

Changes in weight and body composition in physically active first year university students

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Abstract

Introduction. Previous studies showed that transition to university may pose a risk of weight gain among first year university students. However, researchers have overlooked to examine students with unique characteristics that might vary their susceptibility to weight gain. **Aim of Study.** The purpose of this study was to examine changes in body weight and body composition among physically-oriented first-year students. **Material and Methods.** A total of 86 physically active first year students participated in the study. Students' body weight and other body composition variables were measured at three time points during their first year in university. **Results.** Overall, while no significant weight gain was found in first year students at the end of the study compared to the baseline, their average weight gain was lower than earlier findings. However, significant changes in % body fat of students were observed during their freshman year. Both male and female students experienced transitory changes in weight, fat mass, % body fat, and % skeletal mass during the study. Among the total cohort of students, more than 50% gained weight after 7 months in their freshman year despite their high level of physical activity participation. **Conclusions.** This study extends the literature concerning weight gain during transition from school to university among first year students and its association with physical activity. It also shows the potential role of culture affecting the incidence of weight gain in freshman students. Finally, the finding highlights the importance of weight gain prevention programs for first-year university students, even if they are physically active.

KEYWORDS: physical activity, weight gain, South Korea, physically-oriented students, Freshman 15.

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Introduction

Transition to university is found to be associated with changes in lifestyles of students. Changes in lifestyle can involve the adoption of unhealthy behaviors such as eating too much foods high in fat or sugar [5, 10], drinking excessive amounts of alcoholic drinks and/or sugary beverages [24], and being physically inactive [25]. When these unhealthy behaviors are not properly regulated, it can potentially lead to weight gain in students and consequently increase their risk in developing weight-related health problems such as overweight, obesity, stroke, and diabetes [28].

Empirical studies on weight gain in university students are well-documented particularly during the first year of university [3, 9, 10, 12, 14, 17, 20], since transitioning from high school to university is considered a critical period for weight gain [23]. For instance, Lloyd-Richardson et al. [17] found that female students gained an average weight of 1.6 kg, while male students got heavier by 2.5 kg during their freshman year. Levitsky et al. [15] reported that female freshmen students gained 3.1 ± 0.51 kg and 2.0 ± 0.65 kg of weight in the first semester of 2002 and 2003, respectively. Meanwhile, Finlayson et al. [10] revealed that body weight (0.83 ± 2.1 kg) of first year students significantly increased between the baseline and 3 months. Other body composition measures were also found to increase, including BMI (0.29 ± 0.72 kg/m²) and fat mass

(0.88 ± 1.87 kg). Recently, Olansky et al. [20] found that freshmen students gained body weight (3.2 ± 3.8 kg), fat mass (2.5 ± 3.0 kg), and % body fat ($2.3 \pm 4.9\%$), while also lean body mass (0.7 ± 2.1 kg) increased at the end of their first year of university. The results from these studies indeed showed the prevalence of weight gain in first year university students and researchers reported that students' weight gain was due to lifestyle changes associated with transition to university.

However, a majority of these findings came from samples of students from western countries and thereby a lack of information on weight gain of first year university students from other nations. Secondly, while studies found weight gain in first year students, the findings showed disparities in terms of the degree of weight change during the freshman year and therefore need further exploration. Thirdly, previous studies mainly assessed changes in body mass/weight to represent gain or loss of fat mass, but only few reported other measures of body composition found to be relevant not only in determining weight change, but also in evaluating health status of students [10, 20]. Finally, given that physical activity has been shown to prevent weight gain or maintain weight [25, 27], it is plausible to argue that students who are physically active or achieving the recommended level of physical activity of at least 150-300 minutes of moderate-intensity or at least 75-150 minutes of vigorous-intensity aerobic physical activity per week [29] are likely to maintain their weight or avoid weight gain. This might not be a concern for freshmen students pursuing a degree in physical education (PE)/kinesiology, since they are known for being physically active [1, 2, 29]. More so, classes in their first year normally compel them to engage in various forms of sports and exercises and thus they are expected to meet the recommended physical activity level and consequently maintain weight or avoid weight gain. On the other hand, despite being physically active, these students might still be at risk of weight gain considering that they may also potentially practice other unfavorable lifestyle changes when transitioning to university life. However, there is a dearth of empirical studies related to weight changes in specific groups of university students, particularly those students who are physically active or who are attaining the suggested physical activity level requirements during their first year of university.

Therefore, given the limitations of previous studies and research gap in the literature, the objective of this study was to examine changes in body weight and other relevant body composition variables in a specific group

of first-year university students. Specifically, the aim was to examine body composition changes of physically active Korean male and female students during their freshman year. This study bridges a knowledge gap regarding weight change in first year university students from a different nation and provides empirical support concerning weight and body composition changes in a specific group of students who may be less susceptible or resistant to weight gain. Finally, the findings may be used to create appropriate interventions that aim to prevent students' weight gain, which has key implications for students' future health [27].

Material and Methods

Participants

A total of 109 students participated in the study. All participants were first year university students in a private university in Korea. They were freshmen students at the College of Physical Education who majored in physical education ($n = 22$), sports for all ($n = 40$), sport marketing ($n = 1$), and taekwondo ($n = 46$). They were recruited by word of mouth and advertisements from each department website. Participants who volunteered were reminded via email and university's short messaging system about the date and time of the tests. Students were assumed to achieve the recommended level of physical activity per week, for they were required to attend 2-hour practical classes per week during their freshman year, including swimming and track and field, and racket/ball sport. Aside from attending these physical activity classes, a majority of students reported that they were members of different sport clubs such as soccer, basketball, badminton, and tennis with a 2-3 hour session, once or twice a week training schedule. Hence, these physical education major students were accumulating at least 360 to 480 minutes of moderate and vigorous intensity physical activity per week, which qualify them within the physically active category.

From the total sample, 23 students were excluded for missing the remaining one or two testing periods either due to the mandatory 2-year military service for male students or non-appearance. Therefore, 86 first year students (55 men and 31 women; aged 18-22 years) from physical education ($n = 19$), sports for all ($n = 27$), and taekwondo ($n = 40$) were included in the final analysis.

Data collection

Participants' height was measured to the nearest 0.1 cm using a portable stadiometer (Donghwa Science; Korea) consisting of an anthropometer with a simple headboard

by trained research assistants. Body weight, body fat mass, skeletal muscle mass and body fat percentage were measured using bioelectric impedance analysis (InBody 502; Korea). Height and body composition were measured with bare feet with light clothing after removing all metallic objects. Using the measured height and body weight values, BMI was calculated as weight (kg) divided by height (m) squared.

Procedure

Prior to data collection, the appropriate sample size and power were calculated using G*Power. The following values were encoded based on the required input parameters to calculate the total sample size: 1) partial eta squared (η_p^2) = 0.14 assumed to be large effect size; 2) type 1 error probability rate = 0.01; 3) level of statistical power = 95%; 4) number of groups = 2; 5) number of measurements = 3 (time points). Based on the result, 30 participants were needed to determine the minimal detectable effect. The number of participants in this study therefore was more than the required sample size.

Data were collected longitudinally at three points: the beginning of the first semester (March), the end of the first semester (June), and the beginning of the second semester (September). All anthropometric (height, weight) and body composition measurements were performed in the morning (08:00-10:00). Students were instructed not to drink alcohol or caffeine 10-12 hours and not to eat 2-4 hours before testing to increase the accuracy of body composition assessment.

Consent were obtained from all participants and procedures were conducted in accordance with relevant ethical guidelines stated in the Declaration of Helsinki and local ethics board [13, 30].

Statistical analysis

Descriptive statistics (means \pm standard deviations, minimum and maximum values) were initially analyzed to check for parametric assumptions. Tests for normality using the Kolmogorov–Smirnov test of all outcome variables were non-significant and thereby followed a normal distribution. Weight and other body composition variables for all students and for male and females at all three periods were examined via repeated-measures analysis of variance. Moreover, the difference between T1 and T3 of weight and selected predictors of weight were calculated. The computed scores were used to categorize male and female participants into gainers, maintainers, or losers before conducting chi-square tests (χ^2) to examine potential differences in distribution. All analyses were conducted using SPSS 25 for Windows (IBM, Armonk, NY, USA). Significance was set at $p < 0.05$.

Results

Summary of first year students’ relevant outcome measures are presented in Table 1. Overall results showed significant changes in average weight, % body fat, % skeletal mass, fat mass, skeletal mass, and BMI in first year students across three time points. A repeated measures ANOVA with a Greenhouse–Geisser correction showed that mean weight [$F(1.79,152.38) = 3.92, p < 0.05, \eta_p^2 = 0.04$], % body fat [$F(1.66,141.380) = 16.02, p < 0.001, \eta_p^2 = 0.16$], % skeletal mass [$F(1.52,129.84) = 6.65, p < 0.01, \eta_p^2 = 0.07$], fat mass [$F(1.56,132.96) = 9.28, p < 0.001, \eta_p^2 = 0.10$], and BMI [$F(1.34,113.87) = 5.41, p < 0.01, \eta_p^2 = 0.01$] differed significantly between time points. Post hoc tests using the Bonferroni correction revealed that mean weight was higher for T3 compared with T2

Table 1. Changes in weight and body composition of first year university students

N	Time	Variable	Mean	SD	Min	Max	p
n = 86	time 1	weight (kg)	66.21	10.49	44.10	97.90	0.026
			65.90	10.29	45.10	100.00	
			66.52	10.54	44.80	105.60	
	time 2	fat mass (kg)	12.40	4.45	3.60	28.00	0.001
			12.11	4.85	4.30	28.60	
			13.13	4.78	4.50	29.00	
	time 3	skeletal mass (kg)	30.32	6.31	18.60	45.00	0.628
			30.32	6.22	18.60	46.00	
			30.24	6.31	18.70	46.80	

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	time 1	% body fat*	18.91	6.69	5.40	36.30	0.001
	time 2		18.41	7.06	6.40	36.90	a, b, c
	time 3		19.65	6.92	6.80	37.40	
	time 1	% skeletal mass**	45.54	4.35	35.54	54.12	0.004
	time 2		45.78	4.64	35.10	53.33	c
	time 3		45.22	4.72	34.66	58.89	
	time 1	BMI (kg/m ²)	22.72	2.42	18.20	27.70	0.014
	time 2		22.63	2.39	18.00	28.00	phoc nsd
	time 3		22.98	2.47	18.20	29.60	
Male n = 55	time 1	weight	71.56	7.55	56.60	97.90	0.014
	time 2		70.97	7.75	58.50	100.00	c
	time 3		71.91	7.82	59.20	105.60	
	time 1	fat mass	11.10	3.91	3.60	19.60	0.001
	time 2		10.47	4.28	4.30	20.00	a, c
	time 3		11.86	4.55	4.50	24.00	
	time 1	skeletal mass	34.42	3.36	27.70	45.00	0.962
	time 2		34.39	3.19	28.80	46.00	
	time 3		34.38	3.27	27.60	46.80	
	time 1	% body fat*	15.17	4.49	5.40	23.80	0.001
	time 2		14.45	4.77	6.40	24.80	a, c
	time 3		15.85	4.84	6.80	25.20	
	time 1	% skeletal mass**	48.20	2.60	42.47	54.12	0.017
	time 2		48.61	2.81	42.48	53.33	a, c
	time 3		47.97	3.22	42.47	58.89	
	time 1	BMI (kg/m ²)	23.30	2.23	19.50	27.70	0.024
	time 2		23.09	2.30	19.10	28.00	phoc nsd
	time 3		23.57	2.34	18.80	29.60	
Female n = 31	time 1	weight	56.72	7.96	44.10	77.10	0.649
	time 2		56.91	7.84	45.10	77.50	
	time 3		56.96	7.57	44.80	77.60	
	time 1	fat mass	14.71	4.46	8.40	28.00	0.195
	time 2		15.03	4.47	8.30	28.60	
	time 3		15.38	4.38	9.30	29.00	
	time 1	skeletal mass	23.05	2.63	18.60	28.60	0.281
	time 2		23.09	2.67	18.60	28.40	
	time 3		22.88	2.50	18.70	27.20	

time 1	% body fat*	25.53	4.46	18.20	36.30	0.023
time 2		25.44	4.49	18.00	36.90	phoc nsd
time 3		26.39	4.46	18.00	37.40	
time 1	% skeletal mass**	40.82	2.35	35.54	45.18	0.088
time 2		40.75	2.42	35.10	45.05	
time 3		40.35	2.48	34.66	44.90	
time 1	BMI (kg/m ²)	21.68	2.42	18.20	27.20	0.217
time 2		21.80	2.36	18.00	27.20	
time 3		21.94	2.38	18.20	27.30	

Note: a = T1 vs T2; b = T1 vs T3; c = T2 vs T3; phoc nsd = post hoc no significant difference, * fat mass/weight; ** skeletal mass/weight

(66.52 kg vs 65.90 kg). Mean % body fat for T3 was higher than T1 (19.65% vs 18.91%) and T2 (19.65% vs 18.41%), while mean % body fat for T2 was lower than T1 (18.41% vs 18.91). Mean % skeletal mass for T3 was lower than T2 (45.22% vs 45.78%). Fat mass and BMI mean scores between all three time points did not show significant differences.

For skeletal mass, repeated measures ANOVA showed no significant differences between time points [F(1.84,156.85) = 0.44, p = 0.62] (Table 1).

Weight and body composition changes in freshmen male students

Repeated measures ANOVA results showed that male students' average weight [F(1.73, 93.42) = 4.79, p < 0.01, $\eta_p^2 = 0.08$], % body fat [F(1.54,83.46) = 13.11, p < 0.05, $\eta_p^2 = 0.20$], % skeletal mass [F(1.38,74.67) = 5.13, p < 0.05, $\eta_p^2 = 0.08$], fat mass [F(1.28,69.41) = 9.68, p < 0.05, $\eta_p^2 = 0.15$], and BMI [F(1.29,69.68) = 4.76, p < 0.05, $\eta_p^2 = 0.08$], differed significantly between time points.

Post hoc pairwise comparisons using the Bonferroni correction revealed that mean weight for T3 was higher than T2 (71.91 kg vs 70.97 kg). Mean % body fat for T1 was higher than T2 (15.18% vs 14.45%), whereas mean % body fat for T3 was higher than T2 (15.85 vs 14.45%). Mean % skeletal mass for T2 was both greater than T1 (48.61% vs 48.20%) and T3 (48.61% vs 47.97%). Mean fat mass for T1 was higher than T2 (11.10 kg vs 10.47 kg), while mean fat mass for T3 was greater than T2 (11.86 kg vs 10.47 kg).

Skeletal mass mean scores between all three time points did not show significant differences.

After 7 months as freshman students, 60%, 5.5%, and 34.5% of men gained, maintained, and lost weight, respectively. Most men (72.7%) gained fat mass, while

the rest 27.3% lost fat mass. Two-thirds (69.1%) of men gained skeletal muscle mass, while the other students either maintained (1.8%) or lost (29.1%) skeletal muscle mass. Based on the ratio between fat/skeletal mass and weight, more than one-third (38.2%) gained body fat percentage, while maintainers and losers accounted for 5.5% and 56.4%, respectively. However, a majority of male students lost skeletal mass relative to their weight (Figure 1). The observed differences in the distribution for weight ($\chi^2(2) = 24.58$, p = 0.01), fat mass ($\chi^2(2) = 37.78$, p = 0.01), skeletal muscle mass ($\chi^2(2) = 21.96$, p = 0.01), body fat percentage ($\chi^2(1) = 11.36$, p = 0.01), and skeletal mass percentage ($\chi^2(1) = 5.25$, p = 0.05) were all significant.

All in all, after 7 months as first year university students, male students showed changes in their weight, fat mass, and skeletal mass with an average of 0.35 kg, 0.76 kg, and -0.04 kg, respectively. The percentage of ratio between fat/skeletal mass and weight in male students also changed by 0.67% and 0.25% respectively (Figure 2).

Weight and body composition changes in freshmen female students

Repeated measures ANOVA results showed that only female students' % body fat [F(2,60) = 4.02, p < 0.05, $\eta_p^2 = 0.11$] different significantly between time points.

Post hoc pairwise comparisons using the Bonferroni correction revealed that mean % body fat scores for T1, T2, and T3 did not significantly differ between time points.

After 7 months as freshman students, 54.8%, 3.2%, and 41.9% of women gained, maintained, and lost weight, respectively. Nearly two-thirds (67.7%) of women gained fat mass, while the rest lost (29%) fat mass. Most women (65%) gained skeletal mass, while maintainers and losers were 6% and 29%, respectively. In terms of

the ratio between fat/skeletal mass and weight, while more than half (58.1%) of women lost % body fat, most women (68%) also lost skeletal mass relative to their weight. The observed differences in distribution for weight ($\chi^2(2) = 24.58, p = 0.01$), fat mass ($\chi^2(2) = 37.78, p = 0.01$), skeletal muscle mass ($\chi^2(2) = 21.96, p = 0.01$), body fat percentage ($\chi^2(1) = 11.36, p = 0.01$), and skeletal mass percentage ($\chi^2(1) = 3.90, p = 0.05$) were all significant (Figure 1).

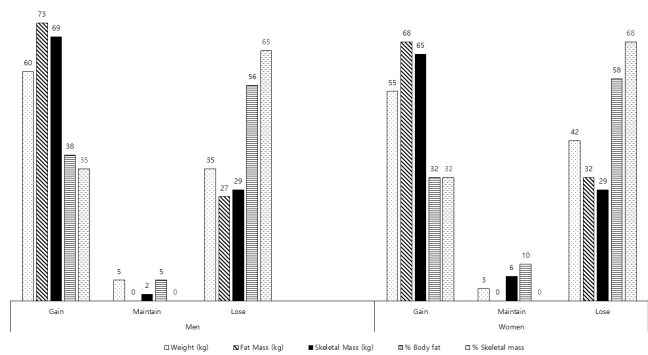


Figure 1. Percentage (%) distribution of changes in body composition characteristics between March and September among first year university students

Note: Positive number represent increased in that parameter.

All in all, after 7 months as first year university students, female students showed changes in their weight, fat mass, and skeletal mass with an average of 0.25 kg, 0.67 kg, and -0.16 kg, respectively. The percentage of the ratio between fat/skeletal mass and weight in female students also changed by 0.86% and 0.47% respectively (Figure 2).

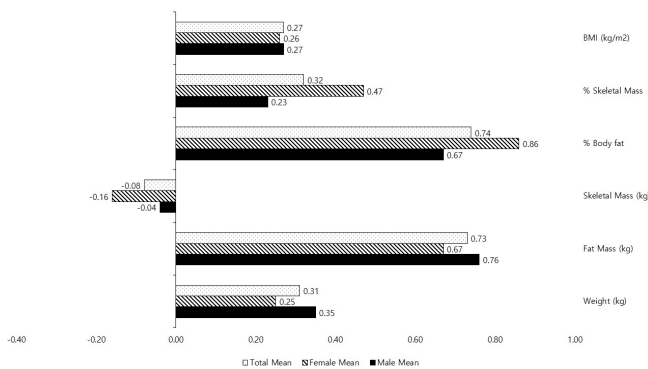


Figure 2. Changes in body composition characteristics between March and September among first year university students

Discussion

The current study examined changes in body weight and other body composition variables of the specific group

of university students, particularly physically active Korean male and female students during their freshman year. Overall, a significant change in students’ weight was found, but only between T2 and T3. That is, first year students gained a substantial amount of weight at the beginning of their second semester than at the end of the first semester in their freshman year. Students’ % skeletal mass significantly changed between T2 and T3 as well. Specifically, students’ skeletal mass percentage dropped 4 months after the end of the first semester. Finally, significant changes in % body fat of students were observed across the three time points. In particular, 7 months after the start of the first semester, first year students’ % body fat showed a sharp rise, but not after an earlier transitory reduction in % body fat at the end of the first semester.

While students’ overall mean weight increased after 7 months in their freshman year compared with their initial weight, the difference was not statistically significant. This result supports previous study [11], but also refutes other findings showing that students gained a significant amount of weight during their first year in university [12, 18, 22]. The discrepancy in the results may be attributed to the study participants, who were students from a specific major that were identified to be physically active. Decrease in PA or low PA during the freshman year has been found to be associated with weight gain. In this case, substantial gain in students’ weight was likely prevented due to the active engagement of the students in various physical activities during their freshman year. It is also noteworthy to report that the 0.31 kg gain in the overall mean weight of physical education major students was lower compared with previously observed average values that ranged between 0.39 kg and 3.38 kg [7, 24, 25].

Physical activity participation is found to be associated with skeletal muscle mass [19]. That is, the more an individual participates in physical activities, the more skeletal muscle mass is likely to develop and vice versa. In this case, the decrease in students’ % skeletal mass at the beginning of the second semester compared to 4 months earlier was likely due to the students’ reduction in physical activity brought about by a break in the semester (summer). This findings therefore highlight the importance of consistent physical activity participation in maintaining skeletal mass in relation to weight and further supports the notion of muscle mass loss and detraining [4]. However, since the physical activity level was not assessed, it would be interesting to determine how much duration was reduced in students’ physical activity level to further understand the association between physical activity and muscle mass.

Interestingly, significant changes in students' % body fat were found during the 7-month study. This finding indicates that first year students reduced their % body fat after the first semester. However, at the beginning of the second semester their % body fat increased considerably higher compared with the baseline score. Despite the significant increase in overall mean % body fat of freshman students after 7 months, mean % body fat of students across the three time points was within the optimal range for good health [6]. However, it is also important to note that the changes in body composition measures of students were mostly an increase in fat mass and a reduction in skeletal mass. Therefore, weight alone should not be considered the sole indicator of health status of physically active students. Rather, other body composition parameters such as fat mass and skeletal mass also need to be taken into account to determine if the gain in weight reflects a healthy or unhealthy state. Moreover, despite the average BMI scores for all time points (T1 = 22.72, T2 = 22.63, T3 = 22.98) were considered normal following the international criteria [27], mean BMIs were almost within the overweight category of 23.0 kg/m² based on Asian and Pacific populations [16, 26]. This implies that despite being physically active, these university students may be susceptible to weight-related health problems if the increasing trend continues and therefore underscores the importance of weight gain prevention.

Weight and body composition changes of male and female students

Studies concerning weight change in male students during the freshman year are scarce. Beaudry et al. [3] found that men significantly gained weight and fat mass and increased BMI and % body fat scores at the end of their study period. Pullman et al. [23] also observed an increase in body weight, BMI, and body fat percentage among freshman men. These previous findings contradict the present result that found no significant changes in weight and other body composition variables after the 7-month study period. These differences may be attributed to the previous sample participants as well as the study length. In the meta-analyses conducted by Vadeboncouer et al. [24] and Vella-Zarb and Elgar [25], study length had a significant impact on participants' weight gain. Nevertheless, the results of the present study revealed that 60% of the total male students gained weight and 58.2% of them were classified as either overweight (30.91%) or obese (25.45%) based on the BMI Asian classification after 7 months in their first year at university [16]. Therefore, interventions that

circumvent future undesirable health consequences of weight gain are warranted.

Similarly, changes in weight and other body composition measures of female freshman students were found to be not substantial. The findings conflicted with previous reports that showed that female freshman students had significant changes not only in weight, but also in all body composition parameters [12]. This discrepancy could be owing to the selected participants being limited to first year students of a specific college/major and identified to be considerably active rather than from a broad-range of subjects [8, 17]. As a whole, 54% of the total female students gained weight and 35.48% of them were classified as either overweight (29.03%) or obese (6.45%) based on BMI Asian classification after 7 months in their first year at university [16].

Strengths and limitations

A strength of the study is that the participants' anthropometric and body composition data were measured following strict protocol across all time periods rather than self-reported data from participants [11]. Self-reported data is suggested to be avoided, because participants tend to overestimate and underestimate their height and weight, respectively, leading to inaccurate results [25]. The sample size with a higher proportion of male students is another strength of this investigation, since a majority of previous studies were comprised of either predominantly female or all female participants [3, 8, 15].

For the limitation, the duration of the study was only 7 months and thereby did not cover the complete freshman academic year. However, study duration is comparable [12, 18] or even longer [14, 21] than previous investigations. Secondly, the sample size might be considered small (86). Twenty three students did not complete the three testing periods and thereby were excluded in the study. Nevertheless, a 78% retention rate of the current study was better than other studies and still exceeded the minimum sample size to achieve statistical power. Lastly, participants were all attending the College of Physical Education, thereby limiting the findings to this sample population. Further studies should include physically active freshman students from other colleges to increase the generalizability of the results. Further, we did not assess students' dietary intake or eating behaviors. Determining the type and amount of food students eat and when and why they consume these foods may provide a better understanding of their health behaviors. Negative health behaviors such as excessive alcohol and junk food intake are potential

predictors of freshman weight gain [25], and identifying what negative health behaviors students engage in, can be informative when creating nutritional programs that target food items or behaviors associated with weight gain.

Conclusions

This study provides important insights concerning the changes in weight and body composition of specific group of freshmen students, as well as underscores the contribution of the physical activity level in preventing weight gain in first year university students. This result therefore demonstrates an association between physical activity and weight gain in freshman students. Secondly, the findings add further knowledge on weight gain (or its absence) when transitioning to university in a non-western nation, particularly in South Korea, and show how culture may affect incidence of weight gain in freshman students. Third, while average weight gain of students did not significantly increase after 7 months in their freshman year, the increase was smaller compared with that observed in other countries. Finally, the proportion of students in terms of weight and fat mass results was somewhat concerning due to the fact that a majority of them gained weight (58%) and fat mass (71%).

It is therefore suggested that weight gain prevention programs are provided for first-year university students, even to those who are physically active. Preventive strategies and interventions are recommended such as nutrition education focusing on late night eating, skipping breakfast, and high alcohol consumption that can lead to weight gain and other detrimental outcomes to one's health.

Conflict of Interest

The authors declare no conflict of interest.

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