Association of Weekly Strength Exercise Frequency and Academic Performance Among Students at a Large University in the United States

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Abstract

Keating, XD, Castelli, D, and Ayers, SF. Association of weekly strength exercise frequency and academic performance among students at a large university in the United States. *J Strength Cond Res* 27(7): 1988–1993, 2013—The study aimed to examine (a) the association between weekly strength exercise frequency and grade point average (GPA), and (b) the demographic characteristics of weekly strength exercise frequency among undergraduate students at a large southern state university in the United States. Health behavior data ($N = 1125$) collected by the American College Health Association at the university in 2008 were analyzed. Analysis of variance was used to investigate weekly strength exercise frequency differences in GPA, sex, ethnicity, and year in university. The results revealed that those who more frequently engaged in strength exercise had significantly higher GPA. There was a significant difference in weekly strength exercise frequency by sex and ethnicity. Findings suggest that regular engagement in strength exercise may not only have physical health benefits but is also associated with academic achievement in high education. There is a need to further investigate the mechanism of strength exercise on GPA among university students.

Key Words university students, GPA, resistance exercise

Introduction

Research has indicated that many lifestyle-related health problems can be prevented by simply increasing physical activity (PA) levels (22,36). The health benefits of both PA intensity (i.e. low vs. high) and type (i.e. aerobic vs. muscular strength) have been widely documented. Some researchers have suggested that low to moderate intensity PA can generate health benefits (11,16,26,28) and improved cognitive performance (5,10,13). Regarding PA type, the importance and benefits of aerobic PA are well documented (20,21,32). Resistance or strength exercises, such as using body weight, free weights, or machines to increase workload, have also been viewed as a safe and effective means of preserving muscle mass, strength, and stability for all ages (11,16,38,39). Because of the scientific evidence related to the benefits of strength exercise on health, the awareness of promoting strength exercise from public health groups has arisen. For example, with the support of American College of Sports Medicine and the American Health Association (4), the USDHHS has recommended that adults should engage in strength exercise that involves all major muscle groups for at least 3 days each week (36). As a result, it is reasonable to believe that the above strength exercise recommendation suggests how adults can maintain sound health and lessen the risk of chronic disease and premature death partly through engaging in strength exercise on a regular basis (8,14).

In addition to the recognition of the physical benefits of muscular strength exercise, emergent literature has begun to provide empirical evidence that PA positively influences cognitive performance in older adults (5,10,28,38), young adults (23,26), and children (6,20,21,38). The underlying assumption is that cognition is usually defined as the ability to acquire and process information and the ability to adaptat to changing situations (39), which is important to all individuals regardless of age. Interestingly, the relationship between strength exercise and cognition among college-age young adults has not been investigated thoroughly. This may be due to the relative stability and optimal cognitive performance in young adulthood after the rapid cognitive development in childhood (36,39). Another reason might be that this line of research is understudied because the cognitive decline from aging does not begin until the third decade of life (39). Furthermore, our knowledge regarding university student participation in strength exercise on a regular basis and demographic variable differences in student strength exercise is also limited as little research has been reported in the literature. To date, a study on adults' strength

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exercise indicated that 21.9% of men and 17.5% of women were strength training 2 or more times weekly in 2004 (7), even though a handful of previous studies have found that strength exercise is beneficial to both male and female students (13,15). In addition, strength exercise is a form of PA that has been historically avoided by female students (15,33). Furthermore, no data are available to quantify sex differences in university student strength exercise engagement. In terms of the strength exercise participation by ethnicity, surprisingly, few studies on the topic have been published. Studies on university student's PA in general, however, indicated that whites had more PA than other ethnic groups with Asians having the least amount of PA (24).

Given that higher education students are being trained as future professionals, they need to master tremendous amount of knowledge and skills. Thus, student cognitive abilities play a critical role in their academic learning, which is generally measured by GPA–a measure of academic success while pursuant of that degree (34). Logically, the relationship of strength exercise and student GPA is of concern for higher education (25,35). However, there is a paucity of research examining the relationship between the 2 factors among university students. Knowledge on the topic would enrich our understanding about the relationship of strength exercise on a higher level of cognition, which requires short-term and long-term memory and creativity. It might shed light on our knowledge about the association of strength exercise and young adult cognition in general and university students in particular, which may lend further credence to the need for comprehensive PA programs including regular strength exercise on college campuses. Moreover, knowledge regarding university student's participation in strength exercise by sex and ethnicity would help us understand whether there are demographic disparities in participation and profile the subgroups by sex and ethnicity that need more help with strength exercise involvement. This information would enrich our understanding about university student's strength exercise patterns and provide baseline data for future effective interventions. Knowledge about student strength exercise changes by year in university could be used to document how student strength exercise involvement is affected by their tenure in higher education. As such, this study builds on the current body of research on the topic by addressing the following research questions: (a) what is the relationship among university students' weekly strength exercise frequency and their GPA? (b) what are the demographic characteristics (i.e. sex, ethnicity, and year in university) related to university students' weekly strength exercise frequency? Based on previous research findings on the topic, we developed the following hypotheses: hypothesis 1–weekly strength exercise frequency would be positively correlated with student GPA; hypothesis 2–student participation in strength exercise increases as students' year in the university passes; hypothesis 3–male students would be more involved in weekly strength exercise than their female counterparts; and hypothesis 4–there is a significant weekly strength exercise frequency difference by ethnicity. It is hoped that the results of the study will stimulate more studies on the topic in the future.

Methods

Experimental Approach to the Problem

A secondary analysis of data collected by the American College Health Association in 2008 (3) was conducted. The study utilized a retrospective nonexperimental research design to examine the association of weekly strength exercise frequency and GPA and to investigate strength exercise participation differences by sex and ethnicity. To address the research questions, weekly strength training frequency was measured by the number of self-reported weekly days of strength exercise (i.e. the number of days participated in muscular strength exercise for at least 30 minutes each week). No information about the intensity of strength exercise was available, however. Students were asked to report their overall GPA by choosing 1 of the 4 options (i.e. A, B, C, and D/F). However, there were only 17 participants reporting a GPA of D/F and could not generate meaningful statistical results. Thus, the GPA D/F group was combined with the GPA C group. The demographic variables included sex, ethnicity, and year in the university. Although age has been commonly examined, this variable was excluded from the analysis because of its small variation ($SD = 4.8$).

Subjects

The Institutional Review Board affiliated with the lead author determined that the analysis of the secondary survey dataset utilized in this research study satisfactorily met the exemption criteria. As a result, no human subject committee approval was needed for the use of these existing data. Data from 1125 university students were used for this study, 61.5% of them were female. The sample was similar to the university population consisting of whites (57.0%), Asians (20.5%), and Latinos (17.2%). All participants were undergraduate students without professional strength training background. In addition, 95.1% of participants were full-time students. The percentages for first through fifth and more year students were 26.4%, 11.5%, 16.7%, 16.1%, and 29.3%, respectively. The average age of the sample was 22.21 ($SD = 4.82$).

Procedures

In this study, data were part of the large data set collected by American College Health Association (ACHA) and National College Health Assessment (NCHA) using an online self-reported survey in 2008 (3). ACHA-NCHA data have been collected nationwide for a decade in an attempt to help universities gain information concerning student health-related behaviors (1–3). The reliability and validity of the survey were tested and were acceptable. Specific information regarding the reliability and validity of the survey was reported elsewhere (1,2). All students at a large southern state university had an equal opportunity to participate in the study voluntarily. The

research design was cross sectional in nature. Referring ACHA (3) will provide detailed information concerning the survey and standardized data collection procedures.

Campus Characteristics. Information concerning the campus setting is important for readers to understand the study completely. There are about 50,000 students annually at the university with free bus services for the students on the edge of campus and the greater community regularly. Block scheduling (i.e. 1.5 or 3 hours) was used for most undergraduate courses with about 15 minutes break time in between. All on-campus exercise equipment and facilities are free for full-time students including 2 large student recreational centers and a number of outdoor exercise facilities (i.e. jogging trails, basketball courts, tennis courts, etc.). The university does not have any required health education and/or physical education courses, but a number of elective PA courses are available in the university curriculum. The university is located where the weather is pleasant for outdoor activities most of the year except when it is excessively hot in the summer.

Statistical Analyses. Data screening was performed before any data analyses were conducted. Cases with more than 50% missing data were deleted. The categorical variables were sex, ethnicity, years in university, and GPA. The descriptive analyses (i.e. frequency) of these variables were conducted first. One-way analysis of variance (ANOVA) was performed to examine hypotheses 1 and 2–GPA differences among strength exercise frequency and year in university, respectively. Hypotheses 3 and 4 were tested by a factorial ANOVA to examine weekly strength exercise frequency differences by sex and ethnicity and the interaction between sex and ethnicity. For significant ANOVA tests, post hoc pairwise comparisons with Bonferroni correction were used to assess specific differences. Effect sizes were also computed for significant results. The cutoff values of effect size for the F statistics were measured by partial eta squared (i.e. η^2). Values for small, medium, and large η^2 were 0.01, 0.09, and 0.25, respectively (30). Significance was set a priori at a p value of less than 0.05. All analyses were completed using SPSS 18.0.

Results

Weekly strength exercise frequency and GPA. The results of one-way ANOVA revealed that there were significant differences in weekly strength exercise frequency by self-reported GPA [$F_{(2, 1124)} = 7.89, p < .001$]. The post hoc test indicated the strength exercise differences between GPAs A and B ($p < 0.05$), GPAs A and C ($p < 0.01$), and GPAs B and C ($p < 0.05$) were significant. The effect size was small (i.e. $\eta^2 = 0.01$) (Table 1).

Weekly strength exercise frequency differences by year in university, sex, and ethnicity. The one-way ANOVA (year in university) indicated that the weekly strength exercise frequency differences by year in university was significant [$F_{(4, 1119)} = 3.84, p < 0.01$] with a large effect size ($\eta^2 = 0.26$).

Table 1. Weekly strength exercise frequency days by *GPA.

Categories	*N*	Mean (*SD*)
GPA		
A	579	3.52 (1.88)†‡
B	415	3.26 (1.92)†‡§
C/D/F	131	2.81 (1.92)‡§

*GPA, grade point average.
†The difference between the 2 groups is significant at $p < 0.05$.
‡The difference between the 2 groups is significant at $p < 0.01$.
§The difference between the 2 groups is significant at $p < 0.05$.

The post hoc test revealed that both first-year and second-year students had significantly fewer days of strength exercise than the fifth-year and above students ($p < 0.001$) while frequency differences among other groups were not significant (Table 2).

The 2 (sex) by 4 (ethnicity) two-way ANOVA results indicated that weekly strength exercise frequency difference was significant [$F_{(7, 1119)} = 3.60, p < 0.01$] with a small effect size ($\eta^2 = 0.02$). The difference was attributed to ethnicity

Table 2. Means (*SD*) of weekly strength exercise frequency by year in university, sex, and ethnicity.

	N	Mean (*SD*)
Year in university		
First	294	3.15 (1.79)*
Second	129	3.04 (1.96)†
Third	188	3.34 (1.89)
Fourth	181	3.41 (1.92)
Fifth and more	328	3.66 (1.96)*†
Sex		
Female	688	3.15 (0.10)
Male	432	3.41 (0.13)
Ethnicity		
White	637	3.59 (0.08)‡§
Latinos	194	3.31 (0.14)‖
Asian	230	2.90 (0.13)‡§‖
Other	59	3.32 (0.25)§

*Indicates that the difference between the 2 groups was significant at $p < 0.01$.
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‖Indicates that the difference between the 2 groups was significant at $p < 0.05$.

[$F_{(3,\ 1119)} = 7.29$, $p < 0.01$] and the effect size was also small ($\eta^2 = 0.02$), whereas no significant weekly strength exercise frequency difference by sex was found. The interaction between sex and ethnicity was also not significant. The post hoc test for weekly strength exercise frequency differences in ethnicity suggested that whites and Latinos participated in significantly more days per week of strength exercise than the Asian group, with whites participating in the greatest number of days for strength exercise among all 4 ethnic groups.

Discussion

Strength exercise has been widely explored as a means for maintaining health such as weight control and aging (5,11,28). As a result, the contribution of strength exercise to college students' physical health is better understood than our knowledge concerning its relationship with cognitive health, as represented by GPA in the current study. The contributions of this study to the knowledge base are twofold as follows: (a) the positive relationship between the number of strength exercise sessions per week and GPA might provide a rationale for further investigating the mechanism of strength exercise engagement on university student's academic performance measured by GPA; and (b) the special attributes of student strength exercise by demographic variables are important for future interventions regarding university student strength exercise involvement. Given that a strong correlation can lead researchers to examine the possibility of a causal relation in follow-up studies, the relationship between strength exercise and GPA warrants more attention of professionals in our field.

Although a positive relationship of PA and GPA has been reported in the literature, most of the studies were conducted with children (6,9,20,23). Similar to the early research in children, this study provided preliminary confirmation of associations between the frequency of strength exercise and GPA. Specifically, for the first time in the literature, the result of the study supported the hypothesis 1 that those individuals who engaged in a higher frequency of weekly strength exercise were more likely to have a higher GPA among university students. Further research is needed to isolate the directionality of this relationship. Unfortunately, existent research has focused on the acute effects of strength training (32) with few studies examining college student strength exercise and their GPA (35). No studies have examined the mechanism of strength exercise on improving university student GPA. Due to the correlational nature of this study, caution needs to be exercised when generalizing these results. Furthermore, the percentage of students with a self-reported GPA of A/B was high (88.4%), which might have skewed the results. On the other hand, the disproportional distribution of GPAs for A, B, and C/D/F might be true as the university uses criterion-referenced grading scale causing a skewed distribution of GPAs. More experimental studies on the topic are needed to examine the causal effects of strength exercise on GPA among university students.

Given that ACHA has attempted to increase university student's PA for more than a decade (24), it is important to track student's PA changes during their time in higher education so that ACHA can monitor the effects of PA interventions implemented on campus, if any (24). Tracking student's PA changes can also provide universities with the information needed for early identification of students who are in need of effective interventions (12,18,31). Although the data in this study are cross sectional, the result of the weekly strength exercise frequency change by year in university can still provide fundamental information concerning student strength exercise pattern changes when they are at the university.

The data from the study partly supported the hypothesis 2 that student participation in strength exercise increases as students' year in the university passes given that there was a nonsignificant difference in weekly strength exercise frequency in the first 4 years in the university. This result is surprising as the data might suggest that the university was not able to help students increase their weekly strength exercise frequency, even though the ACHA has been actively promoting PA, which includes strength exercise on campus for more than 2 decades (24). Researchers have noted that earlier the PA intervention the better the health benefits (27). Therefore, there is a need to promote strength exercise as early as possible at the university. On the other hand, it is important to note that student weekly strength exercise frequency at the fifth-year and above years was significantly higher than the other groups, suggesting that it is possible for university students to increase the frequency of their strength exercise. It remains unknown, however, why the fifth-year and above years group significantly increased their engagement in strength exercise. They might be different from other undergraduate students because they have been at the university longer than the other groups.

Sex differences in PA have been presented in the literature (24,29). It is critical to investigate university student strength exercise difference by sex, as engagement in such activity becomes a matter of choice for the first time in their lives. Information about sex differences in strength exercise might guide future interventions concerning strength exercise. No significant sex difference in weekly strength exercise frequency was found in this study, indicating that both female and male students engaged in a similar frequency of strength exercise. This result did not support our hypothesis 3. However, previous studies on strength exercise differences in sex suggested that females participated in less strength exercise than their male counterparts (17). Moreover, females have been reported to avoid strength exercise even though it is especially beneficial to specific aspects of their physical health (i.e. bone density, reducing of stress, etc.) (37). The primary reason for the aforementioned sex differences resulted from the body image ideologies for different sex as females need to be skinny to be perceived as beautiful, whereas males need to have bulky muscles to be masculine (19,26,37). As a result, males in general, and young adult males in particular, took part in more

strength exercise to gain muscle mass. To our knowledge, however, the present study is the first to report a nonsignificant strength exercise frequency difference by sex among young university students. Research on the topic warrants more attention by professionals in the strength and conditioning field. In addition, it is important to point out that strength exercise consists of FIT (i.e. frequency, intensity, and time). As noted earlier, the data related to strength exercise intensity were not included in the ACHA-NCHA survey. Thus, it is impossible for this study to comprehensively examine strength exercise differences between male and female students.

Ethnicity produced significant differences in strength exercise frequency. In line with results for PA by ethnicity in general (24,29), the data from the present study supported our hypothesis 4 that whites engaged more number of days per week in strength exercise compared with all ethnic groups. Asians in this study reported engaging fewer days per week in strength exercise, which is also in line with previous studies concerning student's general PA (24). Although it is not the focus of the study to examine why Asians had the fewest number of days participating in weekly strength exercise, this finding warrants more attention by strength exercise professionals. To date, studies on Asian student strength exercise involvement are rare, resulting in our limited knowledge about it. In general, previous research on the topic has attributed the above discrepancy to the Asian culture. Studies have suggested that Asian parents do not value their children's engagement in sports and PA, particularly for females (29). However, Hanson (19) noted that Asian women had their own PA preferences, although strength exercise was not preferred. In essence, this result is important as it suggests the need for effective interventions capable of improving this situation. Similar to that for PA promotion, the strength exercise discrepancy among the ethnic groups found by this study lends further credence to suggest a particular need to promote strength exercise among underserved groups. It is also critical to note that attempts to promote strength exercise among specific ethnic groups may yield both academic and social dividends given that the data from this study suggest a positive relationship between the frequency of strength exercise per week and GPA.

Like any research using self-reported data, the accuracy of weekly strength exercise frequency data needs to be verified by objective measures. The data reported in this study might overestimate student weekly strength exercise frequency due to the possible pressure to give socially desirable responses. In addition, the cross-sectional data collection may accurately describe patterns of association but not causality. Thus, an analysis of the association is only a stepping off point to ascertain whether strength exercise participation has the potential to influence student GPA. The study cannot, however, answer the mechanism of strength exercise influencing student cognition directly. As widely known, student GPA and strength exercise are influenced by factors too numerous to be controlled in a single experimental study. Future studies including genetic, demographic, psychosocial, and environmental variables are needed. In addition, the impact of student major on weekly strength exercise frequency was not controlled due to the lack of such data, limiting the ability to explore the specific effects of strength exercise on different types of academic performance such as natural or social sciences that require different kinds of cognition. Caution needs to be applied when generalizing the results of this study.

Practical Applications

Although it is premature to propose that promoting strength exercise can help improve student GPA, the positive association between the number of days of weekly strength exercise and GPA suggests that there is a need to examine the causal relationship between strength exercise and GPA. Furthermore, strength exercise practitioners can use the results of this study that females and underserved ethnic students had the lowest number of weekly strength exercise bouts to provide the rationale for interventions on campus. Finally, the results from the study can help professionals in the fields of strength and conditioning and preventive medicine understand that special interventions are urgently needed to promote strength exercise among university students given that student weekly strength exercise engagement was not increased at the first 4 years in higher education. In essence, research has noted that any changes made at this stage of life are likely to be kept for a long time (27). Thus, every effort is needed to improve student strength exercise in higher education.

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