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**Examining Physical Activity among US College Students following  
COVID-19 Outbreaks and Lockdowns: The Role of Race/Ethnicity and  
Acculturation**

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COVID-19 Outbreaks and Lockdowns: The Role of Race/Ethnicity and  
Acculturation**

**by**

**Duyen Hong Mai Vo**

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## **Dedication**

To my father, who raised me up in a single-parent home and instilled in me a passion for education that he himself did not have the opportunity to pursue. My father has always wanted to become a teacher or a journalist.

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## **Abstract**

### **Examining Physical Activity among US College Students following COVID-19 Outbreaks and Lockdowns: The Role of Race/Ethnicity and Acculturation**

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The University of Texas at Austin, 2023

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Objective: This study examined physical activity among US college students in the context following COVID-19 outbreaks and lockdowns, with a focus on racial/ethnic and cultural determinants. Sample: This study used cross-sectional data of the COVID-19 University Research on Education and Sustainability (CURES) project. Participants were college students from 7 public universities in the US (N = 1210; 75% female; 33.5% White, 9.1% Black, 47.6% Hispanic, and 7.1% Asian; Mage = 21.06; 85.6% born in the US, 51.6% had mother born in the US, and 49% had father born in the US). Method: The International Physical Activity Questionnaire - short form (IPAQ-SF) was used to assess physical activity and the Vancouver Index of Acculturation (VIA) – the American version was used to assess levels of heritage and US acculturation. Results: White students reported statistically significant higher physical activity than Hispanic ( $p < .05$ , Cohen's  $d = .19$ ) and Asian ( $p < .05$ , Cohen's  $d = .36$ ). In sedentary level, White students reported statistically significant lower levels than Asian ( $p < .05$ , Cohen's  $d = -.45$ ).

Asian reported lowest physical activity, highest sedentary level, and highest prevalence of not meeting physical activity recommendation. Small negative correlation was found between heritage cultural level and total weekly physical activity among Hispanic students ( $r = - .09, p < .05$ ). Conclusion: Race/ethnicity and cultural perception and practices could play a role in determine physical activity and sedentary behaviors among college students. The study calls for more qualitative research, and racial/ethnic and cultural-specific interventions to improve physical activity among Hispanic/Latin and Asian student populations.

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## **Chapter 1: Introduction**

### **COVID-19 PANDEMIC AND ITS IMPACT ON PHYSICAL ACTIVITY**

The COVID-19 pandemic marked a turning point in human history. According to the World Health Organization (2020), the spread of COVID-19 has caused dramatic loss of human life worldwide and has severely compromised public health and society, including impaired mental health and disruptions in working life. In addition to the direct impact of COVID-19, there was an indirect, negative impact on health because of stress and reduced physical activity (Hussain et al., 2020). Arora and Grey (2020) reported that the pandemic has caused dramatic shifts in health behaviors including sleep, substance use, physical activity, and diet. In the area of physical activity, 61 studies conducted worldwide were consistent in finding that the pandemic was associated with significant decreases in mobility, walking, and physical activity, and an increase in sedentary behavior (Park et al., 2022). Sher and Wu (2021) also reported that the pandemic has exacerbated inequalities in physical exercise: differences in the level of physical exercise have widened between men and women, between Whites and non-Whites, and across socioeconomic brackets. Given these exacerbated inequalities in physical activity and exercise, it is essential to investigate this problem in specific populations and identify determinants of these disparities.

## **PHYSICAL ACTIVITY**

### **Physical Activity and Health**

According to the World Health Organization (2022), physical activity is defined as any bodily movement produced by skeletal muscles that requires energy expenditure. Physical activity refers to all movements including transport, working, and performing leisure activities (WHO, 2022). In most studies, physical activity outcomes of interest are generally categorized into vigorous-intensity, moderate-intensity, walking, and sitting/sedentary. Regular physical activity is beneficial for human health not only in preventing noncommunicable diseases, but also in improving mental health, well-being, and overall life quality (WHO, 2022). The Centers for Disease Control and Prevention (2023) recommends that adults engage in at least 150 minutes of moderate-intensity physical activity every week, which can be represented as 150 minutes of moderate-intensity activity, 75 minutes of vigorous-intensity activity, or an equivalent mixture of both moderate-to-vigorous-intensity activity (MVPA). This recommendation is approximately equal to 500 Metabolic equivalent minutes of MVPA per week (Lauer et al., 2017; Kaminsky & Montoye, 2014). Metabolic equivalent minutes (MET-minutes) are a useful unit used to measure individuals' physical activity level. According to the 2008 Physical Activity Guidelines for Americans (Leavitt M., 2008, p. 54), a range of 500 to 1000 MET-minutes per week is recommended to achieve enough weekly energy expenditure that would benefit health. MET-minutes are calculated differently depending on the intensity of the activity. Sedentary level, although conceptualized as a physical activity category, indicates being physically inactive. Sedentary behaviors refer to any

waking activities that involve very low energy expenditure, usually at the level of 1.0–1.5 metabolic equivalent units (METs), including sitting, lying down, watching television, and other forms of screen-based entertainment (Tremblay et al., 2017). Higher time in physical activity and lower time in sedentary behaviors may lower cancer risk (Patel et al., 2019). Although physical activity helps ensure healthy growth and development in young people, about 25% of adults and 80% of adolescents worldwide do not engage in sufficient levels of physical activity, which in turn increases risk of death by 20-30% (WHO, 2022).

### **College Students' Physical Activity**

College is an ideal environment to promote physical activity, fitness, and wellbeing (Kljajevic et al., 2021; Williams et al., 2020). Nevertheless, physical activity and exercise levels among college students are insufficient and tend to decline over time (Williams et al., 2020; Biber et al., 2022). An older meta-analysis (Keating et al., 2005) indicated that 40-50% of college students are physically inactive. There was also insufficient research into college students' physical activity, the lack of multiple-level approaches, and the subjective and inconsistent measures of physical activity. A more recent systematic review of published studies on college student physical activity from 2010 to 2020 (Biber et al., 2022) reported a decline in physical activity participation as a function of related factors including social independence, financial burdens, academic difficulties, novel peer influence, and boredom. Students tend to be less physically active as they progress through college (Williams et al., 2020). In addition, there are clear

disparities among college students in physical activity across different gender, race, and ethnicity (Jones et al., 2015; Towne et al., 2017; Williams et al., 2020; Elliott et al., 2022).

### **Racial/Ethnic Disparity among College Students' Physical Activity**

Along with the high prevalence in physical inactivity, racial/ethnic and social disparities in physical activity among US college students have not improved. According to Nelson et al. (2007), social and health disparities exist in college students' vigorous physical activity: male and female Asian students and students from lower socioeconomic brackets were less likely to engage in vigorous physical activity. Among ethnically diverse college students, Hispanic, Non-Hispanic Asians, and Non-Hispanic Blacks report lower physical activity comparing to Whites in studies conducted since 2000 (Suminski et al., 2002; Jones et al., 2015; Elliott et al., 2022). Despite these effects, a systematic review (Biber et al., 2022) has reported a lack of gender and racial diversity in the samples and inconsistent demographic information across studies. Thus, existing research might overlook or fail to include sufficient racial/ethnic minorities as well as underserved population. In general, male students reported higher physical activity than female students across all races/ethnicities (Elliott et al, 2022; Suminski et al., 2002); and a majority of female students did not meet physical activity recommendation across all racial/ethnic groups (Lee et al., 2018). Many studies report higher engagement in sufficient physical activity among Whites comparing to Hispanics, Non-Hispanic Blacks, and Non-Hispanic Asians (Elliott et al., 2022; Williams et al., 2020). Among females,

White students also reported significantly higher moderate-to-vigorous physical activity compared to other races/ethnicities (Elliott et al., 2022; Williams et al., 2020). Among racial/ethnic minorities, Asian students reported the lowest moderate-to-vigorous physical activity compared to all other races/ethnicity – this is especially the case in female Asian students (Elliott et al., 2022; Williams et al., 2020). Towne et al. (2017) found that minority status and being female were strongly associated with inadequate physical activity level among young adults attending university. Thus, there is a need for more studies with racial/ethnic minorities to understand these disparities, as well as to identify associated risk and protective factors. Such studies are essential for achieving health equity among college students.

## **ACCULTURATION**

### **Definitions and Concepts**

Throughout human history, people have moved across geographical areas and changing environments. As a result, people have been going through the process of adjusting and adapting to the different living, social, and cultural environments. That process is associated with the term “acculturation” – the intersection of immigration and cultural integration (Berry J., 2019). Throughout the years, scientists and psychologists have been studying acculturation and its core components and influence on human life. This research has led to various definitions, concepts, and more than a hundred different theories (Worthy et al., 2020). Acculturation was first defined in 1936 by Redfield and colleagues (p. 149) as “phenomena which result when groups of individuals having

different cultures come into continuous first-hand contact with subsequent changes in the original culture patterns of either or both groups.” The Cambridge Handbook of Acculturation Psychology, Sam and Berry (2006) described “the meetings of cultures and the resulting changes are what collectively has come to be known as acculturation” (p.1), which happened when people from diverse backgrounds interact, change their original patterns of life and culture, and thus form the new societies.” John W. Berry (2005) defined acculturation as “the dual process of cultural and psychological change that takes place as a result of contact between two or more cultural groups and their individual members.” Overall, acculturation happens when people immigrate and share their original culture with the new. From that, immigrants go through a process of adjusting their own cultural thoughts, behaviors, and lifestyle to integrate with the new environment and society.

### **Dimensions of Acculturation**

The United States of America is well-known as a country having diverse people from different races, ethnics, and cultural backgrounds. Acculturation in the United States is defined as “an individual-level process through which people acquire the behaviors, attitudes, and values prevalent within American society” (Viruell-Fuentes et al., 2012). Because immigrants are diverse, different dimensions and measurement scales have been developed to apply to various populations and cultural contexts. Acculturation measurement often assesses people’s language, daily customs and habits, idealized lifestyle, and responses to problem situation including relational style, person-nature



relationship, beliefs about human nature, time orientation, and activity orientation (Szapocznik et al., 1978, p.117). The first acculturation model was developed by Gordon (1964), which centered on a unidirectional dimension. The unidirectional dimension described acculturation as a one-line process in which immigrants' heritage culture and the dominant culture are at opposite extremes, and immigrants generally assimilated into the dominant culture (Gordon, 1964). Later, a bidimensional model was proposed by John Berry (1980), describing the process of acculturation to include independent dimensions – one as the heritage culture and the other as the dominant culture. In the bidimensional school of thought, immigrants' maintenance with their heritage identity and culture is separate from their involvement with their identity and culture in the new society (Berry, 1980). The bidimensional dimension is now the prominent model for research.

### **Acculturation and Physical Activity among Asian and Hispanic/Latin Population**

The relationship between acculturation and physical activity is a subject of limited research, especially among some subgroups. A systematic review based on 44 studies (Gerber et al., 2012) reported that mainstream acculturation was associated with higher leisure time physical activity in 57% of all studies after controlling for potential confounds, and regardless of gender, age, and ethnicity. To clarify, the more immigrants acculturated into the dominant culture, the more they engage in physical activity in their leisure time. In particular, studies in North America resulted in either supportive or partly supportive relationships between physical activity and U.S. acculturation (Gerber et al.,

2012). This has largely been studied by comparing recent immigrants against those born in the U.S. or living there for many years. For example, US-born Asian Americans are more likely to meet moderate-to-vigorous physical activity recommendation compared to foreign-born Asians (Sheng et al., 2022; Zhu et al., 2022). In addition, for those who were not US born, higher reported acculturation and longer residence in the US were associated with higher likelihood of meeting physical activity recommendations (Zhu et al., 2022).

Similarly, Asian-American immigrants who lived in the US for more than 10 years were more likely to have sufficient physical activity (Patel et al., 2022) and engage in MVPA compared to those who had been living in the US for less than a year (Yan & Cardinal, 2019). This finding is particularly relevant for international students, who are generally new arrivals and have not had much time to adjust to life in the US. According to Yan (2020), the US college environment and culture represent factors that may contribute to the increase in physical activity among international students. Indeed, her findings suggest that international students do, in fact, increase their physical activity as they spend time in the US (Yan, 2020). There are multiple potential explanations for this finding. US culture often has a different perception of femininity that challenges recently immigrated Asian female students and encourages them to exercise and participate in different types of physical activities (Yan & Cardinal, 2013).

This social-cultural context also has the potential to influence physical activity among Hispanic/Latin population. According to Larsen et al. (2013), typical gender roles, cultural perceptions of femininity, and cultural norms regarding women's ideal bodies

may discourage Latinas from participating in vigorous physical activity and exercising. Hispanic cultural lifestyle, including beliefs about nutrition and physical activity, affect their health care utilization, treatment, and intervention (Wallace et al., 2010). On the other hand, Ham et al. (2007) reported a positive relationship between U.S. acculturation and leisure-time physical activity among Latinos in the U.S. Based on these findings, it might be predicted that higher practice of heritage cultures, especially among Asian or Latino immigrants, would play a significant role in negatively influencing their perceptions and behaviors toward physical activity engagement, and thus their physical activity outcomes. Higher acculturation toward US culture, in contrast, would be predicted to positively associate with an increase in physical activity among Asian and Latino students. To conclude, higher American or heritage cultural practice would likely relate to physical activity outcomes among racial/ethnic minorities and immigrants, especially among women.

#### **STUDY'S PURPOSE AND OBJECTIVES**

The existing literature suggests that U.S. White college students engage in higher physical activity compared to other races/ethnicities, and that the U.S. cultural context and higher acculturation appear to be associated with greater physical activity engagement among Asian, Hispanic/Latin, and immigrants. In the call to action to reduce racial/ethnic disparities and increase equitable physical activity for all Americans (Hasson et al., 2022), investigating disparities and related factors vis-à-vis physical

activity among college students in the context of COVID-19 and beyond is essential for further research and interventions.

Thus, our first goal was to assess physical activity and sedentary levels among all college students following the COVID-19 outbreak, and to examine these levels as a function of race/ethnicity. We hypothesized that there would be racial/ethnic disparities in physical activity and sedentary levels, especially between White and Hispanic or Asian students. Our second goal was to examine the association between physical activity/sedentary level with the two cultural dimensions – endorsement of heritage and US cultural practices – among Asian and Hispanic students. We sought to examine the role of acculturation vis-à-vis physical activity and sedentary behaviors among Asian and Hispanic college students. We hypothesized that US cultural practices would be associated with higher physical activity outcomes and less sedentary activity; and heritage cultural practices would be associated with lower physical activity and more sedentary activities. The present study was designed to address these aims via a multi-university sample of health-related data from the CCOVID-19 University Research on Education and Sustainability (CURES) project.

## **Chapter 2: Methods**

### **THE CURES PROJECT**

#### **Study Background**

These data were cross-sectional and collected between March and August 2021 as part of the CURES Project. The project was developed in response to calls for collaborative research on the impact of COVID-19 on college students (Regan et al., 2023). Although the CURES project covered many domains to assess students personal, academic, and social experience during the first year of the COVID-19 pandemic (Regan et al., 2023), the present study focuses on physical activity, acculturation, and social-demographic domains to adhere with the study's purpose and aims.

#### **Procedures**

Data were collected using an online survey, which took about an hour to complete. Participants were recruited via several methods including online and emailed flyers, social media, web posts, school research pools, and within academic classes. Students participated voluntarily and no monetary incentives were provided. Participants interested in the research first visited an online consent page, which described the study and where they provided consent for participating. Participants were then directed to the online survey administrated by Qualtrics – a secure survey website widely used across many research institutions. Study procedures were approved by all participating universities' Institutional Review Boards for Human Participants. Electronic copies of consent forms were not linked to participants' survey responses and are stored on a

separate, password-protected, cloud-based server that is accessible to the research team (Schwartz et al., in press). Participants' identities are therefore secured, and survey responses are anonymous.

## **Participants**

Participants in the study were undergraduate and graduate students from seven public universities in California, Florida, New York, Texas, and Virginia. Those universities are racial-and ethnic-diverse college settings that should best represent the college student population across the United States. A total of 1992 students completed the survey and were included in the CURES dataset. Demographic information is reported in the results section.

## **MEASURES**

### **Demographic Variables**

Participants responded to demographic questions including their age, current year in university (freshman, sophomore, junior, senior, masters, or PhD), biological sex (male, female, or other), primary racial/ethnic groups (White, Black/African American, Hispanic/Latin American, Asian/Pacific Islander, Native American, Middle Eastern, or other), current gender identity (Transgender, Cisgender, Genderqueer, Non-binary, Agender, or other), self or family annual household income (less than \$30,000, \$30,000-\$50,000, \$50,000-\$100,000, or more than \$100,000), where they were taking classes from currently (Family's home, On-campus, Off-campus House/Apartment, currently not

in classes, or other), whether they were born in the US (yes/no), and whether their mother/father was born in the US (yes/no).

### **Physical Activity**

The International Physical Activity Questionnaire - short form (IPAQ-SF) was used to measure students' physical activity (Craig et al., 2003). The IPAQ-SF consists of 4 questionnaires that measure time spent on vigorous physical activity, moderate physical activity, and walking during the last 7 days, and sitting/sedentary for a day. Descriptions and examples of each type of physical activity were provided to students prior to each questionnaire. In the first questionnaire, students self-reported the number of days they perform any vigorous physical activities during the week prior to assessment. Then, they reported the usual hours and minutes spent on doing vigorous physical activities one of those days. If a student spent 1 hour and 30 minutes engaging in vigorous activities on one of those days, they should enter 1 in the hours box and 30 in the minutes box. Similarly, moderate-intensity physical activities and walking questionnaires used the same response system to measure each category's total weekly minutes. The sitting/sedentary questionnaires only asked about the usual hours and minutes spent during a given day. The IPAQ-SF is a cost-effective method to assess physical activity in large samples (Lee et al., 2011). The IPAQ has been shown to be valid and reliable for college students (Dinger et al., 2006; Nascimento-Ferreira et al., 2022).

To assess physical activity level from the IPAQ's results, total minutes of moderate, vigorous, and walking were calculated for the week. In addition, Metabolic

Equivalent minutes (MET-minutes) were also calculated for each activity. Based on the Guidelines for Data Processing and Analysis of the International Physical Activity Questionnaire (IPAQ) - Short Form (2004), MET-minutes of vigorous activity were calculated by multiplying its total weekly clock minutes by 8. Similarly, moderate activity's clock minutes were multiplied by 4, and walking's clock minutes were multiplied by 3.3 to achieve each activity's MET-minutes for the week. A total MET-minutes across all activities was calculated as the sum of vigorous MET-minutes, moderate MET-minutes, and walking MET-minutes. The total MET-minutes allows us to compare its single value to the range of 500-1000 MET-minutes recommended by the 2008 Physical Activity Guidelines for Americans. Data are reported by median and interquartile range because the distributions are hypothesized to be skewed. In addition, daily and weekly minutes spent in sitting and sedentary behaviors were also calculated to examine levels of physical inactivity.

### **Acculturation**

Acculturation was measured using the Vancouver Index of Acculturation (VIA) – the American version (Paulhus, 2013). The original VIA (Ryder et al., 2000) is a self-report bidimensional instrument developed to assess immigrants' orientation toward their heritage and mainstream cultures and was correspondingly adjusted and applied to different heritage/mainstream cultures. In this study, the mainstream culture is American, and the heritage culture is the primary non-US culture of origin of participants' families. The instrument consists of 20 statements assessing participants' values, social



relationship, and cultural norms toward their heritage and American culture. Examples of VIA's statements are: "I often participate in my heritage cultural traditions," "I often participate in mainstream American cultural traditions," "I would be willing to marry a person from my heritage culture," or "I would be willing to marry a white American person." The odd-numbered items in the instrument assess participants' orientation toward their heritage culture, and the even-numbered items are similar mirrored questions assessing participants' orientation toward "mainstream" US culture. Participants response to each statement on 7-point Likert-type scale range from "Strongly disagree" (1) to "Strongly agree" (7). In our study, the heritage subscale score was calculated as the sum of the odd-numbered questions, and the US subscale score was calculated by the sum of the even-numbered questions. Only participants who were not born in the US or have at least one parent born outside of the US were asked to complete the VIA instrument. The VIA has been a popular self-report instrument among acculturation researchers (Testa et al., 2019).

### **Statistical Analysis**

Data analysis was performed on SPSS version 29. Because this study focused on physical activity and acculturation, participants who did not complete or had missing data on the physical activity and acculturation questionnaires were excluded from our analyses. Descriptive statistics were used to analyze demographic, dependent, and independent variables to examine normality and identify outliers. Based on the Guidelines for Data Processing and Analysis of the International Physical Activity

Questionnaire (IPAQ) – Short Form (2004), data were carefully reviewed and cleaned to either correct or remove false reports of physical activity. A complete cleaning reduced our sample size from 1992 to 1210 participants.

## **Chapter 3: Results**

### **DESCRIPTIVE STATISTICS OF DEMOGRAPHIC VARIABLES**

Of the 1210 participants in our sample who provided valid acculturation and physical activity data, about a quarter were male and three quarters were female. Participants were relatively evenly balanced across undergraduate school years, along with a few graduate students. In terms of race and ethnicity, 33.5% of participants were White, 9.1% Black/African American, 47.6% Hispanic/Latin American, and 7.1% were Asian/Pacific Islander. Most of our participants identified as cisgender (91.5%). Household income levels were also represented relatively even across all participants. With regard to learning location during the spring/summer of 2021, 45.2% were taking classes at family's home, 22.2% on-campus, and 30.9% on off-campus house/apartment, with a small number currently not taking classes or reporting other arrangements. For covariates that have been shown to be related to participants' acculturation, 85.6% reported they were born in the U.S, 51.6% reported their mother was born in the U.S, and 49% reported their father was born in the U.S. Lastly, participants' ages ranged from 18 to 59 years ( $M = 21.6$ ,  $SD = 4.8$ ). Demographic characteristics are presented in Table 1.

Table 1: Demographic Characteristics of Participants

<b>Demographic Characteristics</b>	<b>N</b>	<b>%</b>
<b>Current year in university</b>		
<i>Freshman</i>	323	26.7
<i>Sophomore</i>	234	19.4
<i>Junior</i>	329	27.2
<i>Senior</i>	306	25.3
<i>Masters/PhD</i>	17	1.4
<b>Biological sex</b>		
<i>Male</i>	312	25.8
<i>Female</i>	893	73.9
<i>Other</i>	3	0.2
<b>Races &amp; Ethnicity</b>		
<i>White</i>	405	33.5
<i>Black/African American</i>	110	9.1
<i>Hispanic/Latin American</i>	575	47.6
<i>Asian/Pacific Islander</i>	86	7.1
<i>Native American or Middle Eastern</i>	9	0.7
<i>Other</i>	24	2
<b>Gender Identity</b>		
<i>Transgender</i>	7	0.6
<i>Cisgender</i>	1084	91.5
<i>Non-binary or Gender queer</i>	23	1.9
<i>Agender or Other</i>	71	6.0
<b>Self or family annual household income</b>		
<i>less than \$30,000</i>	351	29.3
<i>\$30,000-\$50,000</i>	278	23.2
<i>\$50,000-\$100,000</i>	326	27.2
<i>more than \$100,000</i>	245	20.4
<b>Place taking classes from currently</b>		
<i>Family's home</i>	546	45.2
<i>On-campus</i>	269	22.2
<i>Off-campus house/apartment</i>	374	30.9
<i>Not in classes or Other</i>	20	2.3
<b>Born in the US (% Yes)</b>	1034	85.6
<b>Mother was born in the US (% Yes)</b>	624	51.6
<b>Father was born in the US (% Yes)</b>	593	49
	<b>Mean</b>	<b>SD</b>
<b>Age</b>	21.6	4.8

**PHYSICAL ACTIVITY AND SEDENTARY LEVEL AMONG COLLEGE STUDENT POPULATION**

Responses to the physical activity questionnaires were computed and reported by median and interquartile range for MVPA MET-minutes, all activities MET-minutes, MVPA clock minutes, walking clock minutes, and sedentary clock minutes for the last 7 days. Reports of MET-minutes allow us to compare the value to the MVPA MET-minutes recommendation (REF), which is from 500-1000 MET-minutes. Based on the nature of the IPAQ questionnaires, time reported daily in sedentary behaviors was multiplied by 7 to reflect the total time for the whole week. This allows accurate comparison with the physical activity times reported in response to questions about weekly physical activity. Distributions of physical activity are positively-skewed, indicating that most participants engaged in 720-4800 MET-minutes of MVPA, and 1752-6785 MET-minutes of all activities per week, with a small number reporting extremely higher physical activity level. Despite that, 286 participants (23.6%) did not meet the weekly MVPA MET-minutes recommendation (see Table 2).

Table 2: Physical Activity and Sedentary Level among College Student Population

Physical Activity & Sedentary Categories	Median	IQR	Under MVPA Recommendation	
			N	%
MVPA <i>MET-mins</i>	2320	720 - 4800	286	23.6
All activities <i>MET-mins</i>	4088	1752 - 6785		
MVPA clock mins	360	120 - 780		
Walking clock mins	340	120 - 840		
Sedentary clock mins	2520	1680 - 3360		

Note: Numbers of minutes and MET-mins were rounded to the nearest integer.

Comparing weekly clock minutes of MVPA, walking, and sedentary behaviors, most participants reported 120-780 MVPA min/week, 120-840 walking min/week, and 1680-3360 sitting/sedentary min/week. Unlike the physical activity distributions, our sedentary distribution appears nearly normal, with the central tendencies being roughly equal (M = 2732, Median = 2520, Mode = 2100).

### **PHYSICAL ACTIVITY AND SEDENTARY LEVEL ACROSS RACE/ETHNICITY**

Racial/ethnic comparisons for physical activity and sedentary behavior are reported by median, interquartile range, mean, and standard deviation across racial/ethnic groups (see Table 3). Four racial/ethnic groups are reported including White, Black/African, Hispanic/Latin American, and Asian. Native American, Middle Eastern, and Other are not included in these comparisons because their sample sizes are too small. Total MET-minutes across all activities (vigorous, moderate, and walking) per week was used as an indicator of physical activity level. Sedentary minutes per day was used to indicate sedentary level among different racial/ethnic groups. An inspection of these participant responses indicated that White students reported the highest physical activity levels, and Asian/Pacific Islander students reported the lowest physical activity levels. The order from highest to lowest in physical activity level is White, Black/African American, Hispanic/Latin American, and Asian/Pacific Islander. This order remains consistent across different central tendency measurements (median, interquartile range, and mean). Similarly, when comparing sedentary behavior levels across racial/ethnic groups, the order is reversed. Specifically, Asian/Pacific Islander students reported

highest time spent engaging in sedentary behaviors, following by Hispanic/Latin American, Black/African American, and White students. This order is shown through the groups' means. Most White, Black/African American, and Hispanic/Latin American participants reported engaging in similar amounts of sedentary time per day, ranging from 240-480 minutes (4-8 hours) per day, with a median of 360 minutes (6 hours). In contrast, most Asian/Pacific Islander students reported higher sedentary level ranging from 300-600 minutes (5-10 hours) per day, with a median of 420 minutes (7 hours). In essence, the average Asian student spent about an hour more in sedentary behaviors than students from other racial groups did.

In addition, numbers and percentages of participants who did not meet the MVPA recommendation were calculated for each racial/ethnic group. Among White participants, 19.8% reported MVPA levels under the recommendation. Among Black/African Americans, the percentage is similar, with 20% participants not meeting the MVPA recommendation. The percentages are higher in the other two groups, with 25% among Hispanic/Latin American and 33.7% among Asian/Pacific Islander students not meeting the MVPA recommendation. This result yield similar pattern to our findings in the total physical activity and sedentary level, which indicating that Hispanic and Asian are the two groups engaging in the lowest levels of physical activity, highest sedentary levels, and highest rates of not meeting MVPA recommendations for daily physical activity.

Table 3: Comparing Physical Activity and Sedentary Level among Different Racial/Ethnic College Student Groups

Race/ Ethnicity	Total MET-mins of all activities per week			Sedentary mins per day			Under MVPA Recommendation	
	Median	IQR	Mean (SD)	Median	IQR	Mean (SD)	N	%
White	4572	2144- 7518	5350 (4024)	360	240- 480	370 (178)	80	19.8
Black/African American	4158	1952- 7040	5098 (4012)	360	240- 480	375 (196)	22	20
Hispanic/ Latin American	3900	1586- 6399	4591 (3852)	360	240- 480	401 (192)	144	25
Asian/Pacific Islander	2355	1188- 5162	3926 (3848)	420	300- 600	452 (207)	29	33.7

Note: other racial/ethnic groups are not included because sample sizes are too small.

A series of one-way ANOVAs were conducted across racial groups to identify significant differences. Effect size – Cohen’s *d* was also calculated for each pairwise comparison (see Table 4).



Table 4: Multiple Comparisons of Differences in Physical Activity and Sedentary Level between Racial/Ethnic Groups

<b>Physical Activity Level (total MET-mins of all activities)</b>	<b>p-value (Tukey HSD)</b>	<b>Effect size (Cohen's <i>d</i>)</b>
White - Black/African	0.997	0.06
White - Hispanic/Latin	<b>0.048*</b>	0.19
White - Asian/Pacific Islander	<b>0.038*</b>	0.36
Black/African - Hispanic/Latin	0.88	0.13
Black/African - Asian/Pacific Islander	0.373	0.3
Hispanic/Latin - Asian/Pacific Islander	0.768	0.17
<b>Sedentary Level (sedentary minutes daily)</b>		
White - Black/African	1	-0.03
White - Hispanic/Latin	0.154	-0.17
White - Asian/Pacific Islander	<b>0.005*</b>	-0.45
Black/African - Hispanic/Latin	0.862	-0.13
Black/African - Asian/Pacific Islander	0.073	-0.38
Hispanic/Latin - Asian/Pacific Islander	0.219	-0.26

Note: (\*) indicates a significant difference at the 0.05 level (2-tailed). Cohen's *d* uses the pooled standard deviation.

Based on the ANOVA and post hoc test results, statistically significant differences emerged in physical activity levels between White and Hispanic/Latin students ( $p < .05$ ) and White and Asian/Pacific Islander students ( $p < .05$ ). In other words, White students reported engaging in statistically significantly higher physical activity level than Hispanic/Latin (Cohen's  $d = .19$ ) and Asian/Pacific Islander (Cohen's  $d = .36$ ) students. In terms of sedentary behaviors, White students reported statistically significant lower levels than Asian/Pacific Islander students ( $p < .05$ , Cohen's  $d = -.45$ ).

In other words, Asian students spent significantly more time in sitting and engaging in sedentary behaviors compared to White students.

**THE ASSOCIATION BETWEEN US/HERITAGE CULTURAL LEVEL AND PHYSICAL ACTIVITY/SEDENTARY LEVEL AMONG HISPANIC AND ASIAN COLLEGE STUDENTS**

Pearson correlation was used to test the correlation between U.S./heritage cultural practice with physical activity and sedentary level. Among the 575 Hispanic/Latin American participants, heritage cultural practice exhibited a small negatively correlation with MVPA MET-minutes ( $r = -.10, p < .05$ ) and all activities MET-minutes ( $r = -.09, p < .05$ ). No association was found between U.S. cultural practices and their physical activity/sedentary level (see Table 5). Among the 86 Asian/Pacific Islander participants, no significant association was found between either U.S. or heritage practice with their physical activity/sedentary level (see Table 6). Due to the small sample size for the Asian/Pacific Islander group, the test might be statistically underpowered to detect small correlations as statistically significant.

Table 5: Correlation between US/Heritage Practices and Physical Activity/Sedentary Level among Hispanic/Latino (N=575)

<b>PA and Sedentary Categories</b>	<b>U.S. Practices</b>	<b>Heritage Practices</b>
MVPA MET-mins	-0.04	<b>-0.10*</b>
All activities MET-mins	-0.03	<b>-0.09*</b>
Sedentary minutes	0.03	0.07

Note: (\*) indicates a significant correlation at the 0.05 level (two-tailed).

Table 6. Correlation between US/Heritage Practices and Physical Activity and Sedentary Level among Asian/Pacific Islander (N=86)

<b>PA and Sedentary Categories</b>	<b>U.S. Practice</b>	<b>Heritage Practice</b>
MVPA MET-mins	0.19	0.002
All activities MET-mins	0.17	0.02
Sedentary minutes	-0.03	-0.07

Note: No significant correlations were found at the 0.05 level (two-tailed).

## **Chapter 4: Discussion**

The present study was designed to assess physical activity and sedentary levels among college students as a function of race/ethnicity, in the context following COVID-19. Our results suggest the presence of disparities between groups, especially between White students and Hispanic and Asian students. Moreover, our results suggest that heritage cultural level among Hispanic students was negatively correlated, to a small extent, with their total physical activity. but not with their sedentary behavior.

### **PHYSICAL ACTIVITY AND SEDENTARY LEVEL AMONG COLLEGE STUDENTS AFTER COVID-19 OUTBREAKS AND LOCKDOWNS**

As a result of the pandemic, college students' health and behaviors were influenced by the closure of campus, gyms, recreation centers, and other academic and exercise settings (Birmingham et al., 2021). Given this lack of available physical activity spaces, it is not surprising that the COVID-19 quarantine period was associated with increases in sedentary behavior and decreases in physical activity among college students (Sidebottom et al., 2021). Despite these dramatic changes associated with the pandemic and associated lockdowns, students who met the recommended physical activity level before the pandemic also generally tended to meet the recommendations during the pandemic (López-Valenciano et al., 2021). Given that our study participants completed the survey between March and August 2021 – one year after the COVID-19 outbreak began in the U.S. – our results reflect students' physical activity and sedentary level during the process of adapting to the new environment following the COVID-19 crisis,

when many universities were still not open for in-person instruction. During that time, students' physical activity and sedentary behaviors might be less impacted by the stay-at-home orders and lockdowns. Because universities were closed, individual factors and physical activity habits (e.g., running outside) were likely to play especially important roles in predicting physical activity outcomes in a highly changing context (Teran-Escobar et al., 2021). Identifying individual and behavioral determinants of physical activity are essential to design effective interventions in the context of COVID-19 and beyond (Hasson et al., 2022). Thus, our study findings could serve to indicate important individual and behavioral factors that may contribute to future research and interventions beyond the pandemic.

According to our findings, nearly a quarter of college students did not meet the minimum MVPA recommendation during March-August 2021 – one year after COVID-19 outbreak. This prevalence was reduced compared to the time during the COVID-19 lockdown – when nearly half of university students did not meet the MVPA recommendation for physical activity (Coakley et al., 2021). Although the prevalence of not meeting MVPA recommendation was reduced in 2021 as compared to 2020, a considerable portion of the college student population was still physically inactive. Future research needs to assess whether this prevalence is continuing to improve, given that the pandemic is ending and that college students are no longer restricted by social distancing and by the closure of gyms and other physical activity spaces. Universities should support students to engage in sufficient physical activity to ensure students' overall health and wellness after the pandemic. In addition to ensuring adherence to minimal physical

activity recommendations, limiting sedentary behaviors (including screen time) is essential to promote students' health. Sedentary behaviors are associated with wide-ranging adverse health impacts, including mortality, cardiovascular disease, cancer risk, metabolic disorders, musculoskeletal disorders, depression, and cognitive impairment (Park et al., 2020). Among college students, higher sedentary time is significantly associated with greater symptoms of stress, anxiety, and depression (Lee & Kim, 2019). According to our results, many college students spent approximately 4 to 8 hours per day on sitting or engaging in sedentary behaviors during the COVID-related campus closures. Over the week, time spent engaging in sedentary behaviors is approximately 7 times higher than time spent in MVPA or walking. A combination of insufficient physical activity and high sedentary behaviors is associated with especially elevated risk of psychological distress among university-based young adults (Uddin et al., 2020).

#### **RACIAL/ETHNIC DISPARITIES IN PHYSICAL ACTIVITY AND SEDENTARY LEVEL**

In terms of physical activity as a whole, our results show distinct differences among the four races/ethnicities: White college students reported higher levels of PA compared to all other races. Black students reported higher level than Hispanic and Asian. Asian students reported the lowest level of PA. Based on the median MET-minutes for all activities per week, White students reported twice the amount of time being physically active than did Asian students. Additionally, Black students are 1.8 times higher, and Hispanic students 1.7 times higher, in physical activity levels compared to Asian students. These results suggest a huge disparity in physical activity between

Asian students and other races/ethnicities, which is consistent with disparities reported in other studies before and during the pandemic (Elliott et al., 2022; Wilson & Bopp, 2021; William et al, 2018).

The percentages of students who do not meet the MVPA recommendation were also different across four racial/ethnic groups. Achieving the minimum 500-1000 MET-minutes MVPA recommendation is associated with better health markers and higher cardiorespiratory fitness (Lauer et al., 2017). According to our result, White and Black students have the same prevalence in not meeting the MVPA recommendation – about 20% of their population fall below the minimum 500 MET-minutes requirement. The prevalence is higher in Hispanic (25%) and Asian students (34%). Being female, Hispanic, and non-White are associated with not meeting MVPA recommendation among diverse university students (Towne et al., 2017). Although minority status emerged as the strongest sociodemographic factors associated with inadequate physical activity level (Towne et al., 2017), fewer studies have investigated the differences among ethnic minority groups. It is important to note that, aside from reporting the lowest physical activity levels among the ethnic groups we analyzed, Asian college students also were least likely to engage in MVPA-recommended levels of physical activity compared to other racial/ethnic groups. This finding is consistent with another study that reported Asian college students having lowest percentages of meeting vigorous physical activity recommendation compared to other races (VanKim & Nelson, 2013). Furthermore, Asian American adults were among the least physically active racial/ethnic groups (Kao et al., 2016), and were unlikely to meet physical activity guidelines even before the pandemic

(Yi et al., 2015). Thus, it is possible that Asian college students' attitudes and habits in physical activity may have been greatly influenced by their family, cultural, and social environments, even when they are away from home for college attendance.

As a group, Asian students reported significantly more sedentary time compared to White, Black, and Hispanic students, with most Asian students spending 1-2 more hours sitting or engaged in sedentary behaviors per day compared students of other races/ethnicities. Statistically, Asian students have significantly higher sedentary level than White students. In the future, Asian population might face higher prevalence of health risks and diseases as a result from their physically inactive college generations.

#### **CULTURAL PRACTICES AND PHYSICAL ACTIVITY OUTCOMES AMONG HISPANIC AND ASIAN COLLEGE STUDENTS**

Among Hispanic/Latin American students, we did not find a relationship between US cultural practices and physical activity engagement. In contrast, we found a small inverse correlation between their heritage cultural practices and physical activity outcomes for Hispanic students. To a small extent, Hispanic college students who engage in more Hispanic/Latin American cultural behaviors may spend less time being physically active. In a previous study, Singh et al. (2008) reported that Hispanic children and adolescents from immigrant families were more likely to be physically inactive, and less likely to engage in regular physical activity and participate in sports, compared to US-born children. Those findings suggest that Hispanic children and adolescents who are surrounded by their heritage culture would engage in lower physical activity and higher sedentary behaviors. This is consistent with our results. Likewise, whereas US



acculturation was found to have a beneficial impact in increasing physical activity and sports participation in Singh et al.'s (2008) study, Hispanic cultural and social influences have been shown to decrease physical activity among Hispanic/Latin American populations (Pare et al., 2019). Barriers to physical activity among Hispanic/Latino people include lack of family and social support for being active, and lack of culturally appropriate physical activity programming (Pare et al., 2019).

Our study did not find any significant relationship between physical activity categories and the two acculturation dimensions among Asian/Pacific Islander college student population. However, due to the small sample size in the Asian subgroup, we may not have been adequately powered. Despite the importance of physical activity and its impact on a range of health outcomes, existing data on Asian-American populations, especially disaggregated by subgroups, remain very limited (Becerra et al., 2014). The lack of research interests and sufficient cultural-specific interventions could be a deficiency and hindrance in improving Asian-American's health. Thus, more research works are needed in this direction.

#### **INTERVENTIONS THAT ARE SPECIFIED TO RACIAL/ETHNIC MINORITIES AND CULTURAL CONTEXT**

In summary, we found significant disparities in physical activity between White students their Hispanic, and Asian counterparts. Asian college students reported the lowest physical activity and highest sedentary levels, especially in comparison to their White peers. For Hispanic/Latin American students, heritage culture retention was negatively related to physical activity – although the magnitude of this association was

actually higher among Asian students. Because physical activity disparities are determined, at least in part, by racial/ethnic and cultural characteristics, it is important to design research and interventions to target these socio-demographic factors (among others). Yan and Cardinal (2013) suggest targeting perceived competence, self-efficacy, positive attitudes, and enjoyment of physical activity in physical activity promotion interventions among Asian international students. Within interventions to promote physical activity, college administrators and policy makers should understand that race/ethnicity is a factor in influencing student physical activity behaviors, and thus approach and revise policies and practices accordingly (Wilson & Bopp, 2021). Furthermore, more qualitative research is needed to further understand and develop racial/ethnic and cultural-specific approaches to promote physical activity among Hispanic and Asian college students.

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