

Effects of Acute Exercise Intensities on Blood Lipid and Growth Factors in Middle School Students with Intellectual Disabilities

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Abstract

Objectives: The purpose of this study was to examine the effects of acute exercise intensities on changes in blood lipids and growth factors in middle school students with intellectual disabilities.

Method: The study participants were randomly assigned into low intensity (n = 8), moderate intensity (n = 9) and high intensity (n = 9) groups. Acute exercise intensities was classified into low intensity (40~54% HRR), moderate intensity (55~69% HRR) and high intensity (70~85% HRR) using heart rate reserve (HRR). Blood lipids (total cholesterol, Triglyceride, high-density lipoprotein cholesterol, Low-density lipoprotein cholesterol) and growth factors (insulin-like growth factor-1, growth hormone, thyroxine, thyroid stimulating hormone) were measured before and after executing the physical activity program.

Findings: According to the results for blood lipids, high-density lipoprotein cholesterol (HDL) was significantly increased in the high-intensity group compared to the low-intensity group. For growth related hormones, insulin-like growth factor-1 (IGF-1) was significantly increased after exercise in the high-intensity group compared to the moderate-intensity group.

Applications: When the same amount of acute exercise was given to middle school students with intellectual disabilities, HDL was found to increase by the largest amount in the high-intensity group. IGF-1 was also found to be most effective in the high-intensity group. Future studies need to comprehensively account for sex and level of obesity.

Keywords: *Acute Exercise, Exercise Intensity, Intellectual Disabilities, Blood Lipid, Growth Factors.*

Introduction

People with intellectual disabilities have higher levels of C-reactive protein (CRP), which is a factor in inflammation and muscle atrophy, than non-disabled people and, coupled with their poor physical activity participation and inadequate diet, results in low exercise performance and high exercise fatigue^[1]. In addition, their below-average intellectual ability and

lack of adaptive behaviour make it difficult to acquire information on the nervous system and acquire new information and technologies^[2]. Their low physical fitness levels, and high obesity rates leads to a decline in motor function as their age increases, high mortality, which requires effective weight management^[3, 4].

Lack of exercise in adolescence is closely associated with obesity and cardiovascular risk factors^[5, 6]. It is also an important factor that affects adult health as well as adult disease^[7]. Nevertheless, there are many studies related to the health benefits of regular exercise for adolescents without disabilities, but there are only a few studies on physical activity whose subjects are adolescents with intellectual disabilities^[7, 8].

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Table 1. Demographic characteristic of the participants

Characteristics	Low intensity group (n = 8)	Moderate intensity group (n = 9)	High intensity group (n = 9)
Female, n(%)	2(25%)	3(33%)	3(33%)
Age (year)	15.75±0.46	15.78±0.44	16.00±0.00
Height (cm)	165.01±7.66	161.10±7.34	164.32±6.05
Weight (kg)	60.88±19.65	58.14±16.50	60.21±10.57
Body mass index (kg/m ²)	24.56±14.27	27.10±13.47	25.19±11.76
VO ₂ max (Ml/kg/min)	59.04±8.50	54.90±14.99	55.44±10.12

Long-term regular exercise is reported to have a positive effect on blood lipids and reduce body fat and abdominal fat, reducing the risk of cardiovascular disease^[9]. It has been shown to directly stimulate adolescent growth-related hormones and contribute to tissue growth and development^[10]. This exercise effect can be considered an adaptation phenomenon due to acute exercise performed at an appropriate amount and intensity. However, most of the studies on blood lipids and growth-related hormones according to acute exercise intensity have been conducted on non-disabled subjects. The results showed a decrease in triglyceride (TG) after moderate intensity exercise, but there was only either no change in high-density lipoprotein cholesterol (HDL-C) or increased HDL-C after high intensity exercise^[11, 12]. Since each researcher has a difference in the exercise intensity and exercise amount used with the subjects, there is a lack of information on which exercise intensity is effective for adolescents with intellectual disabilities. In addition, growth-related factors are expected to be affected by exercise intensity, but the basis for this has not yet been identified.

Therefore, this study conducted simple acute exercise according to three exercise intensity groups for middle school students with growing intellectual disabilities. The purpose of this study is to examine its effects on changes in blood lipids (total cholesterol: TC, TG, HDL-C, Low-density lipoprotein cholesterol: LDL-C) and growth factors (insulin-like growth factor-1: IGF-1, growth hormone: GH, thyroxine: T4, thyroid stimulating hormone: TSH).

Method

1. Participants: This study conducted a convenience sampling of 26 middle school students with mild intellectual disabilities attending special classes in the city of A. Random sampling was performed for the 26 selected participants, dividing them into

groups as follows: nine in the high intensity group (HIG), nine in the moderate intensity group (MIG) and eight in the low intensity group (LIG). The physical characteristics of the study subjects are shown in [Table 1]. Approval for the study was obtained from the Institutional Review Board at The Y University Research Ethics Committee

2. Procedure: The maximum oxygen intake and maximum heart rate were measured using Balke-Ware protocol to set the individual exercise intensity of each participant^[13]. Participants wore portable wireless breathing gas analyzers (K4b², Cosmed, Italy) and wireless heart rate monitors (RS-400, POLAR, Finland).

After a maximal graded exercise testing (GXT), a week was given for resting and this study was conducted. Acute physical exercise intensity was divided into low intensity (40-54% HRR), moderate intensity (55-69% HRR), and high intensity (70-85% HRR) exercise groups using heart rate reserve (HRR)^[14]. Blood samples were collected before and after training to compare changes in blood variables and growth-related factors according to exercise intensity in acute physical activity programs.

3. Measures: The acute exercise program consisted of an aerobic training, and a fitness training exercise program using one's body. The wireless heart rate monitor RS400 was used to set and maintain exercise intensity for each group. The heart rate and exercise time for each set exercise intensity were entered into the heart rate monitor, and an alarm was set when the lower and upper values were measured so that they could be checked during the exercise.

In order to equalize the amount of exercise, the daily exercise amount was calculated to be 10%^[15] of the basic metabolic rate, and the exercise time was calculated as equivalent to 200kcal consumption for

each subject and applied individually.

The blood lipids of TC, TG, HDL-C, and LDL-C were analyzed using a blood analyzer (VITROS DT 60 II, Johnson & Hohnson Co. USA). Analysis of growth-related factors of IGF-1, GH, T4, and TSH was performed using radioimmuno assay (RIA). The analysis of all measurement data was performed by S clinical pathology center.

4. Data Analysis: All data collected in this study was analyzed via the SPSS ver. 22.0 program. To verify the difference of blood lipids and growth-related factors according to acute exercise intensity groups (LIG, MIG, HIG), premeasured values were set as covariates and an analysis of covariance (ANCOVA) was performed. Bonferroni was used for post hoc testing by group. Effect Size (ES) was presented as η^2 (eta). In terms of behavioural science, the effect size was interpreted by η^2 standard (Large: .14,

Medium: .06, Small: .01) as proposed by Cohen [15]. The significance level of all data was set to $\alpha = .05$.

Result

1. Blood Lipids: In order to verify the difference in blood lipid changes by acute exercise intensity (low, moderate, high intensity), the results of ANCOVA with the premeasured values set as covariates are shown in [Table 2]. TC ($F = .536$), TG ($F = 1.895$) and LDL-C ($F = .305$) did not show significant differences by exercise intensity. On the other hand, HDL-C ($F = 4.108$) showed significant difference according to acute exercise intensity. Post hoc test results showed that HIG was significantly lower than LIG ($p < .05$).

In terms of effect of blood lipid by intensity of acute exercise program, triglycerides (η^2 (eta) = 0.141) and HDL-C (η^2 (eta) = 0.263) showed large effects size.

Table 2. Covariance of blood lipids by acute exercise intensity group

		Pre-test Mean±SD	Post-test Mean±SD	Adjust post-test Mean±SE	F-value	η^2
TC	LIG (n = 8)	141.56±27.72	147.89±28.44	150.83±3.24	.536	0.045
	MIG (n = 9)	143.11±18.48	154.00±29.61	155.32±3.23		
	HIG (n = 9)	148.44±31.75	158.67±30.01	154.41±3.25		
TG	LIG (n = 8)	99.11±53.34	121.22±52.05	115.22±13.09	1.895	0.141
	MIG (n = 9)	91.78±49.10	113.33±49.47	110.75±12.93		
	HIG (n = 9)	67.78±31.58	72.44±22.41	81.03±13.29		
HDL	LIG (n = 8)	47.89±9.60	45.89±11.01	52.07±1.73	4.108*	0.263
	MIG (n = 9)	55.44±12.08	55.44±9.71	54.54±1.71		
	HIG (n = 9)	60.11±16.28	64.67±17.41	59.39±1.77		
LDL	LIG (n = 8)	85.56±25.97	88.56±23.53	85.45±2.69	.305	0.026
	MIG (n = 9)	81.00±22.89	86.44±32.72	88.24±2.69		
	HIG (n = 9)	81.44±27.96	86.44±29.13	87.76±2.69		

Unit: mg/dl cm, *: $p < 0.05$, TC; total cholesterol, TG; triglyceride, HDL; high-density lipoprotein cholesterol, LDL: low-density lipoprotein cholesterol, LIG: low intensity group, MIG: moderate intensity group, HIG: high intensity group, SD; standard deviation, SE; standard error

2. Growth Factors: In order to verify the difference of growth-related factor change by acute exercise intensity, the pre measured values were set as covariates. The results of ANCOVA are shown in [Table 3]. GH ($F = 1.700$), T4 ($F = 1.023$) and TSH ($F = 3.111$) did not show statistically significant difference. On the other hand, IGF-1 ($F = 3.991$)

showed significant difference by acute exercise intensity. Post hoc test results showed that HIG was significantly higher than MIG ($p < .05$).

In terms of effect of blood lipid by intensity of acute exercise program, it showed large effect size on IGF-1 (η^2 (eta) = 0.258) and TSH (η^2 (eta) = 0.213).

Table 3. Covariance of growth factors by acute exercise intensity group

		Pre-test Mean±SD	Post-test Mean±SD	Adjust post-test Mean±SE	F-value	η ²
IGF-1	LIG (n = 8)	400.22±87.30	471.44±88.31	474.70±21.56	3.991*	0.258
	MIG (n = 9)	390.00±71.99	448.44±104.77	460.11±21.69		
	HIG (n = 9)	422.33±66.90	557.11±70.19	542.18±21.78		
GH	LIG (n = 8)	2.95±2.00	4.35±4.70	4.19±0.90	1.700	0.129
	MIG (n = 9)	1.76±2.05	2.60±2.74	3.49±0.94		
	HIG (n = 9)	3.61±2.83	2.59±2.04	1.85±0.93		
T4	LIG(n = 8)	7.96±1.02	8.53±1.16	8.30±0.22	1.023	0.082
	MIG (n = 9)	7.75±1.07	7.89±1.33	7.86±0.22		
	HIG (n = 9)	7.47±0.91	7.78±1.10	8.04±0.22		
TSH	LIG (n = 8)	2.00±0.80	2.63±0.77	3.36±0.39	3.111	0.213
	MIG (n = 9)	2.63±1.14	3.71±2.45	3.22±0.39		
	HIG (n = 9)	2.50±1.87	4.70±4.19	4.46±0.39		

unit: ng/mL ,*:

p<0.05, IGF-1; insulin-like growth factor-1, GH; growth hormone, T4; thyroxine, TSH: thyroid stimulating hormone, LIG: low intensity group, MIG: moderate intensity group, HIG: high intensity group, SD; standard deviation, SE; standard error.

according to groups in order to compare/analyze changes in blood lipids and growth related factors under conditions that consume the same calories for middle school students with intellectual disabilities.

Discussion

In this study, three acute exercise intensities (low, moderate, and high) were performed differently

According to the results, blood lipids in HDL-C were significantly higher in HIG than in LIG as shown in [Figure 1].

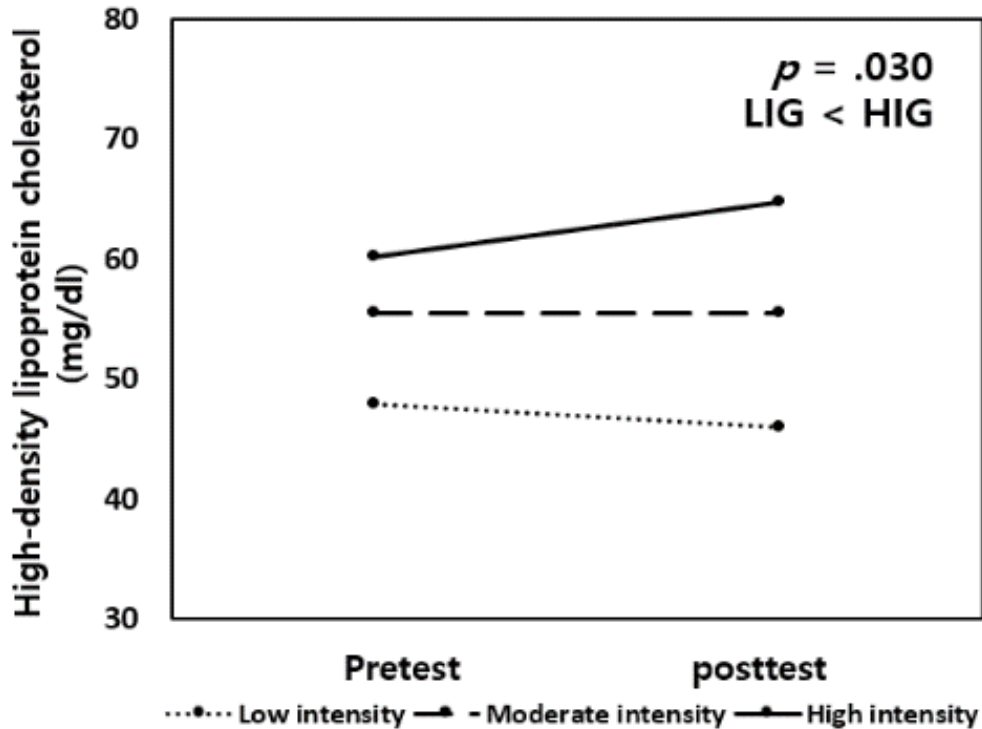


Figure 1. Changes in high density cholesterol with acute exercise intensity

LIG: Low intensity group, HIG: high intensity group:

According to a study comparing blood lipids by acute exercise intensity among university students, triglycerides decreased by more than 10%, from 80%~90% of the individual's lactate threshold (LT), 90 minutes after exercise. For HDL-C, the increase in concentration was greater in LT 90%~100% than during other intensity [16]. Another study examined changes in HDL-C with 70% LT and LT for healthy elderly and reported a significant increase in 24-hour HDL-C in LT [17]. Regarding exercise intensity and blood lipids, Wood et al. [18] reported that low intensity exercise would

not significantly change blood lipoprotein levels, but that high intensity exercise can increase blood HDL-C levels and decrease TG and a reduction in HDL-C could promote the development of atherosclerosis. It is thought that the repetitive increase in HDL-C at high intensity exercise can further stimulate the increase of HDL-C, which is manifested by long-term exercise adaptation.

In growth-related factors, IGF-1 was significantly increased more in HIG than MIG after exercise as shown in [Figure 2].

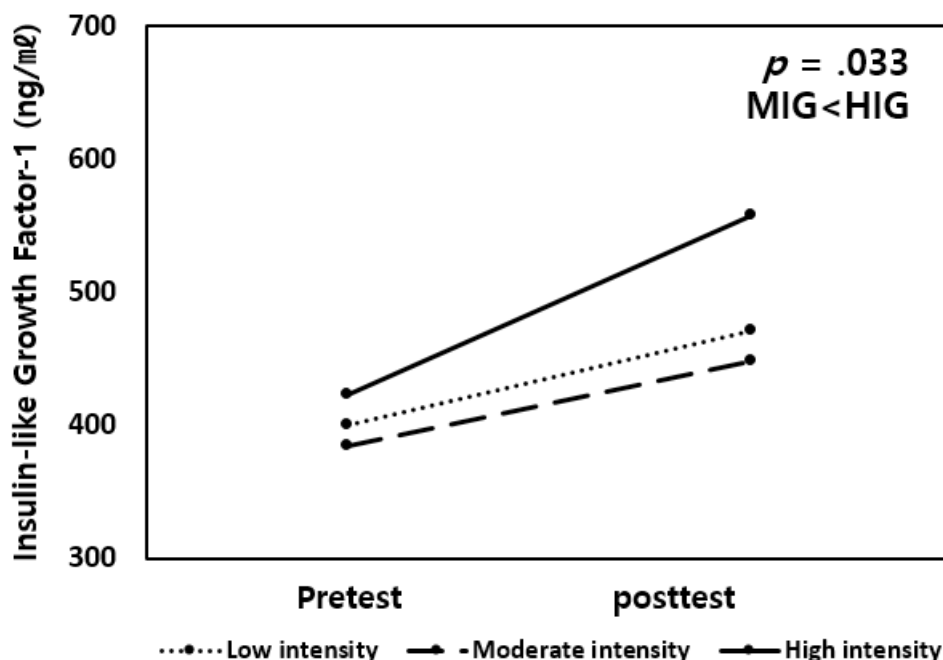


Figure 2. Changes in insulin-like growth factor-1 with acute exercise intensity

MIG: moderate intensity group, HIG: high intensity group

Previous studies confirmed that IGF-1 concentrations were highest at 65%~70% HRmax, suggesting that further studies are needed to examine the response of IGF-1 after exercise at specific exercise intensities [19]. In this study, IGF-1 showed a significant increase during high intensity exercise, but not during moderate intensity, and that there was no significant difference in GH. This result is consistent with the result that GH is increased more in low intensity exercise [20], and that the increase of GH production is independent of each other regardless of an increase in IGF-1 concentration [21, 22].

According to the recently updated 2018 Physical Activity Guidelines for Americans [23], acute physical

activity alone can lower blood pressure, improve sleep, and strengthen the body's ability to convert blood sugar into energy. In this study, targeting adolescents with intellectual disabilities, high intensity exercise in acute exercise increased HDL-C and increasing the synthesis of IGF-1. Based on these findings, more attention and follow-up studies are needed for the physical activity or exercise of adolescents with intellectual disabilities.

Conclusion

When middle school students with intellectual disabilities were given the same amount of exercise by acute exercise intensity, it was confirmed that high

intensity exercise increased HDL-C and had a significant effect on IGF-1. If middle school students with intellectual disabilities continue to perform high intensity exercises in the future, positively changed factors may be further stimulated to prevent cardiovascular disease and to have a positive impact on growth. As this study did not consider the sex and obesity level of people with intellectual disability, further study is necessary considering other factors such these.

Ethical Clearance: Not required

Source of Funding: Self

Conflict of Interest: Nil

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