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Physical Activity and Stress Between American Students and Asian International Students at the University of South Carolina

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Dedication

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Abstract

Many college students are physically inactive and have high levels of stress, and this may be worse among increasing number of international students studying in the US. This study investigated the relationship between physical activity and stress among American students (n=92) and Asian international students (n=64). The Mann-Whitney test was used to compare MET minutes/week from the International Physical Activity Questionnaire short form between those two groups. The independent-samples t test compared the mean of stress from the Perceived Stress Scale between those two groups. Chi-square test was used to compare the percentage of Asian international students and American students who met WHO physical activity guidelines. Multiple regression was used to examine the association between physical activity and stress levels among American students and Asian international students. Asian international students were older (27.5 ± 5.0 yrs) than American students (24.4 ± 5.9 yrs) ($p<.001$). American students had a higher BMI (23.9 ± 4.7) than Asian international students (22.4 ± 3.0) ($p=.014$). The median activity levels of American students (3273.5 MET-minutes per week) was significantly higher than Asian international students (1511 MET-minutes per week) ($Z=-4.668$, $p <.001$). More American students (73.2%) met the WHO physical activity guidelines than that of Asian international students (43.4%) ($\chi2=13.756$, $p=.001$). American students had higher stress levels (19.8 ± 5.4) than that of Asian international students (16.6 ± 4.8) ($p=.001$). There was not a linear association between stress levels

and physical activity levels. In general, Asian international students were relatively less physically active compared to American students, but American students were more stressed. Future studies need to identify the causes of physical inactivity in Asian international students and higher stress levels in American students, so tailored interventions can be implemented to help them meet physical activity guidelines and relieve stress. This can promote a life-long physical activity lifestyle for Asian international students and may also help them reduce their risk of chronic disease later in life.

Keywords: American students; Asian students; college students; physical activity; stress

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Chapter 1: Introduction

In recent years, due to globalization, science, and technology, more and more students have studied abroad in various countries, especially in the United States. There are 27 colleges in the United States among the top 50 universities in the world[1]. Because the United States has high-quality education, it has become one of the most popular countries for international students. Between 2009 and 2010, approximately 691,000 international students entered the United States to study.[1] The number of international students enrolled in the U.S. increased by 59% to approximately 1.1 million from 2009-2010 to 2019-2020.[1] One reason is that the government used to encourage the acceptance of international students to study in the U.S., because they can bring a lot of money into the local economy and provide needed help, such as low-paid teaching and research assistantships.[2]

Many international students choose to enroll at the University of South Carolina (UofSC). In the past 5 years, the number of international students at UofSC has increased almost every year.[3] Due to the pandemic, fewer international students enrolled at UofSC in the fall of 2020 (n=1,321), but the number of international students has increased almost every year in the past 5 years from 1,445 in 2015 to 1,829 in 2019. While the global pandemic is being managed, people's lives are gradually returning to normal. The number of international students increased in 2021 (n=1540).[4] All Asian students account for 65% of the total international students.[4]

International students could have some health risks. Among international students, those who have lived in the U.S. for more than 2 years have higher levels of acculturative stress compared with other international students who have lived in the U.S. for less than 2 years.[5] Individuals with low levels of cultural adaptation are at risk of diseases and worse health behavior, such as intaking more saturated fat or less exercise.[6] After international students arrive in the United States, overall health is different, showing a downward trend, and nearly half of international students gain weight after arriving in the United States.[7] Furthermore, first-year international students spend less time on relaxation and socialization than American students, which could lead to stress.[8,9] Female international students see particularly poor effects; although there is no significant difference in overall health between international male and female students before arriving in the U.S, after living in the U.S, international female students have worse overall health than male students.[7] Other studies found that international students spent less time exercising than native students in the U.S., and the level of participation in physical activity for Asian and African international students is often lower than that of students from the U.S.[10,11] International college students spend an average of 3.4 hours per week on sports activities, and female international students spend significantly less time on physical activity than male international students.[11] In terms of student origin, students from Asian and African countries spend substantially less time participating in physical activity than students from other countries.[11]

The World Health Organization (WHO) physical activity guidelines provide recommendations for exercise volume and intensity for adults aged 18 to 64, including college-aged students. Adults are encouraged to do at least 150 minutes of moderate-

intensity aerobic exercise, at least 75 minutes of vigorous-intensity aerobic exercise, or an equivalent of a combination of moderate and vigorous-intensity physical activity every week.[12] It is also recommended that adults do 2 days or more a week of moderate or greater intensity muscle-strengthening activities, including all major muscle groups.[12] Adults gain additional health benefits by doing more physical activity and spending less time in sedentary behavior.[13]

Individuals who meet physical activity guidelines are at lower risk of developing chronic diseases such as diabetes, cardiovascular disease, and cancer.[14] However, more than a quarter of adults were not physically active in 2016, and women were less active than men.[15] Globally, most college students do not exercise for at least 75 minutes of moderate-intensity aerobic exercise every week, and approximately one-third of adults have multiple chronic diseases.[16,17] 22% of college students are overweight or obese in 22 countries.[18] The American College Health Association Student Health Survey (2014) shows that 35% of college students were overweight or obese according to CDC standards, and individuals who experience obesity early in their adult life have a higher risk of developing cardiovascular disease.[19] In addition, a higher body mass index (BMI) is associated with lower levels of physical activity.[20] Therefore, physical activity can also help manage weight, which may also help lower the long-term risk of cardiovascular disease among college students. Moreover, people who engage in infrequent physical activity are more likely to smoke, but participating in physical activity may help reduce negative stress and smoking.[21,22]

Although physical activity is good for physical and mental health, many students struggle to prioritize exercise. As a result, mental health may be jeopardized. Physical

activity can help to prevent the risk of depression and reduce stress.[19,23] However, an outbreak of COVID-19 in recent years has reduced people's physical activity and has had a large impact on people's mental health. To control the epidemic, stay-at-home orders and the closure of sports venues have reduced people's physical activity.[24] College students may have been fearful of COVID-19 in the U.S., which affects their stress and anxiety levels, and depressive symptoms.[25–27] According to the American College Health Association-National College Health Assessment (Fall 2020), 23.8% of college students suffer from moderate psychological distress, and 25.1% of undergraduate students and 14.8% of graduate students suffer from serious psychological distress.[28,29] However, even before the pandemic, American college students were facing multiple pressures in their lives.[30] Asian international students reported higher rates of serious depressive symptoms (i.e., self-injury, considering suicide, and suicidal attempts) than American students and other international students from different countries. They also tend to report more depressive symptoms they cannot resolve independently, but they have fewer help-seeking intentions in mental health than American students.[31] International students have more stressors because they need to adapt to different cultures and overcome language barriers.[32] People with mental health issues, such as anxiety and depression, are less likely to engage in physical activity.[33]

This paper therefore sets out to improve our understanding of the relationship between physical activity levels and stress levels among Asian international students in the United States. Some research has shown that Asian international students have lower levels of physical activity than American students; however, there is no research explicitly comparing the physical activity levels of Asian international students and

American students at UofSC or universities in South Carolina.[11] This study had four purposes. The primary purpose of this pilot study was to compare the physical activity levels (MET minutes per week) between American students and Asian international students aged 18 and older, and to compare the percentage of students who met the WHO Physical Activity Guidelines between Asian international students to American students aged 18 and older. We hypothesized that Asian international students had lower activity levels (MET minutes per week) and a lower percentage who met the WHO Guidelines compared to American students. The second purpose of this study was to compare the mean stress levels [Perceived Stress Scale (PSS-10) scores)] between American students and Asian international students. Our hypothesis was that Asian international students had higher stress levels (PSS-10 scores) compared to American students. The third goal was to determine whether students' physical activity levels (primary predictor) could predict their stress levels (outcome), controlling their demographics (i.e., age, BMI, sex, graduate students, smoking status, years in the U.S. for Asian international students, and students who met WHO physical activity guidelines) between American students and Asian international students. It was hypothesized that there was a negative association between stress levels and physical activity levels, controlling for other covariates. Finally, this study determined whether Asian or American students moderated the association between physical activity levels (primary predictor) and stress levels (outcome). Our hypothesis was that Asian international students had a stronger negative association between stress levels and physical activity levels compared to American students. The findings determined if it was necessary to intervene and increase physical activity for either or both Asian international students and American students.

Interventions would be designed for those students who had lower levels (MET minutes per week) of physical activity, students who had lower percentages below the WHO physical activity guidelines, and higher stress levels to reduce smoking and reduce the risk of chronic diseases in the future. College is a transition period for many students before they enter the workforce. If we could promote physical activity in these inactive college students, we might help them develop lifelong exercise habits and reduce their chances of chronic diseases after they graduate from college.

Chapter 2: Method

2.1. Participants/Recruitment

This study intended to survey students at UofSC who were full-time and 18 years and older, specifically American students and Asian international students were. This study defines ‘American students’ as those who were born and grew up in the U.S. and defines ‘Asian international students’ as those who were born in Asia and have the nationality of an Asian country, but are students at UofSC. The researcher recruited candidates through flyers, emails, social media platforms, campus events, online postings, and bulletin boards.

2.2. Procedures

Data collection was conducted in the spring semester of 2022 and collegiate athletes at UofSC were excluded. All participants filled out a questionnaire by scanning a QR code or online. Participants had enough time to complete the questionnaire. Before answering the questionnaire, students read the instructions for filling out the questionnaire. The instructions included the purpose of the questionnaire collection and a clarification that the questionnaire was anonymous.

2.3. Measures

2.3.1. Demographics

This questionnaire asked for the students' nationality (e.g., the U.S. or an Asian country), sex (e.g., female and male), age, smoking status (e.g., cigars, cigarettes, smokeless tobacco, and electronic cigarettes), height, weight, and whether they were a collegiate athlete. Asian international students were asked how long they stayed in the U.S. (years).

2.3.2. International Physical Activity Questionnaire short form (IPAQ-SF)

An International Physical Activity Questionnaire short form (IPAQ-SF) was used in the English version.[34] It is a self-reported physical activity that was used for the past seven days and was given to adults aged 18 to 69. The validity and reliability of the English version of the IPAQ-SF was tested.[34] The IPAQ-SF can also be used to compare the level of physical activity among international populations. The survey assesses the number of days of physical activity per week, amount of physical activity per day, and what kind of physical activity was engaged in (e.g., light-intensity activities, moderate-intensity activities and vigorous-intensity activities).[35]

Each activity is converted into the metabolic equivalent of task (MET) and then combined with the amount of exercise (mins/day, days/week) to get the total METs value (MET-minutes/week). Activities are only counted when they exceed 10 minutes. Walking, moderate, and vigorous exercise expends 3.3 METs, 4.0 METs, and 8.0 METs, respectively. For the last 7 days, the formula for walking was 3.3 METs × mins/day × days/week; the formula for doing moderate activity was 4 METs × mins/day × days/week; the formula for doing vigorous activity was 8 METs × mins/day × days/week. The weekly METs are the sum of the total walking METs, the total moderate METs, and

the total vigorous METs. In this way, we can estimate the weekly METs value to evaluate the participants' physical activity levels.[36]

Through the IPAQ-SF, we can clearly know whether the participant has achieved the weekly physical activity volumes recommended by the WHO physical activity guidelines. If the participant does at least 150 minutes of moderate-intensity aerobic activity every week, or at least 75 minutes of vigorous-intensity aerobic activity every week, the participant has reached the recommended aerobic physical activity guidelines.[13]

2.3.3 Body mass index (BMI)

Self-reported height (cm) and weight (kg) from participants were collected to calculate BMI (kg/m^2).[36] BMI rounded to one decimal place.

2.3.4 Perceived Stress Scale, 10-item version (PPS-10)

PPS-10 was used to measure students' stress in their daily lives. The validity and reliability of PPS-10 were tested and found to be acceptable.[37,38] This questionnaire has 10 questions. Each question has 5 possible responses (e.g., never = 0, almost never = 1, sometimes = 2, fairly often = 3, and very often = 4). Four of the questions (4, 5, 7, and 8) with positive connotations are reversely scored (e.g., never = 4, almost never = 3, sometimes = 2, fairly often = 1, and very often = 0).[39] The values of the individual's responses will be totaled. Those totals will be categorized as follows: 0 - 13 (low-stress), 14 - 26 (moderate stress), and 27 - 40 (high stress).[40]

Chapter 3: Data Analysis

This study used SPSS (version 24) for all data analysis. The demographic data recorded includes nationality, sex, age, years spent in the U.S. (for Asian international students), smoking status (i.e., cigars, cigarettes, smokeless tobacco, and electronic cigarettes), height, and weight, and excludes collegiate athletes. This study reported the mean, standard deviation, median and interquartile range, frequency of demographic characteristics, and the percentage of American students and Asian international students who met the WHO guidelines for physical activity aged 18 and older at UofSC.

Furthermore, the study calculated the mean of MET minutes per week between American students and Asian international students. If the sample was not normally distributed, the Mann-Whitney test would be used to compare the median [Inter-Quartile Range (IQR)] total minutes of moderate/vigorous activity between those two groups. The independent-samples t test compared the mean of stress ratings, and the mean of BMI between those two groups. The chi-square test compared American students and Asian international students who met WHO guidelines, and compared sex, smoking status, and stress levels between those two groups. This study used multiple regression determine if there was a linear association between physical activity levels and stress levels among American students and Asian international students, controlling for age, BMI, citizenship, sex, graduate students, smoking status, students who met WHO guidelines, years in the U.S. for Asian international students, physical activity × (American students or Asian

international students), and an interaction term (physical activity × Asian or American students) in the multiple regression model from the linear association. A significance level of $\alpha=0.05$ and a 95% confidence interval were used for all the analyses.

Chapter 4: Results

A total of 156 University of South Carolina college students participated in the survey (Table 4.1), including 92 American students and 64 Asian international students. Asian international students (27.5 ± 5.0 years) were significantly older than American students (24.4 ± 5.9 years) ($p<.001$). The passports of Asian international students were mainly from People's Republic of China (54.7%), Bangladesh (15.6%), Republic of China (Taiwan) (15.6%), and other countries (14.1%). On average, Asian international students have been in the U.S for 2.8 ± 2.3 years. The percentage of females among American students was higher than that of Asian international students ($\chi2=12.696$, $p=.001$). There were more graduate students (63.5%) than undergraduate students (36.5%) ($\chi2=20.470$, $p=.001$). Ninety American students and 62 Asian international students provided their BMI (n=152). The mean BMI of American students (23.9 ± 4.7 kg/m^2) was higher than that of Asian international students (22.4 ± 3.0 kg/m^2) ($p=.014$). Only 14 students were smokers (9%), with no differences between American and Asian international students ($\chi2=.179$, $p=.672$).

Table 4.1 Characteristics of Students at UofSC

Characteristic	Total number of participants (N=156)	American students (N=92)	Asian international students (N=64)	χ^2	p - value
Age [a] (mean ± SD)	25.7 ± 5.3	24.4 ± 5.9	27.5 ± 5.0		< .001
Sex, N (%)				12.696	.001
Female, N (%)	95 (60.9%)	67 (72.8%)	28 (43.8%)		
Male, N (%)	60 (38.5%)	25 (27.2%)	35 (54.7%)		
Missing, N (%)	1 (0.6%)	0	1 (1.6%)		
Type of student				20.470	.001
Graduate, N (%)	99 (63.5%)	45 (48.9%)	54 (84.4%)		
Undergraduate, N (%)	57 (36.5%)	47 (51.1%)	10 (15.6%)		
Body Mass Index [b], **kg/m^2** (mean ± SD)	23.3 ± 4.2	23.9 ± 4.7	22.4 ± 3.0		.014
Smoking status				.179	.672
Yes, N (%)	14 (9.0%)	9 (9.8%)	5 (7.8%)		
No, N (%)	142 (91%)	83 (90.2%)	59 (92.2%)		
Years in the U.S.			2.8 ± 2.3		

[a] Total students (N=155), American students (N=92), and Asian international students (N=63).
[b] Total students (N=152), American students (N=90), and Asian international students (N=62).

4.1 Physical Activity Levels

One-hundred and thirty-six students (82 American students; 54 Asian international students) completed the IPAQ-SF (Table 4.2). The mean activity levels of American students was 3979.2 ± 2997.4 MET-minutes per week and the mean activity levels of Asian international students was 2013.0 ± 2015.4 MET-minutes per week. Because the results were not normally distributed, the Mann-Whitney test was used to compare the median. The median activity levels of American students (3273.5 MET-minutes per week) was higher than the median activity levels of Asian international students (1511 MET-minutes per week) ($Z=-4.668$, $p<.001$). The mean total minutes of moderate intensity activity for American students was 161.5 ± 245.1 minutes and mean

total minutes of moderate intensity activity for Asian international students was 104.3 ± 143.1 minutes. The total number of minutes that American students participated in vigorous activity was 201.9 ± 192.7 minutes, and the total minutes for Asian international students participated in vigorous activity was 89.81 ± 164.39 minutes. There was no difference in the median total minutes of moderate activity between American students (67.5 minutes) and Asian international students (60 minutes) ($Z=-.939$, $p=.343$); however, the median total minutes of American students participated in more vigorous activity (180 minutes) than Asian international students (0 minutes) ($Z=-4.149$, $p<.001$). A total of 61.5% of students met the WHO physical activity guidelines. More American students (N=60, 73.2%) met the guidelines than Asian international students (N=23, 43.4%) ($\chi 2=13.756$, $p=.001$).

Table 4.2 Physical Activity Levels Between American and Asian International Students

	Total number of participants (N=136)	American students (N=82)	Asian international students (N=54)	χ^2	Z-value	P-value
MET-minutes/week (mean ± SD)	3126.1 ± 2825.5	3979.2 ± 2997.4	2013.0 ± 2015.4			
MET-minutes/week [median (IQR)]	2382 (1146, 4259.25)	3273.5 (1956.63, 5498.25)	1511 (849.75, 2393.50)		-4.668	<.001
Total minutes of moderate activity (mean ± SD)	138.81 ± 211.82	161.5 ± 245.1	104.3 ± 143.1			
Total minutes of vigorous activity (mean ± SD)	157.38 ± 189.52	201.9 ± 192.7	89.81 ± 164.39			
Total minutes of moderate activity [median (IQR)]	60 (0, 180)	67.5 (0, 240)	60 (0, 122.50)		-.989	.343
Total minutes of vigorous activity [median (IQR)]	120 (0, 240)	180 (0, 300)	0 (0, 120)		-4.149	<.001
The number of students who meet the WHO physical activity guidelines (N, %)	83 (61.5%)	60 (73.2%)	23 (43.4%)	13.756		.001

4.2 Perceived Stress Scale (PSS-10) scores

One-hundred and thirty-four students completed the Perceived Stress Scale; 56 were Asian international students and 78 were American students (Table 4.3). The mean PSS-10 of American students (19.8 ± 5.4) was higher than that of Asian international students (16.6 ± 4.8) (p=.001). There was a difference in the number of students with low stress, moderate stress, and high stress between American students and Asian international students (χ2=9.248, p=.011).

Table 4.3 Perceived Stress Levels Between American and Asian International Students

	Total number of participants (N=134)	American students (N=78)	Asian international students (N=56)	χ^2	P-value
PSS-10 Score, mean ± SD	18.5 ± 5.4	19.8 ± 5.4	16.6 ± 4.8		.001
Stress levels				9.248	.011
Low stress (0 - 13) (N, %)	23 (17.2)	9 (11.5)	14 (25)		
Moderate stress (14 - 26) (N, %)	99 (73.9)	58 (74.4)	41 (73.2)		
High stress (27 - 40) (N, %)	12 (9.0)	11 (14.1)	1 (1.8)		

4.3 Association Between Physical Activity and Stress Levels

Table 4.4 presents the linear regression model examining the association between physical activity levels and stress levels between American and Asian international students. After controlling demographics (i.e., age, BMI, citizenship, sex, and smoking status), there was not a significant association between stress levels and physical activity levels (p=.724). BMI (p=.003) and sex (p<.001) were associated with the stress levels. 21.5% of the variation in the stress levels is explained by its linear relationship with physical activity and demographics, and 78.5% of variation is due to chance or other factors (R^2=.215, p<.001). Being an Asian international student or American student did not moderate the association between physical activity levels and stress levels (p=.420) (table 4.5).

Table 4.4 Linear Regression Between Stress and Physical Activity Levels Among American Students and Asian International Students after Controlling for Demographics (i.e., Age, BMI, Citizenship, Sex and Smoking Status)

Predictor	Un-std. B	95% CI	Std. Coeff. β	t	P-value
					<.001
Constant	16.903	[8.990,24.817]		4.229	.230
Physical activity levels	<.001	[-.0002,.0004]	.031	.354	.724
Age	-.142	[-.307,.024]	-.144	-1.697	.092
BMI	.331	[.114,.548]	.263	3.019	.003
Citizenship (American students and Asian international students)	-.655	[-2.746,1.436]	-.060	-.620	.536
Sex	-3.692	[-5.607,-1.777]	-.333	-3.817	<.001
Smoking status	-1.147	[-4.983,2.690]	-.049	-.592	.555

Note. R^2=.215. CI = confidence interval for B.

Table 4.5 Linear Regression Between Stress Levels and Physical Activity Levels after Controlling for Demographics (i.e., Age, BMI, Citizenship, Sex and Smoking Status) and the Interaction Term (Physical Activity × American Students or Asian International Students)

Predictor	Un-std. B	95% CI	Std. Coeff. β	t	P-value
					<.001
Constant	16.520	[8.539,24.501]		4.098	<.001
Age	-.136	[-.303,.030]	-.138	-1.626	.107
BMI	.330	[.112,.547]	.262	3.002	.003
Citizenship	.076	[-2.678,2.829]	.007	.054	.957
Interaction term	-0.000309	[-.001,.0004]	-.094	-.809	.420
Physical activity	.000136	[-.0002,.001]	.071	.709	.479
Sex	-3.641	[-5.563, -1.719]	-.329	-3.750	<.001
Smoking status	-1.181	[-5.024,2.662]	-.050	-.609	.544

Note. R^2=.220. CI = confidence interval for B.

Because the covariate 'years in the U.S.' was only for Asian international students in the third purpose, another linear regression model was run that included physical activity levels and demographics (i.e., age, BMI, sex, smoking status, and years in the U.S.) in Asian international students (table 4.6). There were no significant association between stress levels and physical activity levels in Asian international students after controlling for demographics (P=.483).

Table 4.6 Linear Regression Between Stress Levels and Physical Activity Levels in Asian International Students after Controlling for Demographics (i.e., Age, BMI, Citizenship, Sex and Smoking Status) in Asian International Students

Predictor	Un-std. B	95% CI	Std. Coeff. β	t	P-value
					.312
Constant	12.616	[-2.848,28.080]	7.682	1.642	.107
Age	-.277	[-.691,.137]	.206	-1.346	.185
BMI	.538	[-.008,1.084]	.271	1.984	.053
Physical activity	-0.000235	[-.011,.0004]	-.099	-.707	.483
Sex	-2.332	[-5.415,.751]	-.238	-1.523	.135
Smoking status	1.027	[-5.052,7.105]	.049	.340	.735
Years in the U.S.	.201	[-.405,.806]	.100	.668	.508

Note. R^2=.138. CI = confidence interval for B.

Moreover, a linear regression models included physical activity and demographics in graduate students and another linear regression model included physical activity and demographics in students who met WHO physical activity guidelines were run as a secondary analysis. However, there were no association between physical activity and stress levels among graduate students and students who met WHO physical activity guidelines, after controlling demographics in these two models (p=.627; p=.137).

Chapter 5: Discussion

The purpose of this study was to investigate the impact of physical activity on stress among American students and Asian international students at UofSC, and to understand whether physical activity and other factors affect student stress. As expected, Asian international students had lower physical activity levels (MET-minutes/week) and had lower percentages of meeting the WHO physical activity guidelines as compared to American students. There was no significant difference in the minutes that American students and Asian international students engaged in moderate physical activity, but American students did more vigorous physical activity when compared to Asian students. In contrast, American students are more stressed than Asian international students. In linear regression models, physical activity levels and stress levels were not associated. After adding demographics (e.g., age, BMI, citizenship, sex, smoking status, year in the U.S. for Asian international students) and the interaction term (physical activity × American students or Asian international students), physical activity levels and stress levels did not have a negative association among American students and Asian international students.

American students had higher median activity levels than Asian international students and the percentage of American students who met the WHO physical activity guidelines was higher than the percentage of Asian international students in this study.

The hypothesis was consistent with the result that Asian international students had lower activity levels and had a lower percentage who met the WHO physical activity guidelines than American students. These results are similar to another study suggesting north American students have the highest level of physical activity participation, while Asian students have the least.[11] Another study found that Asian Americans were the least physically active of the major racial/ethnic groups.[41] One possible reason for why lower levels of activity were seen among international students as compared to American students is that Asian Americans are more likely to adhere to stay-at-home orders, mask-wearing, and hand washing directives as a result of the COVID-19 pandemic.[42] Their opportunities for physical activity are likely to be low, resulting in less active behavior.[42] Another reason why Asian international students reported so much less physical activity per week than American students in this study could be that more graduate students were Asian international students than American students. Although there were no any association between physical activity and stress levels among graduate students in this study, college students become less physically active over time, which is consistent with the result in this study.[43,44]

The total minutes of vigorous activity for Asian international students was less than half as much as the American students. This finding is consistent with previous literature that suggests Asian students are less likely to participate in vigorous physical activity than American students.[45] Previous literature has suggested that Asian international students did not participate in recreational sports as much as American students, and they were also less likely to play sports with people who they did not know compared to American students even though they liked instructional sports.[46,47] Campus

recreation and international student services should provide more opportunities for Asian international students to promote their regular physical activity and offer more relevant sports courses for them in their leisure time.

American students had a higher mean stress than Asian international students. This was in contrast to our second hypothesis that Asian international students were more stressed than American students. Another study found similar results to this study in that international students had lower academic stress compared with American students.[48] The reason for this result may depend on individuals. Some people have stronger self-regulation to deal with stress, while others do not.[49] Stress levels may have more to do with an individual's tolerance and ability to cope with stress than the environment.[49]

At the same time, stress levels are not only impacted by individual factors, but by different kinds of stressors. Both American and international students experienced similar stressors, such as course pressure, financial pressure, and pressure from family.[50] Because of the recession, American students are very worried about their future career plans and want to do well academically.[51] Chinese parents and Asian parents usually attach great importance to education, apparently willing to make financial support and personal financial sacrifices for their children to go to college.[52,53] White students are more likely than Asian students to use parental loans, savings or job earnings to pay tuition.[53] These factors may lead to greater stress among American students. In addition, succeeding through hard work and the desire to win was a part of American culture and American students had higher self-imposed stressors than international students, which could have led to more stress among American students.[50,54] University health centers should take

steps to help stressed American students gain the tools and skills they need to manage and reduce their stress.[55]

In this study, after controlling for demographics (i.e., age, BMI, citizenship, sex, and smoking status), physical activity levels were not associated with stress, and the relationship was not moderated by Asian or American students. These results were not consistent with the hypotheses that there would be a negative association between stress and physical activity levels, or that Asian international students would have a stronger negative association between stress and physical activity levels compared to American students. This result is similar to that of other papers that state stress and exercise-coping beliefs were not associated with exercise in college students.[56,57] Moreover, 61.5% of students in the current study met physical activity guidelines, which likely influenced the results and contributed to the lack of association between physical activity levels and stress levels.

Chapter 6: Strengths and Limitations

Few studies have focused on the relationship between physical activity levels and stress levels in college students, particularly among international students studying in the United States. This pilot study is the first to examine physical activity and stress levels among American students and Asian international students in South Carolina, and explores whether demographics (e.g., age, BMI, citizenship, sex, smoking status, year in the U.S. for Asian students) and/or the interaction terms (physical activity × American students or Asian international students) could predict stress levels. This study builds on previous articles by speculating on several factors that may affect the results, especially during a pandemic. This study analyzes the physical activity and stress levels of current American students and Asian international students to find out the students' deficiencies in these two areas. It also fills in the gap of lack of research in this field in recent years and lays the foundation for future research on interventions in both groups.

Although this study has several strengths, some limitations cannot be ignored. For example, differences in the number of undergraduate and graduate students could have led to differences in physical activity among Asian international students and American students. In addition, a total of 156 students participated in the questionnaire, which is a small sample size from the university. The results cannot represent all American students and Asian international students across the U.S. Finally, since a questionnaire was used to measure activity, there may have been some students who overestimated or

underestimated their exercise volume.[58] Questionnaires therefore may not be the most accurate method for measuring physical activity levels.[59] Future research could measure physical activity levels using some technological equipment (e.g., pedometer, accelerometer, and/or Fitbit) to improve the accuracy of collecting physical activity data. Also, reasons for lower physical activity among Asian international students and higher stress levels among American students cannot be identified in a cross-sectional study. Longitudinal studies could be used to understand whether demographics, BMI, and years in the U.S. for Asian international students can impact on physical activity levels and stress levels of American students and Asian international students. Studies also can research physical activity levels and stress levels of Asian international students before and after coming to the U.S. to explore whether the new environment affects their physical activity levels and stress levels.

Chapter 7: Future Studies and Implications

University fitness centers, health centers, and campus recreations can take action to enhance the physical activity of Asian international students. To help students understand why they should exercise, relevant offices could promote ways physical activity improves physical and mental health and how inactivity can affect their health on social media platforms, bulletin boards, and at campus events. For example, fitness centers can also record students' weekly activity, and give rewards (e.g., sports water bottles, towels, or souvenirs) to students who meet the physical activity guidelines. Universities can also match Asian international students with sports partners according to their hobbies to encourage them to be active. Future research could identify reasons for the lack of physical activity among Asian international students and implement interventions to improve their physical activity levels.

Similarly, universities should also pay attention to the stress levels of American students and help them find ways to relieve their stress levels and other negative emotions in their lives. Many American students start their college life in a new city. Students from the north may not be able to adapt to the humid and hot summer in the south, and students from the south may not like the cold winter in the north. Many American students, freshmen and sophomores, face cultural and regional differences that can be a stressor in their lives, yet people tend to ignore these stressors. Health centers and student services should provide psychological stress self-assessment questionnaires

to students via social media and emails, which could help some American students may not realize that they are stressed and do not take corresponding measures to reduce stress. The campus recreation can also regularly organize activities that help students reduce stress, such as yoga and meditation in their leisure time. Universities and the government should also reduce financial stress by offering more aid and reduced tuition to poor but outstanding American students. There is not much literature on the physical activity and stress of college students, especially the group of international students, which should be focused on research and identifying existing problems to intervene.

Chapter 7: Conclusion

Ultimately, American students were more physically active than Asian international students. More American students met physical activity guidelines than Asian international students. However, American students faced more stress than Asian international students. Physical activity among American students and Asian international students was not associated with stress levels. Universities and campus recreations should help Asian international students increase physical activity, particularly vigorous intensity physical activity. Health centers and student services can help American students relieve their stress levels. More studies need to research about physical activity levels and stress levels between American students and Asian international students.

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