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Changes in weight indexes and aerobic fitness of physical education students over three years of college


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ABSTRACT

Meckel Y, Galily Y, Nemet D, Eliakim A. Changes in weight indexes and aerobic fitness of physical education students over three years of college. *J. Hum. Sport Exerc.* Vol. 6, No. 1, pp. 112-121, 2011. Data from the national surveys indicate that physical activity and dietary patterns of many college students do not meet the recommendations of health and fitness experts, and that 29.9% of college students are overweight or obese. Thus, the aim of the present study is to track changes in body composition and aerobic fitness of physical education students during their college years. The students (n=174, 89 females, 85 males) were evaluated for body weight, percent body fat, lean body mass and aerobic fitness (2000m running time) at the beginning of their freshman and at the end of junior year. Body weight and percent body fat increased significantly in both female and male students. Aerobic fitness decreased significantly in male students. Increases in body weight and fat percentage occurred mainly in initially thin males and females but remained unchanged in initially overweight students. Aerobic fitness decreased significantly in the initially fastest students but improved significantly in the initially slowest students. Findings suggest that the structured PE program and college atmosphere were not sufficient for the upper quartile students to maintain their body weight and fitness level over the three years in college, suggesting that fitness considerations in this population should be addressed more vigorously. **Key words:** COLLEGE, PHYSICAL EDUCATION STUDENTS, AEROBIC FITNESS, BODY FAT.

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INTRODUCTION

Low levels of physical activity and increased caloric intake have been widely implicated as the two main behavioral causes for the rising prevalence of obesity and overweight in Western society (Elder et al., 2007; Fortier et al., 2002; Hastie et al., 2009; Kahan, 2007). The greatest increase in overweight and obesity in the United States has been observed in the population between the ages of 18 to 29 (Mokdad, 1999). Therefore, it seems reasonable to assume that the college student lifestyle may be a key contributor to this increase in those who pursue a higher education. Indeed, data from the National College of Health Assessment (ACHA, 2005) and the College Health Risk Behavior Survey (Douglas et al., 1997; YRBS, 1997) indicate that physical activity and dietary patterns of many college students do not meet the recommendations of health and fitness experts, and that 29.9% of college students are overweight or obese based on self-reported weight values. Whether only the college lifestyle promotes weight gain and poor physical fitness in this age group or if other factors are involved is a controversial issue. Although students must devote many hours to studying and preparing themselves for their future career, they are still young and are expected to possess the drive and the basic fitness requirements for participating in sport and other physical activities.

Only a few studies have assessed weight changes beyond the freshman year in college (Matvienko et al., 2001; Racette et al., 2005). Moreover, these studies looked at changes in body weight and fatness of non-physical education (PE) students, who spend most of their time in college writing and reading theoretical materials. Recently, Racette et al. (Racette et al., 2008) demonstrated in a large study that body weight and BMI of 204 female and male students increased significantly during four years of college, although these changes were highly variable between students. However, it would be interesting to look at these changes in students who focus on physical-oriented areas such as PE, dance, etc. Therefore, the aim of the present study was to characterize changes in body weight, body fat, lean body mass, and aerobic fitness of PE students over a period of three years in college – from the beginning of the freshman year to the end of the junior year.

MATERIAL AND METHODS

Subjects

One hundred and eighty-nine students attending a College for Physical Education and Sport Sciences began the study. Fifteen students dropped out of school during their college years; therefore, data were collected from 174 students (89 females, 85 males, age 21 ± 1.1 yr).

Experimental design

The data were collected in a series of tests on two different occasions, three years apart from each other, both taking place in the summer. The first series of tests was performed in July 2004, about two weeks before the beginning of the college freshman year. This series of tests was conducted as part of the college's preliminary routine in order to classify the freshmen student's physical characteristics and fitness. The second series of tests was conducted three years later, about a month before graduation from the college, at the end of the junior year. This series of tests was required from the students as part of their obligations for the fitness laboratory class taken during that academic year. The study was approved by the Institutional Human Studies Ethical Committee.

During their three years at the college, participants were engaged in a weekly academic program that integrated theoretical lectures delivered in classrooms and field activity classes (basketball, soccer, track and field, swimming, etc.). An average of about 8 hrs of activity classes was performed by each student every week. All the students undertook the same academic program over the three years of college. The participants were not given any special instructions for performing physical activity in their free time, or any dietary recommendations or consultation. Although we did not measure the leisure time physical activity of the participants in the present study, a physical activity profile of the students at this college (unpublished data) indicates that about 80% of them do not perform any physical activity in addition to their academic requirements, about 10% perform occasional additional activity (no more than one hour per week), and about 10% are competitive athletes (team and individual sports).

Measurements

Aerobic fitness was determined by the time attained in a 2000 m run performed on a 400 m lap tartan track. Running was performed in groups of about 20 participants, with similar environmental conditions on both occasions (morning: 8 a.m., temperature: 26-28 °C, wind: 0.1-0.3 m/sec, humidity: 60-65 %). The participants were instructed to avoid any intense physical activity 48 hr before the run. Before each run, participants performed a 20 min standard warm-up (5 min jogging, 10 min stretching, 5 min running drills). Running times were taken by hand using a standard stopwatch and were rounded to the nearest 0.1 sec. Body weight was measured on a balanced scale to the nearest 0.1 kg while the participants were wearing light delete and shorts. Skinfold measurements at four sites (triceps, biceps, sub-scapular, and supra-iliac) were measured in order to calculate percent body fat, using standard equations (Slaughter et al., 1988). Measurements were performed on both occasions by the same experienced technician who was blinded to the prior anthropometric measurements results and to the results of the first 2000 m run. Lean body mass (LBM) was calculated by subtracting body fat weight from total body weight.

Statistical analysis

Repeated measure ANOVA was used to assess the effect of college life on anthropometric measures and fitness, with time serving as the within-group factor and gender as the between-group factor. We also compared differences in body weight, percent body fat, and 2000 m running time *changes* between the baseline upper and lower body weight, percent body fat, and fitness quartiles, respectively. Multi-linear regression analysis was used to determine factors (i.e., baseline levels or changes in body weight, LBM, and percent fat, and baseline fitness level) that contributed to changes in fitness (2000 m running time) in the PE students. Data are presented as means \pm standard error. Statistical significance was set at p value <0.05 .

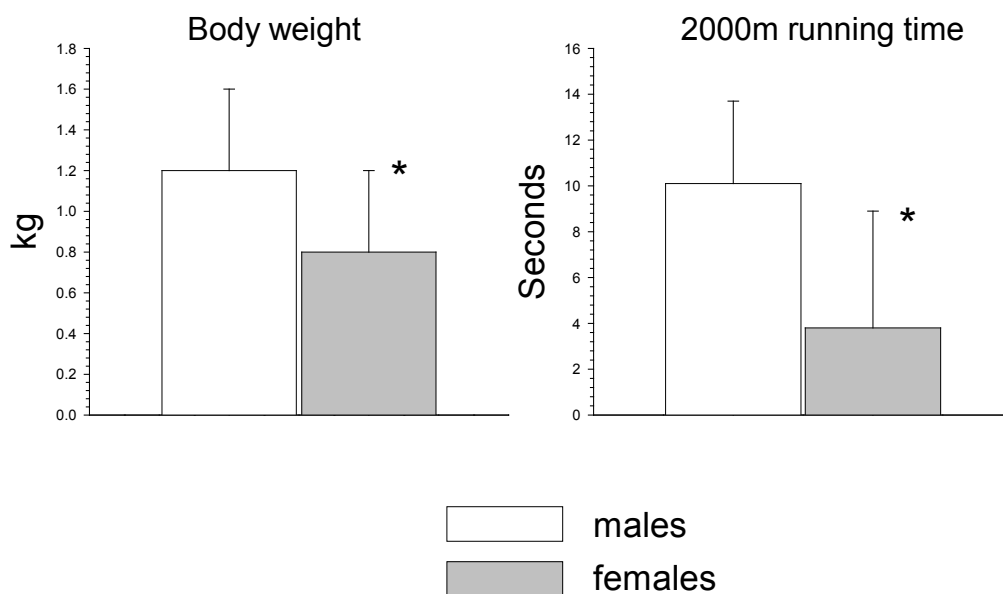
RESULTS

Anthropometric and fitness characteristics of the study participants are summarized in [Table 1](#). There was a significant increase in body weight, body fat, LBM, and 2000 m running time in the male students from the first to the second series of tests. There was a significant increase in body weight and body fat, but not in LBM and 2000 m running time, in the female students during the same time period. Changes in body weight and 2000 m running times were significantly greater in the male compared to the female students (see [Figure 1](#)). Changes in body weight of the PE students during the college years were also compared to changes in body weight of regular (non-PE) college students (results adapted from Racette et al., 2008). While statistical evaluation was not possible, it seems that weight gain during the college years was smaller in both male and female PE students compared to the non-PE students (see [Figure 2](#)).

Table 1. Comparison of body weight, body composition, and 2000m running time in PE students between the freshman year and the end of the junior year (N=174).

	Female Students (n=89)		Male Students (n=85)	
	Pre	Post	Pre	Post
Weight (kg)	57.4±0.7	58.3±0.7*	72.4±1.0	73.9±1.0*
Fat (%)	25.8±0.5	26.6±0.5*	13.2±0.4	14.0±0.4*
LBM (kg)	42.4±0.4	42.6±0.4	62.9±0.8	63.4±0.7*
2000m running time (sec)	647.9±7.6	651.7±8.2	477.2±5.3	487.3±5.2*

Data presented as mean±SEM, *p<0.05, post versus pre results

**Figure 1.** Changes in body weight and 2000 m running time in male and female physical education students during their college years. *p<0.05, males versus females.

We divided the students into quartiles according to their initial 2000 m run results prior to the first year of college. There was a significant decrease in the results of the 2000 m run of both male and female students from the upper quartile (fast runners). In contrast, there was a significant improvement of the 2000 m running times in both male and female students from the lower quartile (slow runners) (see [Figure 3](#); $p < 0.002$).

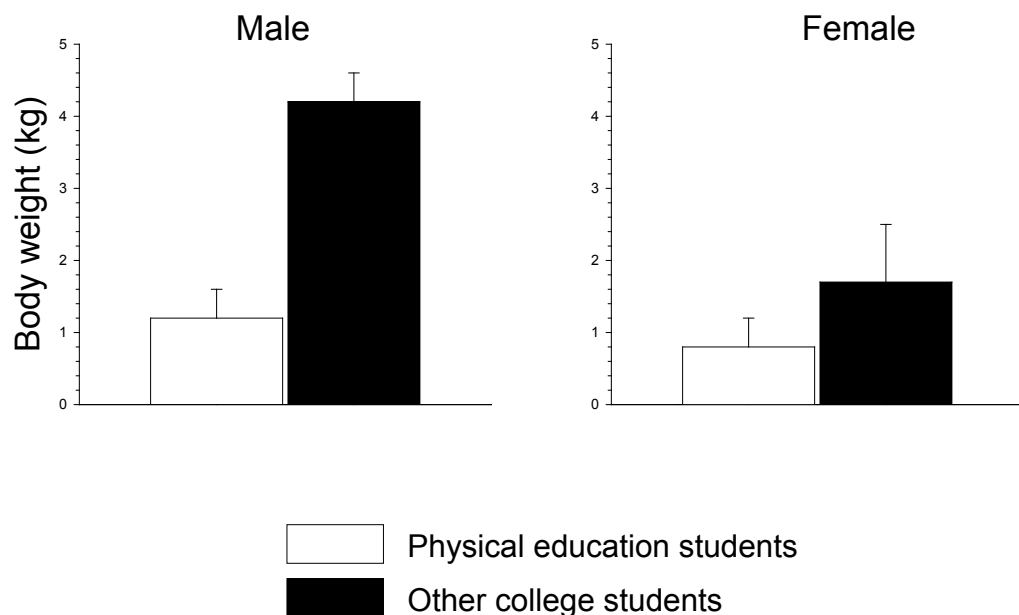


Figure 2. Changes in body weight of male and female physical education students compared to changes in other college students (data adapted from Racette et al., 2008) during their college years.

In addition, we divided the students into quartiles according to their initial body weight and percent body fat. There was a significant increase in body weight among thin male and female students during the college years, while body weight was maintained or slightly reduced in overweight male and female students during that period. There was a significant increase in percent body fat among thin male and female students during the college years, while percent body fat was maintained or reduced in overweight male and female students during that time. Between group (upper versus lower quartile) changes in percent body fat during the college years were significantly greater among the male students (see [Table 2](#)).

Multi-linear regression analysis was performed to determine factors that contributed to the changes in aerobic fitness (2000 m running time) in the PE students. Among the male students, changes in percent body fat accounted for 44.3 % of the change in the 2000 m running time, while change of body weight accounted for 5.7 %, and changes in LBM for 2.8 %. Among the female students, only changes in body fat were found to significantly contribute to changes in the 2000 m running time, accounting for 33.8 % of the change.

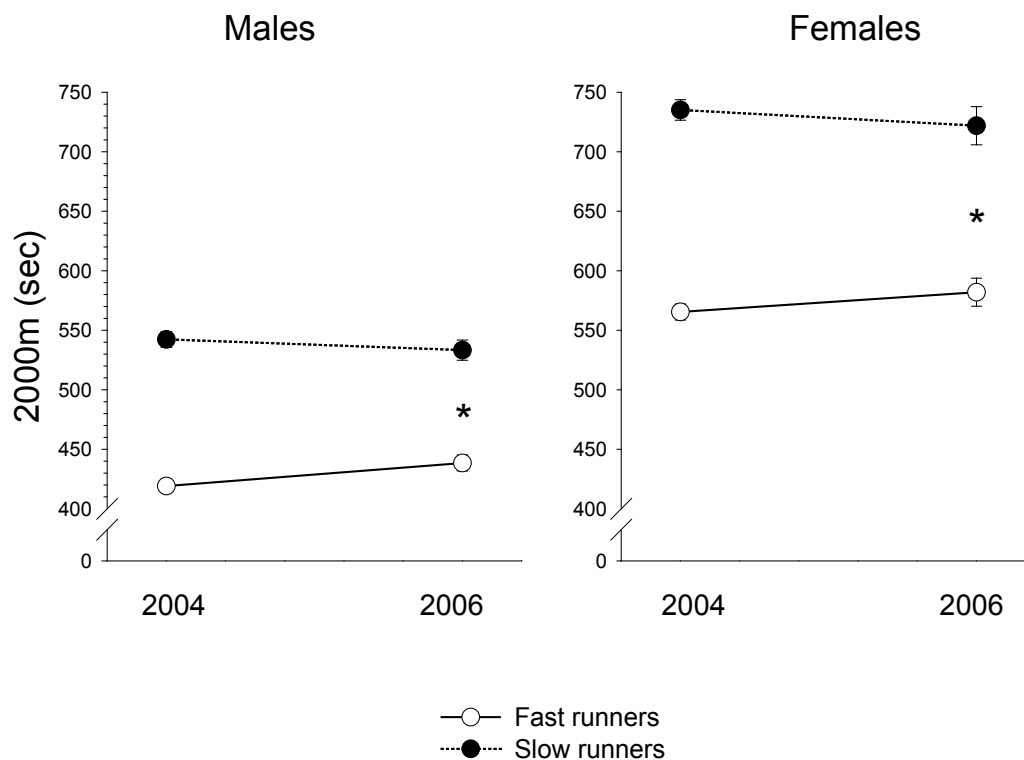


Figure 3. Changes in 2000 m running time during college years among the fastest and slowest male and female students. In both genders fast runners became significantly slower and slow runners became significantly faster during the college years (* $p < 0.002$ for all significant changes).

Table 2. The effect of baseline body weight and baseline percent body fat on changes in body weight and percent body fat in PE student between the freshman year and the end of junior year.

		Body Weight (kg)		Body Fat (%)	
		Pre	Post	Pre	Post
Males	Upper Quartile (n=21)	61.2±0.8	63.9±0.9*	8.9±0.1	10.4±0.5†
	Lower Quartile (n=21)	83.9±1.3	83.4±1.6	18.9±0.6	17.8±0.7
Females	Upper Quartile (n=23)	48.9±0.6	50.3±0.8*	20.0±0.5	22.9±1.0†
	Lower Quartile (n=23)	65.7±0.9	65.1±1.0	30.8±0.6	30.6±0.8

Data presented as mean±SEM

* $P < 0.05$, significant between group change difference (upper vs lower quartile)

† $p < 0.05$, significant greater increase in females compared to males

DISCUSSION AND CONCLUSION

The main findings of the present study are that body weight and percent fat increased significantly in male and female PE students during the three years of college, and that changes in the results of the 2000 m running time indicate a significant decrease in aerobic fitness only in the male students, while female students maintained their aerobic fitness during the three years of college. The significant decrease in aerobic fitness among the males, in contrast to the stability in the females, could be attributed at least partially to the greater increase of body weight in the male compared to the female students (see [Figure 1](#)).

Importantly, however, when dividing the groups into quartiles according to their initial values, it was found that body weight increased significantly mainly among the thin male and female students, but remained unchanged in the overweight males and females during the college years. Similarly, there was a significant increase in percent body fat among the thin male and female students, while percent body fat remained unchanged in the overweight male and female students during that period of time. Consistent with these results, a significant decrease in the results of the 2000 m run was found in male and female students from the upper quartile (fast runners) (see [Figure 3](#)), and the 2000 m running times were improved in the male and female students from the lower quartile (slow runners). Although the present study did not distinguish between the daily physical activity patterns or between the dietary habits of the two subgroups (lower and upper quartile), it seems that over the college years, students from both the upper and lower quartiles tend to lean towards the average (middle quartiles). Overweight and less fit students benefit more from the college lifestyle than thin and fit students. It is possible that the physical obligations and the vigorous and active atmosphere that exists on campus (as a college that specializes in sports and physical activity) encouraged the lower quartile, less fit students to change their lifestyle (physical activity and dietary patterns) into one that better meets the criteria of health and fitness guidelines (ACSM, 1998). As stated earlier, we did not determine the leisure time physical activity of the study participants, however the physical activity profile of our college students (unpublished data) indicate that about 80 % of them do not perform any physical activity in addition to their academic requirements. This suggests that the main cause for the fitness improvement of the lower quartile students was probably due to the college curriculum requirements. On the other hand, the same physical obligations and campus atmosphere, along with the fact that about 10 % of the college students were competitive athletes when they entered the college, were not sufficient for the upper quartile students to maintain their body weight and fitness level over the three years of college.

In order to evaluate the unique effects of attending a physical education college, we compared our results with these of Racette (Racette et al., 2008) which assessed changes in body weight and BMI of regular, non-PE students during four years at a regular college. While statistical evaluation was not possible, the available data suggest that despite the significant increase, weight gain during college years in our study was smaller in both female and male students compared to that of the non-PE students in Racette's study (0.9 versus 1.5 kg and 1.7 versus 4.2 kg for female and male students, respectively) ([Figure 2](#)). It should be noted that while 95 % of the students completed the present study, only 27 % completed the Racette et al study (205 out of 765 students who were assessed as freshmen). The investigators acknowledged that it is possible that students who gained more weight were less likely to return for the second assessment, which could have skewed the results towards an even smaller weight gain than that which actually occurred among the larger sample. In addition, changes in LBM in male and female students in the present study (significant increase in males but not in females, [Table 1](#)) indicate that at least part of the increase in body weight for male students can be attributed to an increase in LBM. Since Racette (Racette et al., 2008) did not measure body composition, changes in LBM values could not be calculated in their study. However,

similar to our findings, the increase in total body weight was higher among the male compared to the female students in their study.

The differences in weight changes between the two studies can be attributed at least partially to the differences in the students' activity patterns. While all the PE students were engaged in a fixed 8 hrs of activity classes per week, about one-third of the non-PE students failed to meet the recommended activity guidelines in the Racette (Racette et al., 2008) study, which reflects activity patterns in college students in the USA (ACHA, 2005). Although Racette et al found that 59 % of the non-PE freshmen students were regularly engaged in aerobic exercise, other investigators showed that only about 25 % of adults in the USA fulfill the recommended levels of physical activity (Pinto et al., 1998; CDCP, 2001), indicating that physical activity patterns decline for most individuals during college and following graduation. Interestingly, very few studies have examined patterns of physical activity, fitness, and health of PE teachers compared to the general population, or of changes in this pattern over the years. Pihl (Pihl et al., 2002) reported that the majority of PE teachers maintained a physically active lifestyle during their leisure time and had a significantly lower adjusted risk for overweight, hypertension, and musculoskeletal disorders compared to sedentary workers. Consistent with this, Misigoj-Durakovic et al. (2004) found that PE teachers (particularly females) had significantly higher levels of sport and leisure time activity, and a lower risk for obesity, hypertension, hypercholesterolemia, and cardiovascular disease compared to the average adult working population.

The importance of body fat to aerobic fitness was demonstrated in our study by the results of a multi-linear regression analysis, which showed that changes in percent body fat accounted for 44.3 % and 33.8 % of the changes in the aerobic fitness for the male and female students, respectively. Similar findings were found in another study for college female and male non-PE students (Tremblay and Chiasson, 2002). In comparison, other possible factors (e.g., total body weight and LBM) made a very small contribution to the fitness changes in the present study. These findings are supported by the low percent body fat that is usually found among endurance-type athletes (Jones and Carter, 2000).

In summary, body weight and body fat percentage increased significantly, although modestly, among PE students during three years of college. In addition, aerobic fitness decreased significantly among the male students. The weight gain of the PE students in the present study was smaller than the weight gain of non-PE students (Racette et al., 2008) during college years. The differences in physical activity patterns between the two types of students (PE versus non-PE) may have long term effects on fitness status, body weight, and health, emphasizing the importance of a healthy lifestyle - in particular increased physical activity - for all types of college students. The selective significant positive improvement in weight and aerobic fitness of the lower quartile over the upper quartile of students suggests that the demands of college PE activities, and possibly the college atmosphere, positively influence the individual behavioral habits of mainly the overweight and lower fitness level students. The structured PE program and college atmosphere were not sufficient for the upper quartile students to maintain their body weight and fitness level over the three years in college, suggesting that fitness considerations in this unique population should be addressed more vigorously.

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