

Title	A comparative study of physical characteristics between Keio university students with and without experience of high school athletic club activities
Sub Title	
Author	西村, 忍(Nishimura, Shinobu)
Publisher	慶應義塾大学体育研究所
Publication year	2007
Jtitle	体育研究所紀要 (Bulletin of the institute of physical education, Keio university). Vol.46, No.1 (2007. 1) ,p.33- 38
JaLC DOI	
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Notes	
Genre	Departmental Bulletin Paper
URL	https://koara.lib.keio.ac.jp/xoonips/modules/xoonips/detail.php?koara_id=AN00135710-00460001-0033

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A Comparative Study of Physical Characteristics between Keio University Students with and without Experience of High School Athletic Club Activities

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The purpose of this study was to investigate whether or not there were any differences in physical characteristics between college students with experience of high school athletic club activities and those without. 55 male and 13 female subjects participated in this study and four categories ((1) Body Composition; (2) Girth Measurement; (3) Fatfold Measurement; and (4) Physical Strength Testing) of physical characteristics were measured. I concluded that male college students with experience of high school athletic club activities tend to have larger muscular volume and stronger muscular strength as compared with male college students without those experiences. In addition, female college students with experience of high school athletic club activities tend to have smaller fat volume, greater muscular endurance, and better flexibility as compared with female college students without those experiences.

キーワード：身体特性，高校体育会系部活動，大学生

Key words : Physical characteristics, High school athletic club activities, College students

Introduction

Some researchers recently have reported that the health related physical fitness of Japan's young generation has been decreasing (Nakano, et al. 2001; Matsu-moto, et al. 2002; Yamazaki, et al. 2003). Some young people go on diet even though they don't have the minimum volume of body fat as well as muscle. It is because they have a distorted interest in the shape of their bodies. They think that the thinner their bodies are, the more beautiful they are (Takimoto. 2006; Nakata. 2006).

Nishimura, et al. (2006), however, mentioned that the health related physical fitness of the latest college students was not likely to decrease. In Keio University, more than 8,000 students have taken physical educa-

tion classes for several years. Their objectives are very diverse. Some examples are to have fun, to improve their quality of lives, to change their lifestyles, and so on. Also, some of them continue to get regular exercise because they used to belong to a team from one of their high school athletic clubs.

A student with experience of high school athletic club activity generally seems to have more volume of muscle and greater physical strength as compared with a student without that. However, there has not been enough research about it. Thus, the purpose of this study was to investigate whether or not there were any differences in physical characteristics between college students with experience of high school athletic club activities and those without.

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Methodology

Subjects were Keio University students who participated in the "Tairyoku-up" classes in 2004. The physical characteristics of 55 male and 13 female subjects were as follows: Male: age (19.7 ± 1.1 y/o), height (173.1 ± 6.3 cm), body weight (66.2 ± 10.4 kg) and Female: age (19.6 ± 0.8 y/o), height (158.7 ± 4.7 cm), body weight (51.5 ± 5.0 kg). Both male and female subjects were further divided into two groups: (1) male and female with experience of high school athletic club activities (male student-athlete (MSA) group: $n=38$, 19.7 ± 1.1 y/o; female student-athlete (FSA) group: $n=6$, 19.7 ± 1.2 y/o) and (2) male and female without experience of high school athletic club activities (male non student-athlete (MNSA) group: $n=17$, 19.8 ± 1.0 y/o; female non student-athlete (FNSA) group: $n=7$, 19.6 ± 0.5 y/o). The subjects of both MSA and FSA groups still have had an opportunity to exercise regularly after the high school graduation.

This study consisted of four categories of physical characteristics for comparing the two groups of male (MSA, MNSA) and female (FSA, FNSA) subjects. The categories were as follows: (1) Body Composition; (2) Girth Measurement; (3) Fatfold Measurement; and (4) Physical Strength Testing (Dintiman, et al. 1999, McArdle, et al. 1994).

Body composition included the following five constituents: (1) Height; (2) Body Weight; (3) Body Mass Index (BMI); (4) Lean Body Mass (LBM); and (5) Percent Body Fat (%FAT). After measuring the thickness of the double layer of skin and subcutaneous tissue with the caliper (Meikosha, Japan), %FAT was calculated by using the Kitagawa's formula for body density and Brozek formula for % FAT below (Sakamoto. 2000). (The details of the measurement site of the caliper are explained below.)

Kitagawa's Formula for Body Density

$$\begin{aligned} \text{Male} &= 1.1242 - 0.00045 \times (\text{Triceps} + \text{Subscapular} \\ &\quad + \text{Navel}) - 0.00049 \times (\text{Waist}) - 0.00016 \\ &\quad \times (\text{Age}) \end{aligned}$$

$$\begin{aligned} \text{Female} &= 1.0933 - 0.00034 \times (\text{Triceps} + \text{Subscapular} \\ &\quad + \text{Navel}) - 0.00035 \times (\text{Waist}) - 0.00023 \\ &\quad \times (\text{Age}) \end{aligned}$$

Brozek's formula for %FAT

$$\text{Male/Female} = (4.57 \div \text{Body Density} - 4.142) \times 100$$

Girth measurement is used as another indirect assessment of body fat (McArdle, et al. 1994). Measurement sites were the following four sites: (1) Upper Arm measured at the mid-point between the shoulder and elbow; (2) Waist measured at above the umbilicus; (3) Hip measured at maximum protrusion; and (4) Thigh measured at just below the buttocks. Duplicate measurements were taken at each site and the average was used. A measuring tape was applied lightly and tautly to the skin surface.

Fatfold measurement is often used for measuring % FAT at various kinds of sports scenes (Kubota. 2004; Yamamoto. 2004). Measurement sites of the caliper were the following four sites; (1) Triceps measured at the mid-point between the shoulder and elbow vertically; (2) Subscapular measured at just below the bottom of the tip of the scapula vertically; (3) Navel measured at 1-inch next to the umbilicus vertically; and (4) Quadriceps measured at the two-thirds point from knee to hip vertically. The caliper was applied with constant tension of 10 g/mm² from its jaws to the skin. Duplicate measurements were taken at each site and the average was used.

Physical strength testing required subjects to execute the following events: (a) Squeezing Power; (b) Sit-up; and (c) Sit-and-Reach. All events followed the new physical strength testing manual of the Ministry of Education, Culture, Sports, Science and Technology. Squeezing power measured muscular strength with the squeeze dynamometer (Takei Scientific Instruments Co., Ltd, Japan). All subjects performed the exercise twice with each hand and the better result was recorded. Sit-up measured muscular endurance. Subjects started in the sitting position with a partner and performed the sit-up motion for 30 seconds. Sit-and-reach measured flexibility and started in the sitting posi-

tion with legs straight. All subjects slowly and gently pushed the sit-and-reach instrument (Takei Scientific Instruments Co., Ltd, Japan) twice and the better result was recorded.

All data results were analyzed by un-pair t test. A P value of 0.05 or less was used to define statistical significance.

Results & Discussion

55 male and 13 female subjects participated in this study and four categories of physical characteristics were measured. Both male and female subjects were classified based on whether or not the subject had an experience of high school athletic club activity. After collecting all data, I compared the two groups of male and female subjects with each other respectively, and confirmed the following findings in this study.

The MSA group VS the MNSA group

The data of four categories of physical characteristics of the MSA and MNSA groups are shown in Table1.

The data of Body Composition of the MSA and MNSA groups were as follows; Height: 173.8 ± 6.7 cm and 171.5 ± 5.4 cm; Body weight: 67.8 ± 9.3 kg and 62.71 ± 2.9 kg; BMI: 22.4 ± 2.7 kg/m² and 21.3 ± 4.1 kg/m²; %FAT: 12.8 ± 2.8 % and 14.1 ± 4.7 %; and LBM: 59.0 ± 7.4 kg and 53.4 ± 8.1 kg. LBM of the MSA group was significantly heavier than that of the MNSA group ($p < 0.05$).

The data of Girth Measurement of the MSA and MNSA groups were as follows; Upper Arm: 26.9 ± 2.5 cm and 24.9 ± 2.9 cm; Waist: 75.0 ± 5.9 cm and 74.0 ± 10.0 cm; Hip: 93.9 ± 5.3 cm and 90.9 ± 9.4 cm; and Thigh: 53.5 ± 4.5 cm and 50.9 ± 6.1 cm. Upper Arm of the MSA group was significantly thicker than that of the MNSA group ($p < 0.05$).

The data of Fatfold Measurement of the MSA and MNSA groups were as follows; Triceps: 7.8 ± 3.4 mm

Table1. Comparison of Physical Characteristics between the MSA group and the MNSA group

Physical Characteristics		Male Student-Athlete Group (N=38)			Male Non Student-Athlete Group (N=17)			Unpaired T Test
Body Composition	Height (cm)	173.8	±	6.7	171.5	±	5.4	NS
	Body Weight (kg)	67.8	±	9.3	62.7	±	12.9	NS
	BMI (kg/m ²)	22.4	±	2.7	21.3	±	4.1	NS
	%FAT (%)	12.8	±	2.8	14.1	±	4.7	NS
	LBM (kg)	59.0	±	7.4	53.4	±	8.1	$p < 0.05$
Girth Measurement	Upper Arm (cm)	26.9	±	2.5	24.9	±	2.9	$p < 0.05$
	Waist (cm)	75.0	±	5.9	74.0	±	10.0	NS
	Hip (cm)	93.9	±	5.3	90.9	±	9.4	NS
	Thigh (cm)	53.5	±	4.5	50.9	±	6.1	NS
Fatfold Measurement	Triceps (mm)	7.8	±	3.4	9.5	±	4.8	NS
	Subscapular (mm)	10.3	±	3.0	11.3	±	5.5	NS
	Navel (mm)	12.1	±	7.2	12.8	±	9.9	NS
	Quadiceps (mm)	9.7	±	4.7	11.4	±	6.3	NS
Physical Strength Testing	Squeezing Power (kg)	45.5	±	6.1	39.0	±	5.9	$p < 0.01$
	Sit-up (times)	30.3	±	4.0	26.8	±	5.8	$p < 0.05$
	Sit-and-Reach (cm)	50.3	±	7.3	44.1	±	9.6	$p < 0.05$

(Mean ± S.D.)

and 9.5 ± 4.8 mm; Subscapular: 10.3 ± 3.0 mm and 11.3 ± 5.5 mm; Navel: 12.1 ± 7.2 mm and 12.8 ± 9.9 mm; and Quadriceps: 9.7 ± 4.7 mm and 11.4 ± 6.3 mm. There was no significant difference in this measurement.

The data of Physical Strength Testing of the MSA and MNSA groups were the following; Squeezing Power: 45.5 ± 6.1 kg and 39.0 ± 5.9 kg; Sit-up: 30.3 ± 4.0 times and 26.8 ± 5.8 times; and Sit-and-Reach: 50.3 ± 7.3 cm and 44.1 ± 9.6 cm. Squeezing power of the MSA group was significantly greater than that of the MNSA group ($p < 0.01$). Sit-up of the MSA group was significantly greater than that of the MNSA group ($p < 0.05$). Sit-and-reach of the MSA group was significantly longer than that of the MNSA group ($p < 0.05$).

All the results of the MSA and MNSA groups above seemed to be related to muscular volume and muscular strength. Because the LBM of the MSA group was heavier, some categories of physical characteristics tended to be affected. As some examples of this, the girth

measurement of upper arm was thicker, the maximum power measurement of squeezing power was stronger, and the muscle endurance of the sit-up was greater as compared with the MNSA group. Thus, the muscular volume and the muscular strength of a male college student with experience of high school athletic club activity was superior to a male college student without experience of high school athletic club activity.

The FSA group VS the FNSA group

The data of four categories of physical characteristics of the FSA and FNSA groups are shown in Table2.

The data of Body Composition of the FSA and FNSA groups were as follows; Height: 159.5 ± 6.0 cm and 158.1 ± 3.6 cm; Body weight: 50.5 ± 5.1 kg and 52.4 ± 5.0 kg; BMI: 19.9 ± 2.0 kg/m² and 21.0 ± 1.9 kg/m²; %FAT: $18.0 \pm 3.8\%$ and $23.2 \pm 3.1\%$; and LBM: 41.3 ± 3.1 kg and 40.3 ± 4.6 kg. %FAT of the FSA group was significantly smaller than that of the FNSA group ($p < 0.05$).

Table2. Comparison of Physical Characteristics between the FSA group and the FNSA group

Physical Characteristics		Female Student-Athlete Group (N=6)			Female Non Student-Athlete Group (N=7)			Unpaired T Test
Body Composition	Height (cm)	159.5	±	6.0	158.1	±	3.6	NS
	Body Weight (kg)	50.5	±	5.1	52.4	±	5.0	NS
	BMI (kg/m ²)	19.9	±	2.0	21.0	±	1.9	NS
	%FAT (%)	18.0	±	3.8	23.2	±	3.1	p<0.05
	LBM (kg)	41.3	±	3.1	40.3	±	4.6	NS
Girth Measurement	Upper Arm (cm)	23.1	±	1.6	24.1	±	1.8	NS
	Waist (cm)	65.4	±	5.7	68.4	±	4.9	NS
	Hip (cm)	87.6	±	3.9	90.4	±	3.9	NS
	Thigh (cm)	50.7	±	3.8	51.7	±	3.8	NS
Fatfold Measurement	Triceps (mm)	12.0	±	3.4	17.3	±	2.2	p<0.01
	Subscapular (mm)	12.3	±	4.1	16.3	±	4.4	NS
	Navel (mm)	12.8	±	4.9	16.9	±	6.8	NS
	Quadriceps (mm)	18.4	±	5.3	21.7	±	3.7	NS
Physical Strength Testing	Squeezing Power (kg)	26.9	±	4.0	24.8	±	3.7	NS
	Sit-up (times)	25.0	±	3.2	18.0	±	1.5	p<0.01
	Sit-and-Reach (cm)	56.6	±	2.8	47.8	±	6.7	p<0.05

(Mean±S.D.)

The data of Girth Measurement of the FSA and FNSA groups were as follows; Upper Arm: 23.1 ± 1.6 cm and 24.1 ± 1.8 cm; Waist: 65.4 ± 5.7 cm and 68.4 ± 4.9 cm; Hip: 87.6 ± 3.9 cm and 90.4 ± 3.9 cm; and Thigh: 50.7 ± 3.8 cm and 51.7 ± 3.8 cm. There was no significance in this measurement.

The data of Fatfold Measurement of the FSA and FNSA groups were as follows; Triceps: 12.0 ± 3.4 mm and 17.3 ± 2.2 mm; Subscapular: 12.3 ± 4.1 mm and 16.3 ± 4.4 mm; Navel: 12.8 ± 4.9 mm and 16.9 ± 6.8 mm; and Quadriceps: 18.4 ± 5.3 mm and 21.7 ± 3.7 mm. Upper Arm of the FSA group was significantly thinner than that of the FNSA group ($p < 0.01$).

The data of Physical Strength Testing of the FSA and FNSA groups were as follows; Squeezing Power: 26.9 ± 4.0 kg and 24.8 ± 3.7 kg; Sit-up: 25.0 ± 3.2 times and 18.0 ± 1.5 times; and Sit-and-Reach: 56.6 ± 2.8 cm and 47.8 ± 6.7 cm. Sit-up of the FSA group was significantly greater than that of the FNSA group ($p < 0.01$). Sit-and-reach of the FSA group was significantly longer than that of the FNSA group ($p < 0.05$).

All the results of the FSA and FNSA groups above seemed to be related to the body fat volume, core strength, and flexibility. Even though the body weights of both the FSA and FNSA groups were not significantly different, %FATs were. It is obvious that the girth measurement of upper arm of the FSA group was thinner than that of the FNSA group. Also, even though there were not significant differences regarding the girth measurement of navel between the groups, the numerical values were clearly different. Consequently, the endurance strength of sit-up and flexibility of sit-and-reach were significantly different between the two groups. Thus, the body fat volume, core strength, and flexibility of a female college student with experience of high school athletic club activity was superior to a female college student without high school athletic club activity.

Overall, I discovered the differences between male and female students with and without experience of high school athletic club activities. Those with experience of high school athletic club activities are superior in strength, flexibility, and endurance. So it is neces-

sary for each college student who participates in the physical education class to be taught/instructed in one's own way. It will be hard for each teacher/instructor to change the teaching method/plan; however, all students seem to be eager for it. Thus, the students will be able to acquire the fundamental knowledge/skill against life-style related diseases, and they should make use of it for their own lives.

The number of female subjects used in this study was the minimum required for statistical comparison. I should collect more numbers of female subjects and need to continue investigating this topic with further research.

Conclusion

This study investigated the differences in physical characteristics between male and female college students with and without experience of high school athletic club activities. My results can be summarized as follows:

- 1) LBM of the MSA group was significantly heavier than that of the MNSA group ($p < 0.05$).
- 2) Upper Arm of the MSA group was significantly thicker than that of the MNSA group ($p < 0.05$).
- 3) Squeezing power of the MSA group was significantly greater than that of the MNSA group ($p < 0.01$).
- 4) Sit-up of the MSA group was significantly greater than that of the MNSA group ($p < 0.05$).
- 5) Sit-and-reach of the MSA group was significantly longer than that of the MNSA group ($p < 0.05$).
- 6) %FAT of the FSA group was significantly smaller than that of the FNSA group ($p < 0.05$).
- 7) Upper Arm of the FSA group was significantly thinner than that of the FNSA group ($p < 0.01$).
- 8) Sit-up of the FSA group was significantly greater than that of the FNSA group ($p < 0.01$).
- 9) Sit-and-reach of the FSA group was significantly longer than that of the FNSA group ($p < 0.05$).

I concluded that a male college student with experience of high school athletic club activity tends to have

larger muscular volume and stronger muscular strength as compared with a male college student without that experience. In addition, a female college student with experience of high school athletic club activity tends to have smaller fat volume, greater muscular endurance, and better flexibility as compared with a female college student without that experience.

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