximum power decreased along with a decrease in maximum oxygen intake, and Houston et al.(1981) reported that the peak torque of the knee extensor and large muscle groups decreased after short-term weight loss. Russel(1983) reported that the typical rapid weight loss pr ocess of weight class athletes can lead to decreases in upper body strength, anaerobic power, anaerobic exercise capacity, lactate threshold, and aerobic power, which can ultimately affect performance. In this study, there was a significant decrease in maximum anaerobic power after 7 days of rapid weight loss, which is consistent with pr evious studies, although there are differences in weight loss period, subjects, and age. These results include a de crease in the ability to activate maximum anaerobic metabolism, such as a decrease in running speed due to rapi d weight loss, an increase in muscle fatigue, a decrease in lactic acid release from muscles into the blood due to dehydration, and energy conversion from glycogen to lactic acid or fat, thought to be due to a change in tempera ment.

As it is said that immunity is the best medicine and treatment, not only athletes but also ordinary people are very interested in ways to increase immunity in relation to health. The human body's defense mechanism is divided into two types: innate defense mechanism and acquired defense mechanism. The acquired defense mech anism is the substance of immunity. Among the proteins present in the body, the substance involved in immune responses is called immunoglobin, which is synthesized in plasma cell and related lymphocytes, and is the only protein with biological antibody activity that perform humoral immune function(Mackinnon, 2000). Immunoglo bin exists in the blood and lymph fluid and circulates throughout the body to recognize and remove antigens that invade from the outside. In addition, it is secreted from various mucous membrane tissues, oral respiratory tract, urogenital tract, etc. in the body that come in contact with the outside and plays a role in preventing foreign anti gens from entering the body(David et al., 1991). There are many factors that affect the body's immune response, but the main factors include disease, diet, nutritional status, psychological stress, age, and level of physical acti vity(Nieman et al., 2004).

Additionally, when the human body consumes food, a by-product called active oxygen is generated in t he process of converting it into an energy source. Although this active oxygen is an essential substance, it is fata lly toxic(Zhao et al., 2012; Kim, 2022). Active oxygens attach to genes and cause damage, which results in agin g and disease progression and can even cause diseases such as cancer. Active oxygens are generated in all living organisms that use oxygen, but at the same time, antioxidant enzymes that remove active oxygen coexist, so the toxicity of active oxygen can be removed. Antioxidant enzymes responsible for these defense mechanisms in th e body include SOD, CAT, and GPX. Among these, SOD is a very important enzyme that combats oxidative str ess and disruption of homeostasis caused by exercise, and its chemical role is to reduce reactive oxygen compou nds by converting them to their original form, serving as the best defense against tissue damage(Ji, 1995).

Rapid weight loss over a short period of time showed a vulnerable response to infection(Tritto et al., 20 18), and Imai et al.(2002) reported that high-intensity exercise and rapid weight loss had a negative effect on T-c ells. Rankin et al.(1996) reported that repeated long-term weight loss can cause a decrease in T-suppressor cells and monocytes among immune cells, which can act as a harmful factor in maintaining the body's immunity. Stan

ek et al.(2019) reported a decrease in SOD after losing 2 to 5% of the usual body weight, and Tsai et al(2011) re ported that long-term training and rapid weight loss in a short period of time brought about significant changes i n IgA, cortisol, lactoferrin and reactive oxygen species, affecting immunity(Knapik et al., 2019).

This study shows significant changes in immune variables (immunoglobin-IgA, IgM, IgG, IgE, active o xygen, antioxidants) after 7 days of rapid weight loss, which is consistent with previous studies, although there a re differences in subjects and ages. These results are thought to be due to rapid weight loss, which has adverse p hysiological effects on the body and causes a decrease in the function of immunoglobin as an antibody.

V. CONCLUSION

Short-term weight loss through intense exercise and dietary restrictions was found to be highly likely to have a negative impact on athletic performance and health. Weight control is very important in weight class competitions and is one of the inevitable factors for athletes. Furthermore, it plays an important role in determining the outcome of the match. Therefore, it is important to control body weight or diet to maintain lean body mass while maximizing reduction of body fat in daily life to solve the pain of rapid weight loss during training or competition. In addition, it is believed that in-depth future research is needed on the relationship between recovery period and exercise performance after short-and long-term weight loss.

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