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Corresponding author  
E-mail: [kjk744@kmu.ac.kr](mailto:kjk744@kmu.ac.kr)

Peer reviewer  
E-mail: [kinesiology@j-institute.jp](mailto:kinesiology@j-institute.jp)

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## Relationship Between Body Composition, Physical Fitness, and Blood Variables in ELEMENTARY SCHOOL GIRLS

**Park Ju-sik<sup>1</sup>**

*Keimyung University, Daegu, Republic of Korea*

**Kim Jae-hoon<sup>2</sup>**

*Pohang University of Science and Technology, Pohang, Republic of Korea*

**Kim Ki-jin<sup>3\*</sup>**

*Keimyung University, Daegu, Republic of Korea*

### Abstract

*The purpose of this study was to investigate the effect of exercise program application and the relationship between physical fitness factors and blood variables according to various obesity evaluation criteria for 73 elementary school girls in D-city. As a result of study, body fat percentage and BMI significantly ( $p < 0.05$ ) decreased after exercise program application. In the case of physical fitness factors, it was found that the right, left, and upper body strength, long jump, and physical efficiency index were significantly ( $p < 0.05$ ) increased. In the case of blood variables, insulin, GOT, and GPT significantly ( $p < 0.05$ ) increased, and glucose and HDL-cholesterol significantly ( $p < 0.05$ ) decreased. As a result of the correlation analysis between body composition-related indicators and physical fitness factors, body fat percentage, BMI, WC, WHR, and WHtR showed significant ( $p < 0.05$ ) correlation with back muscle strength, and BMI, WC, WHR, and WHtR had significant ( $p < 0.05$ ) correlations between right and left grip strength. The body fat percentage showed a significant ( $p < 0.05$ ) inverse correlation with sit-up, standing long jump, and physical efficiency index, and BMI showed a significant ( $p < 0.05$ ) correlation with sit and reach, and a significant ( $p < 0.05$ ) inverse correlation with standing long jump and physical efficiency index. WHtR showed significant ( $p < 0.05$ ) inverse correlation with in standing long jump. As a result of correlation analysis of body composition-related indicators and blood variables, body fat percentage, BMI, WC, WHR, and WHtR showed ( $p < 0.05$ ) significant correlation with blood insulin concentration and GPT. Body fat percentage and BMI showed a significant ( $p < 0.05$ ) correlation with triglycerides, and a significant ( $p < 0.05$ ) inverse correlation with GOT and HDL-cholesterol. WC showed a significant ( $p < 0.05$ ) correlation with triglycerides and a significant ( $p < 0.05$ ) inverse correlation with HDL-cholesterol. WHtR showed a significant ( $p < 0.05$ ) inverse correlation with HDL-cholesterol. When the results of this study were put together, the 12-week complex exercise program confirmed the positive improvement effect of physical composition and physical fitness factors of elementary school girls.*

**[Keywords]** Elementary School, Body Composition, Obesity, Physical Fitness Factors, Blood Variables

## 1. Introduction

Korea's entrance exam-oriented education has been affecting the decrease in the physical activity of children due to the increase in the share of private education as well as the decrease in the proportion of arts and science subjects[1][2]. In addition, previous studies by the Ministry of Education, Science and Technology(2013) and Sang-cheol Han(2003)[3][4] reported that the physique of elementary, middle and high school students improved compared to the past, but the deterioration of physical fitness and physical function due to reduced physical activity was serious. This decrease in physical fitness is reported to be a risk factor that not only reduces metabolic function but also increases the prevalence of various types of metabolic syndrome[5]. Se-woong

Jang and Koo-in Jeong(2010) report that the prevalence of obesity increases and the physical fitness decreases in proportion to the physique improvement of elementary school students[6]. Obesity among children and adolescents, such as elementary school students, is likely to lead to adult obesity, and this obesity has been reported to cause various types of metabolic syndrome and complications and to increase mortality[7][8][9][10][11].

Prevention of obesity in children and adolescents is very important because it can have a negative effect on mental health such as inferiority, anxiety, decreased self-esteem, and depression[6][12][13]. The Korean Society for Obesity(2008)[14] reported that the prevalence of obesity of elementary school students in 2005 increased from 12.1% to 18.3% as compared to 1998. In addition, the prevalence of obesity among children and adolescents aged 6-18 in Korea is reported to be 10% in 2013[15], but males are 12.2% higher than females 7.7% [16][17]. The results of a previous study[18] that investigated the risk of cardiovascular disease in obese children and adolescents reported that obese children and adolescents had a higher risk of cardiovascular disease than children who maintained adequate weight. Obesity is assessed through various methods with abnormally increased fat storage in the body. However, considering the economics and convenience of measurement, a relatively simple method through the human body is used for the evaluation of obesity. Body mass index(BMI), waist circumference(WC), skin-fold method, hip / waist hip ratio(WHR), waist circumference/Waist-to-height ratio(WHtR) has been suggested.

However, it is true that there are many areas to be compensated for compared to the method of assessing obesity using expensive measurement equipment such as computed tomography(CT) or dual-energy x-ray absorptiometry(DEXA). The body mass index has a high relationship with body fat mass and body fat percentage, but it can be evaluated as higher than the actual body fat percentage in children and adolescents in the acute period or in elite athletes with small height. Waist circumference is an indirect evaluation method of the abdomen and visceral fat, and is highly related to the risk of abnormal cardiovascular metabolism. However, whether the increased area of body fat is subcutaneous fat or visceral fat cannot be confirmed by measuring waist circumference.

The skin fold measurement method using a caliper shows a high relationship with the subcutaneous fat and body fat percentage, but the difference in the measured value is large depending on the skill of the tester. Obesity and abdominal obesity are evaluated based on hip / waist circumference, but recently, waist / height ratio has been used as an important index to predict cardiovascular disease[19][20][21][22][23]. Ashwell & Gibson(2016) reported that the risk factors for cardiovascular disease were higher when the waist / height ratio was 0.5 or more[24], and Kim Tae-Nyun(2016) suggested that the waist / height ratio is to be a useful indicator for the risk of obesity and metabolic syndrome in adults as well as children[25]. Looking at various previous studies related to obesity in children and adolescents, Heo Sun and Jang Jae-Hoon(2009) reported positive effects on body composition and blood lipid profiles after applying an 8-week exercise program to 20 obese children[26], Ryu Jae-Cheong et al.(2012) reported positive effects of physical education gifted programs for 2nd-6th graders on physical fitness, physique, and exercise performance[27]. Eunjin Baek and Mangyun Lee(2007) report positive effects of 8-week walking and skipping compound exercise training on body composition, fitness, blood lipids, and growth hormone in elementary school students[28]. Most of the previous studies report the effect of applying a temporary exercise program. Therefore, this study analyzed the effects of exercise measures through the application of exercise programs tailored to the 4th grade physical education progress to increase the likelihood of exercise persistence, and confirmed the relationship between physical fitness and blood variables according to the obesity evaluation criteria through various measurement system of physical structure for the important basis for prevention and management of obesity.

## 2. Research Method

### 2.1. Research subjects

Subjects were consisted of 73 elementary school girls located in D city. All subjects participated in the experiment with the consent of the parents and themselves, and were fully explained the purpose, method, and precautions of the experiment before the experiment. Physical characteristics are shown in <Table 1>.

**Table 1.** Physical characteristics of subjects(N=73).

Age(yr)	Height(cm)	Body weight(kg)	%fat(%)	BMI(kg/m <sup>2</sup> )
9.19 ±0.39	138.04 ±7.07	34.18 ±7.74	26.39 ±6.39	18.22±2.76

Note: Values are mean±SD.

### 2.2. Exercise program

Elementary school students in this study performed a combined exercise program consisting of aerobic and resistance exercise for 12 weeks at a frequency of 3 times per week. Two of the three exercises a week consisted of a combined exercise program in accordance with the physical education progress of the fourth grader in the elementary school. One exercise time was conducted for 40 minutes. The warm-up exercise was performed for 5 minutes, and this exercise was conducted for 30 minutes with an aerobic exercise program and a resistance exercise program that can be performed by couple. The rearranging exercise was performed for two minutes of gymnastics and stretching for 5 minutes, and maintained the RPE of 9-11.

### 2.3. Measurement

#### 2.3.1. Body composition

Height, body weight, lean body mass and body fat percentage were measured using InBody J50(Biospace, Korea), and body mass index was calculated using body weight and squared height(kg/m<sup>2</sup>). The waist circumference measured the horizontal position of the lower part of the ribs and the middle part of the upper part of the iliac crest, and the hip circumference measured the widest part of the hip to calculate the ratio of the waist circumference to the hip circumference. Waist circumference/height ratio was calculated by dividing waist circumference(cm) by height(cm).

#### 2.3.2. Physical fitness

As a measurement item of muscle strength, the maximum muscular strength of the low back was measured using a back muscular dynamometer(Takei, Japan), and the maximum muscular strength of the left and right forearm muscles was measured using a grip strength dynamometer(Takei, Japan). For the muscular endurance measurement, the sit-up was performed, and the maximum number of repetitions was measured for 30 seconds[29]. Flexibility measurement item was bent forward in a sitting position, and power measurement item was measured by the standing long jump. For cardiopulmonary fitness, Harvard's step test was conducted, and after a 3-minute step exercise at a rate of 30 minutes per minute, the heart rate of 1 minute to 1 minute 30 seconds, 2 minutes to 2 minutes 30 seconds, and 3 minutes to 3 minutes 30 seconds was measured. The value was calculated using the formula for calculating the physical efficiency index {[Total exercise time(seconds) / (total of 3 times of heart rate × 2)] × 100}.

#### 2.3.3. Blood variables

Subjects in this study were kept on a fasting for 12 hours, and 10 ml of blood was collected from the brachial vein. The concentrations of glutamic oxaloacetic transaminase(GOT), glutamic pyruvic transaminase(GPT), triglyceride(TG), total cholesterol(TC), high density lipoprotein cholesterol(HDL-C), low density lipoprotein cholesterol(LDL-C) are pre-treated using the respective analysis kits(CHOD-PAP Sys 1, TG GPO-PAP Sys 1, HDL-C plus), followed by a spectrophotometer(COBAS MIRA PLUS) with analyzing the sample and the standard on the absorbance of a wavelength of 500 nm, 550 nm, and 580 nm. Blood insulin concentration was analyzed by Radio Immuno Assay method using Insulin IRMA(Biosource, Belgium). Blood glucose concentration was measured by using a kit(GLU-HK, Asan Pharmaceutical, Korea) using the enzyme-based Hexokinase(HK) method to react 320  $\mu$ l of GLU-HKR-1 and 80  $\mu$ l of GLU-HK R-2 with 3  $\mu$ l of the sample. After the absorption, the absorbance was measured at a main wavelength of 340 nm and a sub-wavelength of 415 nm. GOT and GPT were mixed with 260 and 130  $\mu$ l of serum samples 15  $\mu$ l and enzyme reagents A and B(Asan Pharm, Co. 706, Korea), respectively, using an absorbance analyzer(Hitachi 7170, Japan) were measured under a dominant wavelength of 340 nm and sub wavelength of 600 nm conditions.

## 2.4. Statistical analysis

Mean and standard deviation of each measurement variable were calculated using the SPSS 21.0 program. Paired t-tests were conducted to analyze the differences between before and after exercise program application, and Pearson correlation coefficients were calculated to analyze the relationship among body fat percentage, body mass index, waist circumference, hip/waist circumference, waist circumference/height ratio, health related physical fitness, and blood variables. The statistical significance level was set to  $p < .05$ .

## 3. Result

### 3.1. Body composition

The changes of body composition before and after the application of the exercise program are shown in <Table 2>.

**Table 2.** Changes of body composition between before and after exercise program.

Items	Pre-exercise(N=73)	Post-exercise(N=73)	t	P
Body weight(kg)	34.18 $\pm$ 7.74	34.45 $\pm$ 8.03	-2.514	.014**
%fat(%)	26.39 $\pm$ 6.39	24.27 $\pm$ 7.70	4.265	.001**
BMI(kg/m <sup>2</sup> )	18.22 $\pm$ 2.76	17.95 $\pm$ 2.86	3.814	.001**
WC(cm)	57.14 $\pm$ 7.37	57.55 $\pm$ 7.42	-1.367	.176
WHR	0.80 $\pm$ 0.05	0.79 $\pm$ 0.04	1.595	.115
WHtR	0.418 $\pm$ 0.04	0.417 $\pm$ 0.04	0.731	.467
% fat of skinfold(%)	21.57 $\pm$ 6.21	21.76 $\pm$ 6.19	-0.941	.350

Note: Values are mean $\pm$ SD, \*\*  $p < .01$ (as compared to pre-exercise)

BMI: body mass index; WC: waist circumference;

WHR: Ratio of waist circumference to hip circumference; WHtR: waist-to-height ratio.

### 3.2. Physical fitness

Changes in physical fitness factors before and after the application of exercise programs are shown in <Table 3>.

**Table 3.** Changes of physical fitness between before and after exercise program.

Items	Pre-exercise(N=73)	Post-exercise(N=73)	t	P
Back muscular strength(kg)	28.54±7.63	26.66±6.80	2.543	.013*
Right grip strength(kg)	12.45±2.92	15.09±3.01	-10.172	.001**
Left grip strength (kg)	12.37±3.05	14.39±3.37	-7.865	.001**
Sit-up(frequency )	17.99±5.42	21.16±4.44	-6.457	.001**
Sit and reach(cm)	9.49±6.94	9.89±6.70	-1.065	.290
Standing long jump(cm)	102.33±15.74	115.76±17.58	-7.623	.001**
Physical efficiency index(%)	55.85±7.90	57.92±8.83	-2.229	.029*

Note: Values are mean±SD, \* p<.05, \*\* p<.01(as compared to pre-exercise).

### 3.3. Body composition blood variables

Changes in blood variables before and after application of exercise programs are shown in <Table 4>.

**Table 4.** Changes of blood variables between before and after exercise program.

Items	Pre-exercise (N=73)	Post-exercise (N=73)	t	p
Insulin(μIU/ml)	8.66±9.02	12.03±15.63	-2.371	.020*
GOT(mg/dL)	23.42±5.22	24.32±4.91	-2.170	.033*
GPT(mg/dL)	12.82±4.39	14.70±5.04	-4.036	.001**
Glucose(mg/dL)	87.10±5.10	82.34±5.24	6.751	.001**
TC(mg/dL)	173.30±23.51	169.38±36.72	1.772	.081
HDL-C(mg/dL)	58.23±10.54	52.67±10.49	7.027	.001**
LDL-C(mg/dL)	99.65±23.61	95.69±24.62	1.979	.052
TG(mg/dL)	77.08±52.13	80.81±36.77	-0.775	.441

Note: Values are mean±SD, \* p<.05, \*\* p<.01(as compared to pre-exercise).

### 3.4. Analysis of correlation between body composition and physical fitness factors

<Table 5> shows the results of analyzing the correlation between body composition-related indicators and physical fitness factors.

**Table 5.** Relationship between physical fitness and body composition.

	Back muscular strength	Grip strength (Right)	Grip strength (Left)	Sit-up	Sit & reach	Standing long jump	Physical efficiency index
%fat	.238*	.089	.060	-.298*	-.016	-.398**	-.272*
BMI	.315**	.378**	.281*	-.107	.240*	-.252*	-.294*
WC	.345**	.450**	.420**	-.102	.179	-.217	-.219

WHR	.290*	.240*	.273*	-.027	.125	-.128	-.012
WHtR	.304**	.275*	.242*	-.106	.165	-.241*	-.197

Note: Values are Pearson correlation coefficients, \* p<.05, \*\* p<.01.

### 3.5. Analysis of correlation between body composition and blood variables

<Table 6> shows the results of analyzing the correlation between body composition and blood variables.

**Table 6.** Analysis of correlation between body composition and blood variables.

	Insulin	GOT	GPT	Glucose	TC	HDL-C	LDL-C	Triglyceride
%fat	.337**	-.284*	.279*	-.028	.064	-.372**	.165	.261*
BMI	.529**	-.326**	.251*	-.061	.039	-.436**	.196	.248*
WC	.551**	-.155	.234*	-.046	.041	-.364**	.184	.245*
WHR	.368**	.001	.319**	-.106	.146	-.125	.225	.058
WHtR	.433**	-.111	.344**	-.053	.130	-.367**	.276*	.200

Note: Values are Pearson correlation coefficients, \* p<.05, \*\* p<.01

TC: total cholesterol; HDL-C: high density lipoprotein-cholesterol; LDL-C: high density lipoprotein-cholesterol.

## 4. Discussion

The purpose of this study was to provide basic data for the prevention and management of obesity in elementary school girls by analyzing the effects of exercise program application for elementary school girls and checking the relationship between physical fitness factors and blood variables according to the obesity evaluation criteria. Youfa Wang(2002) reported an increase in obesity among elementary school students by 6.4 times for men and 4.7 times for women for 18 years[30], and the World Health Organization(2012) reported that childhood and obesity was a serious public health problem in the 21st century. It is recognized as[31]. As the most effective management method for obesity, many previous studies have suggested exercise and correct eating habits[32][33][34][35]. As a result of this study, the application of a regular exercise program significantly(p <.01) decreased body fat percentage and BMI with a significant(p <.01) increase in body weight. The effect of reducing body fat percentage and BMI after exercise program was consistent with the results of a number of previous studies[36][37][38][39][40][41].

However, a significant increase in body weight(p <.01) was somewhat different from the results of previous studies, but considering the significant reduction effect of body fat percentage and BMI, it could be evaluated as a positive effect due to a decrease in body fat and an increase in muscle mass. In the case of physical fitness factors, it showed a tendency to increase in all the measurement items except the back muscular strength. Especially, the grip strength left and right(p <.01), the sit-up(p <.01), the standing long jump(p <.01), and the physical efficiency index(p <.05) showed a significant increase. In many previous studies have analyzed the effect of applying exercise programs on children, most fitness factors such as muscle strength, muscular endurance, balance, agility, and cardiorespiratory endurance are

reported to be significantly improved or improved tendency after applying exercise programs[42][43][44], therefore these previous results supported to this results.

However, the decrease in back muscle strength, which is a measure of muscle strength, is not considered to have a positive effect on the composition of the combined exercise program in this study, or the intensity and duration of exercise, and it is necessary to improve and supplement the exercise program in the future. Physical activity and participation in exercise programs are known to reduce the prevalence of cardiovascular disease through positive changes in body composition and blood variables[40][41][45]. Blood glucose concentration showed significant decrease( $p < .01$ ) after exercise program in this study, and it appears to be consistent with the results of previous studies. Although blood insulin levels, GOT, and GPT were found with statistical differences, these changes of all items were shown within the normal range, and HDL-C concentration was found to have decreased within the normal range.

Changes in blood lipid profiles require changes in dietary habits and exercise program for a relatively long time, and in view of this, previous studies of Kraus et al.(2002)[46] positive changes in blood lipids have a longer duration of exercise than exercise intensity. It is thought that some of the results of this study could be interpreted by this previous study[46]. In other words, it is considered that the duration of exercise program in this study is not sufficient for positive improvement of blood lipids, especially HDL-C concentration. It has been reported that obesity in children and adolescents has a negative effect on blood lipid changes, increasing various complications and mortality, including cardiovascular disease[6][7][8][11][47]. In addition, stress on appearance and negative physical image have adverse effects on mental health[12][13], and socio-economic costs are also incurred[48]. The obesity of children and adolescents is likely to lead to obesity in adults, so it is considered that continuous solutions should be sought.

As a result of analyzing the correlation between body composition-related indicators and physical fitness factors, body fat percentage showed a significant( $p < .05$ ) correlation with back muscle strength, and significant( $p < .01$ ) inverse correlation showed between sit-ups and standing long jump. BMI showed a significant correlation with back muscle strength, right grip strength( $p < .01$ ), left grip strength and sit and reach( $p < .05$ ), and showed significant inverse correlation with standing long jump and physical efficiency index( $p < .01$ ). WC showed a significant( $p < .01$ ) correlation with the back muscular strength and grip strength. WHR showed a significant( $p < .01$ ) correlation with the back muscular strength and grip strength. WHtR showed a significant( $p < .05$ ) correlation with back muscular strength( $p < .01$ ) and grip strength, and showed a significant( $p < .05$ ) inverse correlation with standing long jump.

These results confirmed that the positive correlation between body composition-related factors and muscular strength measurement items, whereas body composition-related factors were inversely correlated with muscular endurance, power, and cardiopulmonary endurance, and the difference among body composition-related factors could not be confirmed, respectively. As a result of analyzing the correlation between body composition-related indicators and blood variables, body fat percentage showed significant correlation with blood insulin concentration( $p < .01$ ), GPT and TG( $p < .05$ ), and GOT( $p < .05$ ) and HDL-C( $p < .01$ ). BMI showed a significant correlation with blood insulin level( $p < .01$ ) and GPT and TG( $p < .05$ ), and it was significant inverse correlation with GOT( $p < .01$ ) and HDL-C( $p < .01$ ). WC showed a significant correlation with blood insulin concentration( $p < .01$ ), GPT and TG( $p < .05$ ), and showed a significant inverse correlation with HDL-cholesterol( $p < .01$ ). WHR showed a significant( $p < .01$ ) correlation with blood insulin levels and GPT.

WHtR showed a significant correlation with blood insulin level, GPT( $p < .01$ ) and LDL-C( $p < .05$ ), and showed a significant( $p < .01$ ) inverse correlation with HDL-C. After applying the aerobic and resistance exercise program in many previous results[49][50][51][52][53], the effects of exercise training on the changes of blood variables were not consistent. As a result of this study, the 12-

week combined exercise program significantly increased most of the physical fitness factors, whereas no positive changes in blood variables were found. However, although the body weight of most elementary school girls in this study falls within the normal range, and considering that exercise intensity and duration were not sufficient due to the application of an interest-oriented exercise program to motivate participation in exercise programs, these results in this study can be regarded as a sufficiently meaningful results.

## 5. Conclusion

The purpose of this study is to suggest basis data for the prevention and management of obesity in elementary school girls by the analysis of the effects on physical fitness factors and blood variables and the association among of body composition, physical fitness, and blood variables after applying exercise programs in elementary school girls. As a result of analyzing body composition, physical fitness factors, and blood variables in 73 elementary school girls in metropolitan cities, the 12-week combined exercise program could not confirm positive changes in blood variables, but significantly increased physical fitness factors. Therefore, the combined exercise program with aerobic and resistance exercise applied in this study is considered to be an effective exercise program for improving physical fitness in elementary school girls. As a suggestion, further research is needed to analyze differences between more subjects and gender.

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## 7. Contribution

### 7.1. Authors contribution

	Initial name	Contribution
Lead Author	PJS	-Set of concepts <input checked="" type="checkbox"/> -Design <input checked="" type="checkbox"/> -Getting results <input checked="" type="checkbox"/> -Analysis <input checked="" type="checkbox"/> -Make a significant contribution to collection <input checked="" type="checkbox"/> -Final approval of the paper <input checked="" type="checkbox"/>
Corresponding Author*	KKJ	-Corresponding <input checked="" type="checkbox"/> -Play a decisive role in modification <input checked="" type="checkbox"/> -Significant contributions to concepts, designs, practices, analysis and interpretation of data <input checked="" type="checkbox"/>
Co-Author	KJH	-Participants in Drafting and Revising Papers <input checked="" type="checkbox"/> -Someone who can explain all aspects of the paper <input checked="" type="checkbox"/>

### 7.2. Authors profile

#### Lead Author

**Park Ju-sik** / Keimyung University Professor

B.A. Keimyung University

M.A. Keimyung University

Ph.D. Keimyung University

#### Research field

- Effects of Long-term Endurance Exercise and Salvia Miltiorrhiza Vinegar on Body Composition and Insulin Resistance in High Fat Diet-induced Obese Rats, Korean Journal of Food Preservation, 24(5) (2017).
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#### Major career

- 2005~2014. Gyeongju University, Professor

- 2015~present. Keimyung University, Professor

**Corresponding Author****Kim Ki-jin** / Keimyung University Professor

B.A. Kyungpook National University

M.A. Kyungpook National University

Ph.D. Sungkyunkwan University

## Research Field

- Exercise Training-induced PPAR- $\beta$  Increases PGC-1 $\alpha$  Protein Stability and Improves Insulin-induced Glucose Uptake in Rodent Muscles. *Nutrients*, 12(652) (2020).
- Effects of Aerobic and Resistance Exercise on Myokines in High Fat Diet-induced Middle-aged Obese Rats. *International Journal of Environmental Research and Public Health*, 17(2685) (2020).

## Major Career

- 1987~1989. Sport Science Institute of KSC, Researcher
- 1989~1996. Korea Institute of Sport Science, Senior Researcher
- 1996~present. Keimyung University, Professor

**Co-Author****Kim Jae-hoon** / Pohang University Science and Technology Professor

B.A. Keimyung University

M.A. Keimyung University

Ph.D. Keimyung University

## Research field

- The Relationship of the Waist-to-height Ratio with Physical Fitness in College Students, *The Korean Journal of Growth and Development*, 26(4) (2018).
- Effects of High-intensity Interval Training on Aerobic Ability, Anaerobic Power Abilities in University Rowers. *Journal of Coaching Development*, 21(4) (2019).

## Major career

- 2011~2016. Keimyung University, Researcher
- 2017~present. Pohang University of Science and Technology, Professor