JOMH
Journal of Men's Health

Original Article
DOI: 10.22347/1875-6859.14.1.6

THE RELATIONSHIP OF EXERCISE FREQUENCY TO BODY COMPOSITION AND PHYSICAL FITNESS IN DORMITORY-DWELLING UNIVERSITY STUDENTS

Dormitory, Exercise Habit, Body Composition, and Physical Fitness

By Seok Hee Kim[1*], Hyuek Jong Lee[2*], Wi-Young So[3]

[1]Assistant Professor, School of Humanities and Social Science, College of Liberal Arts and Convergence Science, Korea Advanced Institute of Science and Technology, Daejeon-si, Republic of Korea.

[2]Postdoctoral Fellow, Key laboratory of Animal Ecology and Conservation Biology, Institute of Zoology, Chinese Academy of Sciences, Beijing, 100101, People's Republic of China.

[3]Associate Professor, Sports and Health Care Major, College of Humanities and Arts, Korea National University of Transportation, Chungju-si, Korea.

*These authors contributed equally to this work.

CORRESPONDING AUTHOR Wi-Young So: wowso@ut.ac.kr

Submitted: October 27, 2017. Accepted: January 15, 2018. Published: February 1, 2018.

Abstract

Background and Objective

The health benefits of regular exercise are well known, and the transition to adulthood is an important time for establishing exercise habits. In this study, we aimed to identify the degree of obesity prevention and fitness according to exercise level in male and female university students who live in dormitories.

Material and Methods

This study included 1,808 university dormitory residents, 1,263 men and 545 women, who completed a sociodemographic questionnaire and were classified into groups according to exercise habit. Sociodemographic data were expressed as frequency and percent, and one-way analysis of variance was conducted to examine the group difference according to exercise habit.

Results

Weight, muscle mass, lean body mass, and basal metabolism were significantly higher in male university students living in dormitories who habitually exercise at least 3 times a week compared to those who exercise less often ($p<0.05$). The body mass index was higher in female university students living in dormitories who exercise at least 3 times a week compared to those who exercise less often ($p<0.05$). The former group could also perform a greater number of sit-ups ($p<0.01$) and had greater back strength ($p<0.01$) and faster

whole-body reaction time (p<0.01). Women who exercised at least once a week could perform more push-ups versus those who did not exercise (p<0.01). Male university students living in dormitory who exercise at least 3 times a week had higher systolic blood pressure and greater grip strength than male students who exercised twice a week or less (p<0.05); they could also do more push-ups (p<0.05).

Conclusion

University students who exercise at least 3 times a week have somewhat higher fitness and healthier body composition compared to those who exercise twice a week or less. These differences may impact lifetime fitness and body composition.

University dormitories aid in building self-reliance and the spirit of independence as well as affecting students' daily life, culture, study habits, and preparation for employment. The university dormitory is developing to provide total care for university students.

Entering college at 18–20 years of age is an important period in a young person's life as this experience can help to establish behavioural patterns that could lead to a healthy lifestyle in adulthood and old age.[1] However, risky health behaviour that could induce overweight and obesity are prevalent in many college students.[2] It has been reported that students are at highest risk of gaining weight in their junior or freshmen year.[3] Studies conducted in the United States have shown that students in their junior or freshmen days in university experience higher weight gain than same-aged people who do not attend university.[4,5] Studies in Europe[6,7] have reported that a popular name for college weight gain, "freshman 15," was coined due to the myth that first-year university students gain 15 pounds; although the students studied did gain weight over the first year, the typical gain was smaller in reality than in the myth.[8,9] During freshman year, changes in diet, drinking, and exercise habits can continue to impact students' weight and health over time.[10] A recent study suggested that this weight gain persists over 4 years, indicating that it may have ramifications later in life.[11]

Many studies regarding the weight gain of freshmen students have been conducted in the United States. However, university culture is highly varied; for example, university students in most European countries live in considerably different circumstances,[6,7] more often with their parents or in student houses than in dedicated dormitories. Many factors have been found to influence weight gain, including membership in student groups, which can create a less regular eating schedule; furthermore, students with irregular schedules are also less willing to change their eating habits when encouraged to make healthy choices.[12]

Since cultural influences vary between countries and even between corps students and non-corps students, it is vital to study each population to increase the effectiveness of intervention. This is one of the first studies on weight and fitness in Korean university students.

The physical activity patterns of most college students living in dormitories are not at optimal levels and get worse over time: one third of college students are sedentary and tend to become less physically active throughout their college years.[2,13] Dormitory living can present considerable heterogeneity in spatial distribution of eating and physical activity locations, which can affect behaviour. Uncontrolled dormitory environments can worsen the health status of university students, but encouraging them to participate in sports and physical activity can prevent those problems.

In general, exercise results in physical and psychological benefits. Regular exercise helps to maintain body weight and prevents metabolic syndromes such as obesity, diabetes and cardiac diseases.[14] In addition, exercise improves self-esteem,[15] anxiety,[16] depression and mood[17]; therefore, exercise is a critical factor that could affect emotional welfare. Furthermore, exercise improves short-term memory by activating prefrontal and occipital cortexes, indicating that exercise may improve academic achievement in college students.[18] Therefore, engagement in exercise among first-year university students is the first step to helping students maintain a healthy lifestyle in college and later life. In this study, we aimed to identify the obesity and fitness level of university students living in dormitories

according to exercise level, therefore providing useful data for promotion of physical activity on campus.

METHODS

Participants

We enrolled 1,808 male and female university students who live in dormitories. Students were randomly selected and details regarding their sociodemographic characteristics including exercise habits, life habits, safety consciousness, and health status were collected. Students were classified into groups according to exercise habit and gender.[19] The sociodemographic and physical characteristics of the subject are shown in Table 1 and Table 2. Prior to participation in this study, students provided voluntary informed consent. Of 1,808 subjects, 1,263 (69.9%) were male and 545 (30.1%) were female. Five hundred and 3 men (39.8%) and 165 women (30.3%) exercised more than 3 times a week; 230 men (18.2%) and 96 (17.6%) women exercised less than twice a week, and 185 men (14.6%) and 108 women (19.8%) reported no exercise. Three hundred and forty five men and 176 women did not respond to this question.

TABLE 1 The Sociodemographic Characteristics of the Participants

Variables	Items		*n*	%
Sex	Male		1263	69.9
	Female		545	30.1
Age	15–20	Men	300	23.8
		Women	78	14.3
	21–25	Men	504	39.9
		Women	274	50.3
	26–30	Men	459	36.3
		Women	193	35.4
Exercise habit	3 times a week	Men	503	39.8
		Women	165	30.3
	Less than twice a week	Men	230	18.2
		Women	96	17.6
	None	Men	185	14.6
		Women	108	19.8
	Non-response	Men	345	27.4
		Women	176	32.3
Eating habit	Regular	Men	651	51.5
		Women	262	48.1
	Irregular	Men	267	21.1
		Women	107	19.6
	Non-response	Men	345	27.4
		Women	176	32.3
Food salt level	Blandness	Men	158	12.5
		Women	79	14.5
	Normal	Men	620	49.1
		Women	257	47.2
	Salty	Men	140	11.1
		Women	33	6.1
	Non-response	Men	345	27.3
		Women	176	32.2

Smoking habit	Non-smoking	Men	665	52.7
		Women	290	53.2
	Ex-smoking	Men	191	15.1
		Women	75	13.8
	Smoking	Men	62	4.9
		Women	4	0.7
	Non-response	Men	345	27.3
		Women	176	32.3
Drinking habit	Non-drinking	Men	281	22.2
		Women	105	19.3
	Less than twice a week	Men	594	47.0
		Women	252	46.2
	More than 3 times a week	Men	43	3.4
		Women	12	2.2
	Non-response	Men	345	27.4
		Women	176	32.3
Drug use	Almost no	Men	779	61.7
		Women	290	53.2
	Sometimes	Men	102	8.1
		Women	60	11.0
	Almost everyday	Men	37	2.9
		Women	19	3.5
	Non-response	Men	345	27.3
		Women	176	32.3
Annual distance traveled by car	Under 2,000 km	Men	533	42.2
		Women	222	40.7
	2,000 km–4000 km	Men	248	19.6
		Women	110	20.2
	Over 8,000 km	Men	137	10.8
		Women	37	6.8
	Non-response	Men	345	27.4
		Women	176	32.3
Seat belt habit	Fastening seat belt	Men	702	55.6
		Women	260	47.7
	Sometimes	Men	183	14.5
		Women	98	18.0
	Almost every time	Men	33	2.6
		Women	11	2.0
	Non-response	Men	345	27.3
		Women	176	32.3

Average sleep time	7–8 hours	Men	662	52.4
		Women	245	45.0
	9 hours or more	Men	24	1.9
		Women	14	2.6
	6 hours or less	Men	232	18.4
		Women	110	20.2
	Non-response	Men	345	27.3
		Women	176	32.2
Current physical health status	Very good	Men	216	17.1
		Women	68	12.5
	Normal	Men	635	50.3
		Women	276	50.6
	Bad	Men	25	4.6
		Women	110	20.2
	Non-response	Men	387	28
		Women	91	16.7
Life satisfaction	Almost complete satisfaction	Men	623	49.3
		Women	252	46.2
	Normal	Men	274	21.7
		Women	112	20.6
	Bad	Men	21	1.7
		Women	4	0.7
	Non-response	Men	345	27.3
		Women	177	32.5
Extended unhappiness during past year	None	Men	778	61.6
		Women	303	55.6
	Once	Men	120	9.5
		Women	58	10.6
	More than twice	Men	19	1.5
		Women	8	1.5
	Non-response	Men	346	27.4
		Women	176	32.3

TABLE 2 Physical Characteristics of Subjects

N = 1,808	**Men (n = 1,263)**		**Women (n = 545)**	
	Mean	**Standard deviation**	**Mean**	**Standard deviation**
Age (years)	23.84	3.65	24.25	3.12
Height (cm)	172.70	8.20	163.26	9.06
Weight (kg)	72.03	10.97	55.53	6.71
Body mass index (kg/m^2)	23.74	3.23	21.18	2.25
Body fat (%)	19.78	6.61	28.55	5.14
Waist-hip ratio (%)	0.85	0.04	0.81	0.03

Evaluation of Body Composition

The measurement of body composition was conducted according to the recommendations in Applied Body Composition Assessment.[20] Students were asked to remove any metal objects that they were carrying, and measurements were conducted 30 min after urination and following a 5 minute period of rest. Weight, body mass index (BMI), and percentage of body fat were assessed using a body composition measuring instrument, Inbody 720 (Biospace Co., Seoul, Korea).

Physical Fitness Tests

Physical fitness was evaluated by conducting tests of aerobic capacity, muscular strength, muscular endurance, flexibility, and agility according to guidelines in Advanced Fitness Assessment and Exercise Prescription.[21] Aerobic capacity was evaluated using a bicycle ergometer (Aerobike 75XL, Combi Co., Tokyo, Japan). Muscular strength was evaluated based on measurements of back muscle strength and grip strength; muscular endurance was evaluated by measuring the number of sit-ups and push-ups performed in 60 seconds; flexibility was evaluated via a sit and reach test; agility was evaluated by measuring reaction time to auditory stimulus; and power was evaluated by vertical jump using a digital measuring instrument (Helmas O_2Run, Seoul, Korea).

Statistical Analyses

Male and female students were each divided into 3 groups: students who reported exercising at least 3 times a week (the 3+ group), students who reported exercising once or twice a week (the 1–2 group) and students who reported no exercise (the 0 group). One-way analysis of variance and a Tukey post-hoc test was used to determine differences between groups reporting different exercise habits. Statistical analysis was performed using IBM SPSS Statistics ver. 18.0 (IBM Co., Armonk, NY, USA). The significance level was set at $p<0.05$.

RESULTS

Differences in Body Composition According to Exercise Habit among University Students Living in Dormitories

Table 3 shows differences in body composition between groups of dormitory-dwelling university students. Compared to the other 2 groups, men who exercised more than 3 times a week (the 3+ group) showed significantly higher weight ($p<0.05$); muscle mass ($p<0.01$); fat-free mass ($p<0.01$); and basal metabolism ($p<0.01$). Women who exercised 3 times a week had higher BMIs than women who exercised less often or not at all ($p<0.05$).

Difference in Cardiovascular Function and Physical Fitness According to Exercise Habit among University Students Living in Dormitories

Table 4 shows the differences in cardiovascular function and physical fitness between groups. Men in the 3+ group had higher systolic blood pressure and grip strength (both $p<0.05$), and could perform more push-ups ($p<0.05$) compared to men in the other 2 groups.

Women in the 3+ group could perform more sit-ups ($p<0.01$), had greater back and grip strength (both $p<0.01$), and had faster whole-body reaction times ($p<0.01$) than women in the other 2 groups. Both women who exercised 3+ times and women who exercised 1–2 times could perform more push-ups ($p<0.01$) than women who reported no exercise.

DISCUSSION

University life is characterized by a time of new found independence through which students become responsible for their own routines, and as such this marks a critical juncture for education and the formation of healthy habits.[22]

Different styles of residences, including boarding houses, dormitories, relatives' houses, and residential houses may affect the lifestyle of university students. Health promotion behaviour that can be affected by these factors may also affect optimal well-being, personal achievement, and productive life.[23] Furthermore, because university students experience rapid physical, mental, and social development, and experience fewer specific symptoms of ill health, they may be more insensitive to the necessity of health care than older adults.[24]

Maintaining proper fitness is necessary for health promotion and maintenance; cardiorespiratory fitness, especially, is very important for a consistent supply of oxygen and the removal of carbon dioxide and

TABLE 3 The Difference of Body Composition According to Exercise Habit in University Students in Dormitory

Variables	Exercise habit	Men					Women				
		n	Mean±SD	F	p	Post-Hoc	*n*	Mean±SD	F	*p*	Post-Hoc
Body weight (kg)	At least 3 times a week	503	72.06±10.71	3.423	0.033*	a>b,c	165	56.06±6.62	2.458	0.087	NS
	Once or twice a week	230	70.90±9.94				96	54.18±7.01			
	No exercise	185	69.73±11.47				108	55.05±6.59			
Muscle mass (kg)	At least 3 times a week	503	32.56±4.07	11.766	<0.001***	a>b,c	165	21.33±2.22	1.295	0.275	NS
	Once or twice a week	230	31.77±3.57				96	20.91±2.37			
	No exercise	185	30.98±3.83				108	20.96±2.39			
Body mass index (kg/m^2)	At least 3 times a week	503	23.79±3.05	2.933	0.054	NS	165	21.48±2.12	3.879	0.022*	a>b,c
	Once or twice a week	230	23.36±2.90				96	20.73±2.39			
	No exercise	185	23.21±3.58				108	20.97±2.27			
Body fat (%)	At least 3 times a week	503	19.54±6.33	0.806	0.447	NS	165	29.05±5.14	1.224	0.295	NS
	Once or twice a week	230	19.94±6.01				96	28.08±5.26			
	No exercise	185	20.19±7.44				108	28.96±4.85			
Waist-hip ratio (%)	At least 3 times a week	503	0.86±0.04	3.612	0.027*	NS	165	0.82±0.04	1.187	0.306	NS
	Once or twice a week	230	0.85±0.04				96	0.81±0.04			
	No exercise	185	0.85±0.04				108	0.81±0.04			

Lean body mass (kg)	At least 3 times a week	503	57.58±6.79	10.521	<0.001***	a>b,c	165	39.59±3.82	1.694	0.185	NS
	Once or twice a week	230	56.38±5.95				96	38.74±3.90			
	No exercise	185	55.09±6.36				108	38.95±3.99			
body fat mass (kg)	At least 3 times a week	503	14.47±6.43	0.041	0.959	NS	165	16.47±4.43	1.712	0.182	NS
	Once or twice a week	230	14.52±6.04				96	15.43±4.58			
	No exercise	185	14.64±7.84				108	16.11±4.06			
Obesity degree (%)	At least 3 times a week	503	108.15±13.85	2.845	0.059	NS	165	102.30±10.08	3.791	0.023*	NS
	Once or twice a week	230	106.21±13.17				96	98.76±11.39			
	No exercise	185	105.60±16.37				108	99.87±10.82			
Basal metabolic rate (kcal)	At least 3 times a week	503	1613.79±146.60	10.523	<0.001***	a>b,c	165	1224.95±82.42	1.664	0.191	NS
	Once or twice a week	230	1587.74±128.66				96	1206.95±84.28			
	No exercise	185	1559.95±137.29				108	1211.25±86.15			

**p<0.05, ***p<0.001; tested by one-way analysis of variance with Tukey post-hoc test SD = standard deviation; NS = none significant; a = 3 times a week; b = twice a week; c = none.*

TABLE 4 The Difference of Cardiovascular Function and Physical Fitness According To Exercise Habit in University Students In Dormitory

	Men						**Women**				
Variables	**Exercise habit**	***n***	**Mean±SD**	**F**	**p**	**Post-Hoc**	***n***	**Mean±SD**	**F**	***p***	**Post-Hoc**
Systolic blood pressure (mmHg)	At least 3 times a week	503	120.44±12.23	4.120	0.017*	a>b,c	165	108.08±14.16	1.245	0.289	NS
	Once or twice a week	230	119.60±13.98				96	107.24±10.73			
	No exercise	185	118.70±11.93				108	110.08±14.54			

Diastolic blood pressure (mmHg)	At least 3 times a week	503	71.67±33.14	0.430	0.650	NS	165	71.44±40.91	0.562	0.570	NS
	Once or twice a week	230	72.67±9.33				96	68.15±7.90			
	No exercise	185	72.84±8.36				108	71.91±8.93			
Heart rate (beats/ min)	At least 3 times a week	503	77.30±12.72	1.661	0.191	NS	165	83.19±70.71	0.116	0.891	NS
	Once or twice a week	230	78.65±11.73				96	80.58±12.46			
	No exercise	185	83.82±12.80				108	83.45±11.16			
VO2max (ml/kg/ min)	At least 3 times a week	503	51.00±38.81	5.642	0.004**	NS	165	35.45±22.38	0.605	0.547	NS
	Once or twice a week	230	47.75±34.85				96	38.59±22.08			
	No exercise	185	44.84±31.29				108	36.28±21.78			
Sit-up (reps/30sec)	At least 3 times a week	503	22.46±4.60	0.873	0.418	NS	165	17.31±4.97	13.408	<0.001***	a>b,c
	Once or twice a week	230	20.99±4.60				96	15.70±4.67			
	No exercise	185	18.97±5.09				108	14.19±4.95			
Push-up (Reps)	At least 3 times a week	503	29.91±12.65	3.339	0.036*	a>b,c	165	25.75±12.72	13.083	<0.001***	a,b>c
	Once or twice a week	230	24.32±11.29				96	23.60±12.33			
	No exercise	185	20.59±9.97				108	18.33±9.40			
Back strength (kg)	At least 3 times a week	503	98.90±22.84	2.388	0.092	NS	165	64.19±23.90	10.360	<0.001***	a>b,c
	Once or twice a week	230	89.08±21.88				96	57.00±18.32			
	No exercise	185	81.45±22.63				108	52.62±17.41			
Grip strength (kg)	At least 3 times a week	503	40.45±7.83	4.554	0.011*	a>b,c	165	27.25±9.15	7.068	0.001**	a>b,c
	Once or twice a week	230	38.24±8.13				96	24.36±7.31			
	No exercise	185	35.24±7.91				108	23.80±7.18			
Vertical jump (cm)	At least 3 times a week	503	41.12±8.02	0.144	0.866	NS	165	27.81±8.23	1.849	0.159	NS
	Once or twice a week	230	38.45±7.79				96	26.17±6.07			
	No exercise	185	36.78±7.16				108	26.03±8.09			

Reaction time (ms)	At least 3 times a week	503	255.18±65.75	1.897	0.151	NS	165	282.75±56.32	5.539	0.004**	a<b,c
	Once or twice a week	230	260.76±56.44				96	308.64±77.59			
	No exercise	185	271.97±70.00				108	306.01±76.68			
Balance (sec)	At least 3 times a week	503	23.38±31.09	1.887	0.152	NS	165	27.86±29.59	0.054	0.947	NS
	Once or twice a week	230	19.75±25.68				96	27.68±32.10			
	No exercise	185	19.25±25.06				108	26.56±36.99			
Sit & reach (cm)	At least 3 times a week	503	6.91±9.70	5.511	0.004**	NS	165	11.02±9.84	1.123	0.326	NS
	Once or twice a week	230	5.57±10.78				96	11.37±9.36			
	No exercise	185	2.84±9.65				108	12.70±8.12			

**p<0.05, **p<0.01, ***p<0.001; tested by one-way analysis of variance with Tukey post-hoc test.*
SD = standard deviation; NS = none significant; a = 3 times a week; b = twice a week; c = none.

body wastes. Recently, an inverse relationship was reported between cardiorespiratory fitness and metabolic syndrome.[25] Obesity, and abdominal obesity *per* se, induce metabolic syndrome through multiple risk factors including hyperglycemia, hyperlipidemia, and hypertension.[26] Metabolic syndrome is an important health and social problem, as untreated metabolic syndrome can cause premature death via type 2 diabetes, cardiovascular disease, and stroke.[27]

Exercise has many benefits, including an increase in basal metabolism with increase of energy expenditure and activation of metabolism,[28,29] a decrease in blood pressure,[30] and an improvement in cardiorespiratory fitness.[31]

The significantly higher muscle mass, lean body mass, and basal metabolism of participants in the 3+ group of male students indicates that this cohort has a more healthy body composition, despite their heavier weight.

Although the 3+ group of female university students had higher BMIs compared to those in the other 2 groups, students in this group were not obese. The incidence of obesity in our study group was lower than that reported in the Korea National Health and Nutrition Examination Survey (2015), which showed a prevalence of 36.5% and 26.4% among men and women, respectively, aged more than 19 years old. It was also lower than that reported by the American National Health and Nutrition Examination Survey (2005-2008), which showed 72.8% and 63.0% obesity or over-weight prevalence in mean and women more than 20 years old with >25kg/m^2 of BMI, and 32.9% and 35.6% obesity prevalence in men and women with >30 kg/m^2.[19]

Men in the 3+ group had higher systolic blood pressure, but this was still within normal range. In general, blood pressure increases after exercise, and decline of blood pressure is related to vascular compliance. Acute aerobic exercise can have a positive effect on vascular compliance. The 3+ group's significantly higher push-up and grip strength are likely to result from higher muscle mass and lean body mass that would positively affect muscular function.

Our findings that the 3+ group of dormitory-dwelling women were more fit than the other groups differ with the report that female university students showed no difference in exercise habit or showed decreasing tendency,[32] but it is assumed that maintaining regular exercise more than 3 times a week can affect health-related fitness. However, it is thought that the reason for decreasing exercise habit in other studies may be due to lack of time, motivation, and

housework support; this could be partly ameliorated by dormitory life.[32]

In this study, men and women living in dormitories showed significant differences in strength and endurance performance according to exercise habit. Blood pressure and heart rate also differed, although insignificantly, between groups. The development of obesity and metabolic syndrome as a result of changes in cardiorespiratory fitness is not limited to adulthood; prevention of these diseases is also necessary in the adolescent period and during young adulthood and university life.

Although dormitory-dwelling university students may not maintain fitness habits throughout their entire lives, regular exercise habits can have a positive effect on the change of body composition and fitness variables. This study examined the effect of participation in exercise, including intermittent participation, and found that more frequent participation positively correlated with fitness markers.

CONCLUSION

The higher scores on some fitness tests of university students who exercise at least 3 times a week compared to those who exercise twice a week or less indicate that exercise habits have a strong influence on the fitness of university students, which are likely to persist in later life. Differences in body composition are also evident, although not as pronounced, and may have even greater effects on lifetime health. College students living in dormitories should be encouraged to adopt healthy exercise habits.

DISCLOSURE

The authors have no conflicts of interest to declare.

REFERENCE

1. Pierce EF, Butterworth SW, Lynn TD, O'Shea J, Hammer WG. Fitness profiles and activity patterns of entering college students. J Am Coll Health 1992;41(2):59–62.
2. Racette SB, Deusinger SS, Strube MJ, et al. Changes in weight and health behaviors from freshman through senior year of college. J Nutrit Educat Behav 2008;40(1):39–42.
3. Boujut E, Bruchon-Schweitzer M. A construction and validation of a freshman stress questionnaire: an exploratory study. Psychol Rep 2009;104(2):680–92.
4. Association ACoH. The american college health association national college health assessment (ACHA-NCHA), Spring 2003 reference group report. J Am Coll Healt 2005;53(5):199.
5. Huang TT-K, Kempf AM, Strother ML, et al. Overweight and components of the metabolic syndrome in college students. Diabet Care 2004;27(12):3000–1.
6. Deliens T, Clarys P, De Bourdeaudhuij I, Deforche B. Weight, socio-demographics, and health behaviour related correlates of academic performance in first year university students. Nutrit J 2013;12(1):162.
7. Finlayson G, Cecil J, Higgs S, Hill A, Hetherington M. Susceptibility to weight gain. Eating behaviour traits and physical activity as predictors of weight gain during the first year of university. Appetite 2012;58(3): 1091–8.
8. Boujut E, Koleck M, Bruchon-Schweitzer M, Bourgeois M-L, editors. La santé mentale chez les étudiants: suivi d'une cohorte en première année d'université. Annales Médico-psychologiques, revue psychiatrique. Elsevier; 2009.
9. Crombie AP, Ilich JZ, Dutton GR, Panton LB, Abood DA. The freshman weight gain phenomenon revisited. Nutrit Rev 2009;67(2):83–94.
10. Hoffman DJ, Policastro P, Quick V, Lee S-K. Changes in body weight and fat mass of men and women in the first year of college: A study of the "freshman 15". J Am Coll Health 2006;55(1):41–6.
11. Gropper SS, Simmons KP, Connell LJ, Ulrich PV. Changes in body weight, composition, and shape: a 4-year study of college students. Appl Physiol Nutrit Metabol 2012;37(6):1118–23.
12. de Vos P, Hanck C, Neisingh M, Prak D, Groen H, Faas MM. Weight gain in freshman college students and perceived health. Prevent Med Rep 2015;2:229–34.
13. Vella-Zarb RA, Elgar FJ. The 'freshman 5': a meta-analysis of weight gain in the freshman year of college. J Am Coll Health 2009;58(2):161–6.
14. Lin X, Zhang X, Guo J, et al. Effects of exercise training on cardiorespiratory fitness and biomarkers of cardiometabolic health: a systematic review and meta-analysis of randomized controlled trials. J Am Heart Assoc 2015;4(7):e002014.
15. Arias-Palencia NM, Solera-Martínez M, et al. Levels and patterns of objectively assessed physical activity and compliance with different public health guidelines in university students. PloS One 2015;10(11):e0141977.

16. Kim S, Kim J. Mood after various brief exercise and sport modes: aerobics, hip-hop dancing, ice skating, and body conditioning. Percept Motor Skills 2007;104(3_suppl):1265–70.
17. Byrne A, Byrne D. The effect of exercise on depression, anxiety and other mood states: a review. J Psychosomat Res 1993;37(6):565–74.
18. Li L, Men W-W, Chang Y-K, Fan M-X, Ji L, Wei G-X. Acute aerobic exercise increases cortical activity during working memory: a functional MRI study in female college students. PloS One 2014;9(6):e99222.
19. Park SJ, Lee JH, Woo SJ, et al. Five heavy metallic elements and age-related macular degeneration: Korean National Health and Nutrition Examination Survey, 2008–2011. Ophthalmology 2015;122(1):129–37.
20. Heyward VH, Wagner DR. Applied body composition assessment: Hum Kinetics 2004.
21. Heyward VH, Gibson A. Advanced fitness assessment and exercise prescription 7th edition: Hum Kinet 2014.
22. Small M, Bailey-Davis L, Morgan N, Maggs J. Changes in eating and physical activity behaviors across seven semesters of college: living on or off campus matters. Health Educat Behav 2013;40(4):435–41.
23. Pender NJ, Murdaugh CL, Parsons MA. Health promotion in nursing practice. 2006.
24. Troyer D, Ullrich IH, Yeater RA, Hopewell R. Physical activity and condition, dietary habits, and serum lipids in second-year medical students. J Am Coll Nutrit 1990;9(4):303–7.
25. LaMonte MJ, Yanowitz FG, Hunt SC, Adams TD. Fitness and the metabolic syndrome among severely obese adults. Med Sci Sports Exercise 2004;36(5):S7.
26. Shaw DI, Hall WL, Williams CM. Metabolic syndrome: what is it and what are the implications? Proc Nutrit Soc 2005;64(3):349–57.
27. DeFronzo RA, Ferrannini E. Insulin resistance: a multifaceted syndrome responsible for NIDDM, obesity, hypertension, dyslipidemia, and atherosclerotic cardiovascular disease. Diabet Care 1991;14(3):173–94.
28. Brehm BA. Elevation of metabolic rate following exercise. Sports Med 1988;6(2):72–8.
29. Poehlman ET, Viers HF, Detzer M. Influence of physical activity and dietary restraint on resting energy expenditure in young nonobese females. Can J Physiol Pharmacol 1991;69(3):320–6.
30. Kiefer I, Kunze U, Mitsche N, Kunze M. Obesity in Austria: epidemiologic and social medicine aspects. Acta Med Austr 1997;25(4-5):126–8.
31. Jakicic JM, Clark K, Coleman E, et al. American College of Sports Medicine position stand. Appropriate intervention strategies for weight loss and prevention of weight regain for adults. Med Sci Sports Exercise 2001;33(12):2145–56.
32. Eyler AA, Baker E, Cromer L, King AC, Brownson RC, Donatelle RJ. Physical activity and minority women: a qualitative study. Health Educat Behav 1998;25(5):640–52.