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Effects of Regular Physical Activity Habits on Health-Related Physical Fitness and Cardiovascular Health Factors of Early-Adult College Students

Sun Ho, Kim[1]
[1] *Department of General Education, Nambu University, Gwang, South Korea*
Corresponding Author: leegymking100@naver.com

ABSTRACT: *Physical activity differs from repeated labor in that it promotes health while using all the muscles of the human body. Practicing physical activities that you can easily practice in your daily life, such as swimming, running, climbing, fitness, walking, biking, jumping rope, yoga, and stretching, can have health-boosting effects. In the process of human development, the 20s are the peak period physically and mentally, so the importance of health tends to be underestimated, and lifestyle habits that are helpful to health tend to be the lowest. The aim of this study was to investigate changes in health-related physical factors and cardiovascular functional indicators after early adult college students regularly participated in physical activity. The physical activity group consisted of 132 people who regularly participated in physical activity for more than 30 minutes a day, 2-3 days a week, for more than 6 weeks, and the non-exercise group consisted of 115 people who did not participate in regular physical activity. The subjects were measured and compared for health-related physical fitness factors (%fat, muscle strength, muscular endurance, cardiopulmonary endurance, balance) and cardiovascular function indices (thigh circumference, rate pressure product, pulse vascular elasticity). In the regular physical activity group, % fat, muscle strength, muscular endurance, maximal oxygen consumption, balance, thigh circumference, rate pressure product, and vascular elasticity each showed significant positive values. There were also significant correlations between thigh circumference and health-related indicators, thigh circumference, and cardiovascular function indicators, respectively. In this context, it is very important to encourage college students to practice healthy living and help them develop healthy lifestyle habits.*

KEYWORDS: P*hysical activity, Health related physical fitness, Cardiovascular health factor, Early adult.*

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I. INTRODUCTION

In the era of the 4th Industrial Revolution, which is a convergence of cutting-edge information and communication technologies, diseases that threaten health are changing from infectious diseases to chronic-degenerative diseases and brain-related diseases. Accordingly,interest in health promotion behaviors such as lifestyle habits that are closely related to health is increasing (Sangrajrang et al., 2013).

Physical activity is a representative lifestyle of health promotion. Regular physical activity promotes and protects mental and physical health. Physical activity has been reported to be beneficial for all age groups (Katzmarzyk et al., 2022). Regular physical activity is a major protective factor for the prevention and management of non-communicable diseases (NCDs). In fact, those who meet the recommended level of physical activity have a 20-30% reduction in the risk of early death (Katzmarzyk et al., 2022). In addition, diseases such as cardiovascular disease, depression and dementia, and type 2 diabetes can be prevented by 5% to 8% through regular physical activity. These preventable non-communicable diseases (NCDs) affect healthcare services and society as a whole, as well as individuals and families. In particular, physical activity helps with cognitive decline and mental health, including the prevention of symptoms of depression and anxiety, and improves children's educational standards (WHO, 2022).

However, due to the advancement of science and technology and cultural changes, awareness of the need for physical activity and opportunities to participate are decreasing as indoor work and leisure activities increase (KHEPI, 2023). More than one in four adults and more than 80% of adolescents worldwide do not meet the WHO-recommended level of physical activity for optimal health (WHO, 2022). Physical inactivity is associated with increased risk of various diseases and death. That is, 6.4% of premature deaths and 6-10% of deaths from non-communicable diseases are caused by physical inactivity. In particular, lack of physical activity was found to be the leading cause of death in 30% of ischemic heart disease deaths. Worldwide, approximately 76 trillion won in medical expenses were spent annually due to physical inactivity, and the loss of productivity due to deaths cau

sed by physical inactivity amounted to approximately 20 trillion won. Therefore, physical inactivity is not only a n individual health problem, but also a social and economic problem that incurs huge costs in the country and gl obally (KHEPI, 2023).

According to the Korea Centers for Disease Control and Prevention's National Health and Nutrition Ind ex (2024), the prevalence of obesity in early adulthood (19-29 years old) among young age groups was 31.1%, d yslipidemia was 7.9%, anemia was 5.9%, atopic dermatitis was 16.9%, and health checkups were 67%, indicatin g that the younger generation also needs to be interested in and educated about health management.

Lifestyle habits in early adulthood are closely related to health in middle and old age. However, early a dult college students strongly feel that they are subjectively healthy despite having unhealthy lifestyle habits. Be cause of this perception, it is not easy to form the right health habits. Therefore, it is very important to encourage early adult college students to practice regular life and firmly form healthy lifestyle habits (Martinez et al., 2016 ; Mckay & Diem, 1995).

In this context, this study aimed to investigate the impact of physical activity habits on health-related ph ysical fitness and cardiovascular health indicators in college students, an early adult group closely related to heal thy middle-aged and old-age lifestyle habits.

II. METHODOLOGY

1. Subject

The subjects of this study were 300 male college students aged 19–29 who applied for a liberal arts cou rse at N University. Among the selected male students, a total of 247 enrolled, excluding 18 students majoring in physical education, 18 who applied for two courses consecutively, 12 who did not respond to the questionnaire, and 13 who did not agree to the experiment. In accordance with the 1975 Helsinki Declaration revised in 2000, written consent was obtained from all participants before inclusion in the study. In addition, all respondents were asked whether they were willing to participate in the study and were informed that confidentiality was guarantee d and that they could participate or withdraw at any time. The physical activity group consisted of 132 people (a ge; 21.41±0.97yr, height; 173.18±3.59cm, weight; 72.69±4.02kg, bmi; 24.29±3.67, career; 1.03±0.08yr) who re gularly participated in physical activity for more than 30 minutes a day, 2–3 days a week for more than 1 year. T he non-exercise group consisted of 115 people(age; 22.01±0.83yr, height; 171.92±2.97cm, weight; 73.67±3.95kg , bmi; 25.23±2.91) who did not participate in regular physical activity.

2. Evaluation items & method

1) Questionnaire survey

Regular exercise habits were determined according to the frequency of exercise participation per week, exercise time, and exercise duration (ACSM, 2020). The questionnaire on exercise habits was used in the Comprehensive Physical Fitness Diagnosis System jointly developed by the Korea Institute of Sports Science (2013) and O_2Run. The contents of the questionnaire consisted of a total of 11 items, including 4 basic personal information and 7 items on exercise and health habits of college students. Exercise habits were analyzed by the current exercise frequency (once, twice, more than three times a week, irregular). After completing the questionnaire individually, the confidentiality of the questionnaire contents was protected, and if there was anything missing or not completed after completing the questionnaire, the response recovery rate was increased again through the questionnaire. A total of 300 people participated in the survey, and the questionnaires collected by 247 people were used for data analysis.

2) Health related fitness

Health-related fitness measurement items follow the guidelines of ACSM (2020) and Jackson & Pollock (1978), and consist of body composition (%fat), muscle strength (grip strength), muscular endurance (sit-ups), cardiopulmonary endurance (VO_2max)), and balance (standing on one leg with eyes closed). Body composition was measured using Inbody 720 (Biospace Co., Korea). Muscle strength, muscle endurance, and cardiopulmonary endurance were measured by the IC card method using a comprehensive physical fitness diagnosis system (2013) jointly developed by the Korea Sports Science Institute and O_2run. That is, the grip strength was performed twice with the grip strength, and the average value was used. Muscular endurance was measured by measuring the number of times arms were crossed in front of the chest for 60 seconds. Balance was measured by measuring the time to stand on one leg with eyes closed. Cardiopulmonary endurance was measured using an aerobike measuring device SH-9600K (O_2run Co., Ltd., Korea). That is, after setting the program of the measuring device to a physical fitness test, wear the pulse sensor on the earlobe and adjust the cord length of the pulse sensor. Next, measure the resting heart rate, enter the individual's basic information (gender, age, weight, height), press the start button to rest for 1 minute, and then start pedaling until a beep is heard. At this time, the pedal rotation speed should not fall below 40 rpm for more than 1 minute continuously, and pedal until it reaches 75% of the maximum heart rate. After the measurement is finished, the subject cools down for 1 minute and then gets off the chair.

3) Cardiovascular function

Factors related to cardiovascular function were vascular elasticity, myocardial oxygen consumption, and thigh circumference. Among the items related to vascular function, vascular elasticity was measured. That is, PWV 3.0 (Pulse Wave Speed Test System, Korea Medical Technology, KOREA), which is an equipment that measures the pulse wave speed, was used. Subjects arrived at the laboratory 1 hour before the measurement, settled for about 30 minutes, and then lay flat for measurement. That is, 2 electrodes were attached to the left arm joint and 1 electrode to the right arm joint. After that, the sensors were inserted into both thumbs to prevent them from falling out, and a cover was placed to prevent light from entering, and the vascular elasticity of the upper limbs was measured according to the manufacturer's instructions. After that, the sensors inserted into both thumbs were replaced with both big toes to measure the vascular elasticity of the lower limbs. The measured value was calculated as the average value by selecting a confidence interval for 20 seconds among the data measured for 30 seconds.

The thigh circumference was measured at the thickest part of the left and right thighs using an anthropometric tape measure. The thigh circumference was measured twice in 0.1-cm increments using a tape measure in a longitudinal direction of about 3 to 5 cm below the groin (Adrian et al., 2021, Lee et al., 2022). When measuring thigh circumference, stand with your feet apart and measure the most protruding part of your thigh. Be careful not to slouch. It is difficult to measure accurately if you stand slouched. Also, be careful not to tighten the tape measure so much that it does not lie flat on the skin.

Myocardial oxygen consumption was measured as the product of heart rate and systolic blood pressure (Xu et al., 2017). Resting heart rate was measured using an Onyx pulse oximeter (Ninon, USA) with a sensor attached to the first joint of the subject's index finger (Benoit et al., 1997). Systolic blood pressure was measured using IHB (A & D, Japan) to adjust the elbow height to reach heart-like height and then 2 to 3 cm above the left elbow joint.

4. Statistical analysis

The measurements obtained in this experiment were calculated using the SPSS Package Ver.21.0 statistical processing program to calculate the mean and standard deviation of each measurement item. All data were subjected to error verification to maintain the accuracy of data analysis, and the group sample t-test was used to verify and analyze the differences between the regular physical activity group and the non-exercise group. The correlation between variables was verified using the bivariate correlation coefficient method, and all statistical significance levels were set at .05.

III. FINDINGS

The purpose of this study was to investigate the effects of regular physical activity on health-related physical fitness and cardiovascular functional indicators. As shown in Figure 1 and Table 1, the group that regularly participated in physical activity showed significant values in health-related physical fitness factors (% fat, VO_2max, muscle strength, muscular endurance, and balance) and cardiovascular function indices (vascular elasticity, myocardial workload, and thigh circumference). In addition, in the group participating in physical activity regularly, health-related physical fitness factors (intensity, muscle endurance, cardiopulmonary endurance, balance) and cardiovascular functional indicator factors (waist circumference) showed significant normal relationships, respectively. Also, health-related physical fitness factors (fatty rate) and thigh circumference showed inverse correlation, and inverse correlation was found between cardiovascular function indicator factors (waist circumference), myocardial burden, and vascular elasticity, respectively.

Table 1. Correlation Coefficient between related factors

	a	b	c	d	e	f	g	h	i
a	1.00								
b	-.576**	1.00							
c	-6782**	.697**	1.00						
d	-.591*	.501*	.539*	1.00					
e	-753*	.723*	.667*	.494*	1.00				
f	.664*	-.526*	-.540*	-.450*	-.659**	1.00			
g	.571*	-.450*	-.470*	-.521**	-.502*	.475*	1.00		
h	.457*	-563*	-398*	-4.69*	-.493*	.459*	.781**	1.00	
i	.382	.731	.872**	.685**	.842**	-.659*	-.696**	-.572*	1.00

a; %fat, b;muscle strength, c;muscle endurance, d; balance, e;latin capital v with dot above, f;RPP(mmHg.bpm×10^2), g;RFPWV(ms); right foot pulse wave velocity, h;LFPWV(ms); left foot pulse wave velocity, i;THC; Thigh circumference(cm)

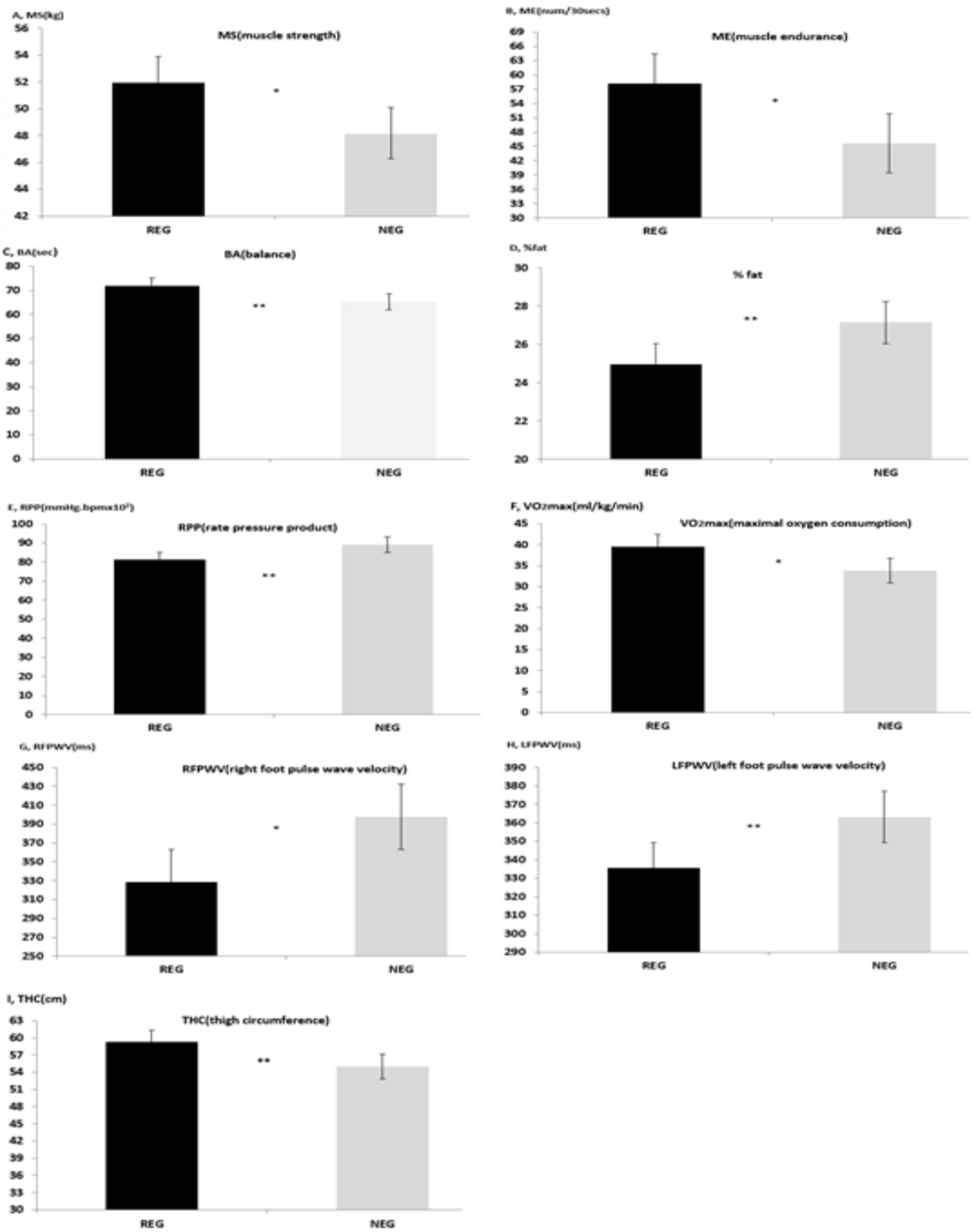

Figure 1. Dependent Variables according to regular physical activity group

REG; Regular physical activity group, NEG: Non physical activity group. MS; Muscle strength, ME; Muscle endurance, BA; Balance, %fat; body fat rate, RPP(mmHg.bpm×10^2), VO_2max(ml/kg/min);, FPWV(ms); right foot pulse wave velocity, LFPWV(ms); left foot pulse wave velocity, THC; Thigh circumference(cm)

IV. DISCUSSION

As life expectancy increases, people are increasingly concerned about how long they live and how well they live. A healthy body and mind can have a significant impact on society as a whole. Therefore, methods to maintain and promote optimal health of members of society are being proposed (WHO, 2022).

Regular lifestyle habits are an important means of managing and maintaining health in optimal condition. An effective way to manage health is to actively practice healthy lifestyle habits before various diseases occur. One of the active ways to manage health is to regularly participate in physical activities in daily life. The focus of the World Health Organization's Physical Activity Recommendations for Health (WHO, 2022) is to improve the level of physical activity of the entire population to prevent non-communicable diseases in the first place. In this context, forming healthy lifestyle habits can be said to be the first step to disease prevention and health promotion.

Physical activity refers to any physical movement that promotes energy consumption of skeletal muscle s. Physical activity is a different concept from labor that repeats only limited movements. Regularly practicing m ovements that can be done in daily life, such as hiking, walking, cycling, jumping rope, yoga, and stretching, can have the effect of improving health. However, many people suffer from various chronic diseases due to their life style habits, which do not participate in various physical activities in their spare time (Warburton & Bloodin, 20 19).

Lack of physical activity negatively affects the health of all age groups and lowers their quality of life. This leads to increased morbidity and mortality due to non-infectious non-infectious diseases (NCDs). In particular, a persistent and widespread lack of physical activity poses a large economic burden on the national healthcare system and the global economy (WHO, 2022; Katzmarzyk et al., 2022).

College students in early adulthood have relatively low awareness of the importance of regular physical activity due to their high level of physical ability and objective health and relatively low mortality or morbidity of disease. However, since various adult diseases related to lifestyle occur after having a long potential, the health promotion behavior of early adult college students is very important in preventing chronic diseases in the middle-aged, elderly, and elderly in the future. It is very important to recognize the importance of exercise based on correct health knowledge in early adulthood, especially as the age increases, it can strengthen functional abilities to lead to better quality of life (Pender et al., 2006).

Physical ability plays an important role in determining health and overall well-being. Participation in regular physical activity is widely recommended as one of the methods of prevention and treatment of cardiopulmonary circulation-related diseases, especially since cardiovascular ability is a basic ability necessary for life and daily activities (Wenger, 2008). It is well known that increased physical activity and regular participation in physical activity has a positive impact on physiological, psychological and socio-cultural factors and provides a variety of health benefits. In particular, regular participation in exercise is effective in preventing cardiovascular diseases related to lifestyle diseases (Who, 2022).

Among cardiovascular functions, the rate pressure product (RPP) is an indicator of heart and lung function that is obtained by multiplying the resting heart rate by the systolic blood pressure. As myocardial burden increases, myocardial oxygen consumption increases and the burden on the myocardium also increases, so it can be said to be an important indicator of the risk level of patients with heart disease (Nanayakkara et al., 2019; Villella et al., 1999). In addition, maximal oxygen consumption (VO_2max) is widely used as a major indicator for evaluating cardiopulmonary function, and is also widely used as a measure of exercise function development. Since maximal oxygen consumption is highly correlated with lifestyle-related diseases, it is important to maintain a high maximal oxygen consumption to maintain a healthy state (Mondal & Mishra, 2017).

When vascular damage occurs, the elasticity and stiffness of the artery change, and pulse wave velocity is an indicator reflecting this change (Yamashina et al., 2002). Increasing pulse wave velocity increases the stiffness of the arteries, putting a strain on the ventricles, reducing cardiac output, increasing myocardial oxygen demand, and promoting arteriosclerosis.. When blood vessels are damaged and fibrosis progresses due to various factors such as lack of physical activity, hormones, metabolites, and aging, the elasticity and buffering capacity of the artery are lost (Kawasaki et al., 2011).

It is no exaggeration to say that thigh circumference and thickness are directly related to health. Thigh circumference measurement is a related anthropometric method to help identify those at high risk of early onset and death. Since thigh muscles account for 30-40% of the total skeletal muscle mass of the human body, thigh muscles are used as indicators of metabolic function and cardiovascular disease risk factors (Berit et al., 2009; Chao-Lei et al., 2020). .Thigh circumference has been shown to reflect skeletal muscle mass better than waist circumference or measurement circumference of other human body parts (Bigard et al., 2005), and it has been reported that the incidence of diseases such as diabetes, hyperlipidemia, and high blood pressure increases as the thigh circumference decreases (Snijder et al., 2005; Chao-Lei et al., 2020; Adrian et al., 2021). In both men and women, the smaller the thigh circumference, the higher the risk of cardiovascular and coronary heart disease and total mortality. When the thigh circumference is less than about 60 cm, the risk of premature death is significantly increased (Berit et al., 2009). It has been reported that the higher the thigh circumference, the lower the risk of

cardiovascular death (Adrian et al., 2021), and the lower the thigh circumference, the higher the risk of heart disease or early death (Berit et al., 2009).

Chronic diseases related to lack of exercise due to changes in lifestyle habits are closely related to health-related physical fitness. Health-related physical fitness can be defined as the ability to liven up daily life or prevent diseases related to lack of physical activity in the early stage. Health-related physical fitness factors include body fat percentage (% fat), cardiopulmonary endurance, muscle strength, muscle endurance, and balance between body composition components. Low health-related physical fitness due to reduced physical activity is one of the major factors in high mortality (Who, 2022). Low health-related physical fitness levels are a risk factor for chronic diseases such as cancer, diabetes, obesity, hypertension, bone and joint diseases, depression, and decreased musculoskeletal function (Warburton & Bredin, 2019).

According to a comprehensive review of the studies reported to date (WHO, 2022; Blair et al., 2004; Brown et al., 2004; Gaeini et al., 2015; Marina et al., 2020; Adrian et al., 2021), regular physical activity is effective in preventing cardiovascular diseases related to lifestyle-related diseases. In addition, improving health-related physical fitness through regular physical activity-exercise habits is effective in maintaining health as age increases. In particular, forming healthy lifestyle habits such as participating in regular physical activities at all ages can be said to be the first step in disease prevention and health promotion.

This study was conducted to raise awareness of the importance of regular physical activity from early adulthood among college students because lifestyle habits formed in college are likely to be maintained even in adulthood. About 45% of college students who participated in this study participated in physical activity regularly. Statistics Korea (2023) also reported that the physical activity participation rate of Koreans in their 20s was lower than that of those in their 60s (50.5%). These results are thought to be because college students have a low participation rate in physical activity due to reasons such as schoolwork, employment, and part-time jobs, and they believe that their physical abilities and health levels are relatively high, so they have a relatively low awareness of the importance of physical activity.

In addition, the higher the physical activity habits of college students in the early adult stage, the more positively it had an effect on health-related physical fitness (%fat, muscle strength, muscular endurance, balance, cardiopulmonary endurance) and cardiovascular function indices (rate pressure product; RPP, maximal oxygen consumption). In particular, participation in regular physical activity was confirmed to be related to an increase in thigh circumference, and thigh circumference showed a high correlation with health-related physical fitness and cardiovascular indices. These results are consistent with the results showing a negative correlation between thigh muscle mass and metabolic and cardiovascular disease risk factors such as insulin resistance, blood sugar, and serum lipid concentrations (Snijder et al., 2004; Van Pelt et al., 2002; Berit et al., 2009; Chao-lei et al., 2020]. In addition, it is thought that regular physical activity effectively increases thigh muscle mass and improves muscle strength, thereby reducing metabolic function and cardiovascular disease risk factors.

V. CONCLUSION

The group of college students who regularly participate in physical activities showed significant figures in health-related physical fitness factors (%fat, muscle strength, muscle endurance, cardiopulmonary endurance, balance) and cardiovascular functional indicator factors (waist circumference, vascular elasticity, rate pressure product), respectively. Based on the above results, it can be said that an active health management method is not far away or difficult, but exists in our daily lives and involves regular and periodic participation in physical activity. In particular, it is very important to encourage college students with low participation in physical activity due to schoolwork, job preparation, part-time work, etc. to practice healthy lifestyle habits and firmly form healthy lifestyle habits. However, prospective studies need to investigate the relationship between calf circumference, limb circumference, and cardiovascular function to provide important prognostic information on health including cardiovascular health.

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