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**COLLEGE STUDENT AEROBIC AND MUSCLE-STRENGTHENING ACTIVITY
INEQUITIES**

A Dissertation in

Kinesiology

by

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ABSTRACT

The benefits of physical activity to individual physical and mental health, as well as wider society, are well established. Yet, the physical activity participation levels of many remain insufficient, and considerable disparities (inequities) exist. Physical activity inequities tend to mirror those in associated health outcomes. Thus, identifying and understanding the reasons underpinning physical inequities is crucial to achieving equitable health outcomes. Emerging adulthood (18-25 years) is an important portion of the life span for shaping lifelong health trajectories through the development of health behavioral tendencies and habits. It is a period during which many pursue a post-secondary education, thus making institutions of higher education ideal settings to promote physical activity and address inequities in a cost-effective manner at a larger scale.

This dissertation is comprised of five studies. The first is a scoping review that critically examines the contemporary college student physical activity literature, in particular how physical activity is measured and disparities are examined. Studies two and three examine disparities in college student aerobic and muscle-strengthening activity based on intersection of gender with race/ethnicity and sexual orientation respectively. Study four examines disparities in college student aerobic and muscle-strengthening activity based on gender identity. Finally, study five examines college women's perceptions of factors contributing to gender disparities/inequities in physical activity and campus recreation facility use using one-on-one interviews.

Findings can be distilled into two conclusions. Firstly, it is untenable to ignore or treat socio-demographic characteristics as mutually exclusive categories when researching or promoting physical activity. Secondly, multiple levels of influence must be considered by those researching and promoting physical activity, as failure to appreciate and address any level of

influence (socio-demographic characteristics, intrapersonal factors, interpersonal factors, environments, or policies) risks compromising attempts to reach and achieve meaningful conclusions and improvements in physical activity respectively.

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Chapter 1

Introduction

Benefits of physical activity

The associations between physical activity, both aerobic and muscle-strengthening, and favorable physical and mental health are well established. Physical activity is associated with reduced risk/prevalence of various non-communicable diseases,^{1,2} mental illnesses³⁻⁵ and both premature¹ and all-cause mortality.² These individual health benefits benefit society through the reducing disease/illness and associated healthcare costs and increasing productivity.⁶⁻⁸ Benefits of physical activity extend beyond the health of individuals, as physical activity can also contribute to the development and advancement of individuals and society as a whole.⁹ Thus, it is evident that both individuals and society have much to gain from being physical active and promoting physical activity respectively.

Physical activity among emerging adults

Physical activity tends to decline over the course of the lifespan, beginning in adolescence.^{10,11} However, one of the most considerable declines in physical activity is observed during the transition from adolescence to adulthood.¹²⁻¹⁵ This period is often referred to as emerging adulthood (18-25 years¹⁶), and is a sensitive period in life for shaping lifelong health trajectories through the development of health behavioral tendencies and habits.¹⁷ While death may not be on the horizon for most emerging adults, health behaviors during emerging adulthood can have considerable implications on health later in life. Yet, many emerging adults in the US participate in insufficient levels of both aerobic and muscle-strengthening activity.^{18,19}

Many emerging adults are unaware that risk factors, such as obesity and hypertension, can contribute to the development non-communicable diseases,²⁰⁻²² and do not perceive themselves as at risk.^{20,23} However, this complacency is unfounded based on the prevalence of metabolic syndrome,²⁴⁻²⁸ obesity,^{18,29} hypertension,^{25,30} anxiety,³¹ and depression³¹⁻³⁴ among

students. Despite the clear need for cost-effective population-level physical activity interventions among emerging adults,³⁵ physical activity interventions among emerging adults have been ineffective to date.³⁶⁻³⁸ The failure of previous interventions to achieve a sustainable change in physical activity in a cost-effective manner is attributable to their neglect of environmental and policy factors.³⁹

Factors influencing physical activity

Numerous models and theoretical frameworks conceptualize factors that influence physical activity. The socio-ecological model that posits there are various, and interacting, influences on health behaviors such as physical activity, and conceptualizes multiple levels of influence: intrapersonal, interpersonal (social and cultural), organizational, community, physical environment, and policy.⁴⁰ According to constraints theory, physical activity is dependent not on the absence of constraints (although this may be true for some), but on their negotiation, which may modify, rather than prevent participation.⁴¹ Moreover, the theory also suggests that intrapersonal, interpersonal, and structural constraints tend to be negotiated sequentially from the most proximal (intrapersonal) to the most distal (structural)⁴² depending on one's stage in life.⁴³ Taking these frameworks into account, alleviating the perception and facilitating the negotiation of constraints at all levels is crucial to increasing physical activity,⁴⁴⁻⁴⁶ and sustained physical activity is largely dependent on the ability to continue to negotiate constraints imposed by ever-changing factors.⁴¹⁻⁴³

Policies

Policies and legislation, from the federal level through the institutional level, have the potential to both perpetuate and address inequities in physical activity opportunities. Title IX of the Education Amendments Act⁴⁷ is an example of legislation that has increased women's opportunities and actual participation in various sporting activities within educational institutions in the US.⁴⁸ Though Title IX was defined for intercollegiate athletics, its general principles apply to club sport and intramural programs.⁴⁹ Despite this, there is inconsistent compliance with Title IX regulations,

with evidence indicating that, though much improved, gender inequities exist in club⁵⁰ and intramural sports.^{50,51} However, whether Title IX extends to the use of campus recreational facilities and spaces has yet to be clarified or tested.

Emerging evidence is accumulating to suggest that a case could be made concerning gender inequities the campus recreational facility access/use,⁵²⁻⁵⁸ and there appears to be a disconnect between the policies and actual practices of campus recreation departments with respect to diversity, equity, and inclusion.⁵⁹ Many departments have anti-discrimination policies, yet inequities in opportunities, facility use, and physical activity persist. A flaw of Title IX is the intersection of gender with other personal characteristics place any such arguments outside of the purview of Title IX.⁶⁰ Thus, inequities attributable to a combination of gender and race/ethnicity, sexual orientation, and/or religion could not be addressed using Title IX. Thus, the burden falls on institutions of higher education in the US to proactively address inequities in campus recreational facility access/use by holding themselves accountable to their existing anti-discrimination policies.

Environment

Both the physical and built environment can influence physical activity behaviors. The built environment refers to the human-made space and surroundings in which individuals participate in activities,⁶¹ and it can have a considerable impact on physical activity behaviors. For example, specific to campus recreation facilities, the built environment encompasses facility location, facility design, as well as the type and orientation of equipment and other amenities within facilities. Physical location of facilities is important, as proximity of facilities to one's place of residence can influence use and therefore activity levels. Students residing closer to facilities report greater physical activity,⁶²⁻⁶⁴ and the proximity of student housing to campus can also influence active travel (walking or biking for travel),⁶⁵ as can bike lanes and the connectedness of bicycling infrastructure the community.⁶⁶ Colleges spend a considerable amount of money on campus recreational facilities and programs, which are important retention and recruitment tools.⁶⁷

Environmental factors that influence student physical activity extend well beyond the tangible natural and built environment. Environmental factors also include the organizational setting (i.e. the size and function of the educational institution), the “human aggregate” that is the socio-cultural characteristics of those in an environment, and the “social capital”, or supportiveness, of the setting for physical activity.⁶⁸

Interpersonal factors

Social support, both perceived and real, can be a facilitator or barrier to physical activity depending on its presence or absence in emerging adults.^{69,70} Social support pertains to the belief, or perception, that one is cared for, esteemed and valued, and belongs to a network⁷¹ and is particularly important during stressful times⁷² which are common for college students. Research from other populations has demonstrated a positive association between social support and physical activity across the lifespan.⁷³⁻⁷⁷ While some research has found no relationship between social support and physical activity,^{45,78} other research indicates that the absence of social support is a barrier to physical activity among students⁷⁹ and that the source and type of social support may influence the relationship between support and physical activity.⁸⁰ In addition, negotiation of interpersonal constraints are among the most frequently employed strategies employed by college students to be physically active,^{44,81-84} and have been shown to differentiate between those who insufficiently active and those who are physically active.⁴⁴

Intrapersonal

In addition to supportive interpersonal relationships, environments, and policies individuals must also possess the confidence (efficacy) and motivation to participate in physical activity. Enjoyment⁸⁵⁻⁸⁸ and self-efficacy are both predictors of physical activity.⁸⁹⁻⁹² Motivation is also commonly associated with physical activity, and is an important factor consider given motives differ considerably based on socio-demographic characteristics.^{87,93-97} However, findings suggest that the ability to negotiate physical activity constraints, rather than motivation be to be physical

active, is a stronger predictor of behavior.⁴⁴ In that the relationship between motives with physical activity is mediated, likely fully, by constraint negotiation.⁹⁸⁻¹⁰⁴ Thus, facilitation of constraint negotiation is fundamental to physical activity promotion, and differences in constraints should contribute to the design of interventions. For example, women are more constrained overall, in particular by intrapersonal constraints such as a lack of motivation/interest, a lack of self-confidence, participation being too fatiguing, and health problems, as well as interpersonal constraints.¹⁰⁵⁻¹¹¹ In addition to the aforementioned psychological intrapersonal factors, socio-demographic characteristics (i.e. gender, race/ethnicity, sexual orientation, and religion, etc.) also influence physical activity levels as evident by physical activity inequities based on such characteristics.

Physical activity inequities

Physical activity participation levels tend to follow a social gradient, with those less advantaged tending to be less physically active, and more likely to experience the adverse health outcomes associated with insufficient physical activity.¹¹² Of the factors mentioned above, many are controllable by those in positions of power, and it is common for them to be embedded in larger societal power structures.¹¹³ By contrast, while some socio-demographic characteristics are fluid, gender identity, race/ethnicity, sexual orientation, religion, etc. are largely outside of individuals' control. Moreover, such characteristics can, and should, not be treated as categories of experience.¹¹⁴ The interaction of socio-demographic characteristics with other factors such as policies, environments (social and built) and other individuals can impact physical activity. For example, a Muslim woman may experience greater difficulty using a shared space to exercise compared to an irreligious man or woman, or Muslim man. Thus, it is important efforts are made to implement and enforce policies, construct environments, and alleviate interpersonal and psychological constraints to provide equitable physical activity participation opportunities for all individuals

Understanding the reasons underpinning existing inequities is necessary to address them, but the initial step is demonstrating their existence based on the intersection of socio-demographic characteristics and demanding that researchers examining physical and other health behaviors and outcomes begin to assess and acknowledge inequities in health behaviors and outcomes based on the intersection of these characteristics. After establishing the existence of inequities the reasons underpinning them, particularly reasons that are readily and tangibly changeable, must be identified and solutions proposed and tested.

Scope/Aims

Many college students participate in insufficient physical activity, and better understanding of inequities is imperative to informing effective interventions. A review of the contemporary college student physical activity literature is needed to guide ongoing research practices concerning student physical activity and ultimately begin to generate quality evidence that can inform successful physical activity promotion. Establishing that there are physical activity, both aerobic and muscle-strengthening activity, inequities (disparities) based on the intersection of socio-demographic characteristic is important to guide researchers and physical activity promoters to not treat such characteristics as mutually exclusive. Finally, how various factors interact to influence student physical activity inequities is poorly understood. The overarching goal of this dissertation is to address these gaps in knowledge and provide a foundation to guide future research and efforts pertaining to the provision of equitable physical activity opportunities during emerging adulthood. The aims of each dissertation study are listed below:

- **Chapter 2:** To critically examine the design and quality of contemporary research involving college student physical activity participation, focusing on physical activity measurement, assessment of socio-demographic characteristics, and examination of inequities based on socio-demographic characteristics.

- **Chapter 3:** To examine aerobic and muscle-strengthening activity participation disparities based on the intersection of gender and race/ethnicity among US college students.
- **Chapter 4:** To examine aerobic and muscle-strengthening activity participation disparities based on the intersection of gender and sexual orientation among US college students.
- **Chapter 5:** To examine aerobic and muscle-strengthening activity participation disparities based on gender identity among US college students.
- **Chapter 6:** To examine college women's perceptions of factors contributing to gender inequities in physical activity and campus recreational facility use, and to explore/identify strategies to address these barriers and provide more equitable student physical activity participation opportunities.

Chapter 2

A scoping review on college student physical activity: How do researchers measure activity and examine inequities?

Oliver W. A. Wilson., Michael Panza., M. Blair Evans. B., & Melissa Bopp

Abstract

Background: The purpose of this scoping review was to critically examine the design and quality of contemporary research involving college student physical activity participation, focusing in particular on measurement of physical activity, assessment of socio-demographic characteristics, and examination of disparities based on socio-demographic characteristics. **Methods:** Systematic searches were conducted in four electronic databases. **Results:** From 28,951 sources screened, data were extracted from 488 that met inclusion criteria. The majority of studies were cross-sectional in design (91.4%) and employed convenience sampling methods (83.0%). The median number of students meeting the aerobic physical activity recommendations (equivalent of 150min/week of moderate physical activity) and muscle-strengthening activity recommendations (two or more times/week) were 58.1% (n=133) and 47.8% (n=8) respectively. With the exception of age and sex, socio-demographic characteristics were rarely assessed, and disparities based upon them even more scarcely examined, with no apparent increase in reporting over the past decade. **Conclusions:** Physical activity levels among college students remain concerningly low. The generalizability of the findings from contemporary literature is limited due to study design, and acknowledgement of the influence that socio-demographic characteristics have on physical activity has largely been overlooked. Recommendations for future research directions and practices are provided.

Introduction

A massive amount of research has been, and continues to be, conducted on physical activity participation among college students across a range of fields. Such research is crucial to promoting physical activity during emerging adulthood (18-25 years¹⁶), a sensitive period in the lifespan for shaping lifelong health trajectories through the development of health behavioral tendencies and habits.¹⁷ Such research should be a priority given the association of physical activity with physical and mental health.^{1,115} Especially because many college students are insufficiently physically active,¹¹⁶ and adverse physical (e.g. hypertension, obesity, and metabolic syndrome^{25,28-30,117}) and mental health (e.g. anxiety, stress, and depression^{118,119}) outcomes are already prevalent among college students. Furthermore, previous efforts to increase student physical activity have largely proven ineffective to date.^{36,37}

Given the size of the body of literature and the importance of this research to the current and future health and wellbeing of both students and wider society, ensuring that college student physical activity research is of high quality, inclusive, and produces meaningful and generalizable results is of paramount importance. The goal of this paper is to review the contemporary body of college student physical activity literature in order to guide future research and efforts to promote college student physical activity. In particular, several aspects of the literature are worth reviewing, including: physical activity measurement, sample characteristics, and the acknowledgement and examination of physical disparities activity based on socio-demographic characteristics.

First, measurement is a core component of quality research, and has emerged as a fundamental concern in physical activity research.¹²⁰ While advances in technology have made objective measures such as wearable activity monitors more accessible and affordable,¹²¹ self-report physical activity measures will likely continue to be used in observational research. Though susceptible to overreporting of physical activity,^{122,123} valid and reliable self-report

measures of physical activity, such as the International Physical Activity Questionnaire (IPAQ) and Global Physical Activity Questionnaire (GPAQ), are available.^{124,125} Such tools are relatively inexpensive and easy to administer in comparison to existing objective measures. However, it is currently unclear to what extent valid and reliable self-report measures, such as the IPAQ and GPAQ, are used in observational research, or whether there has been an increase in use of objective measures in observational research as has been observed in intervention studies in recent years.¹²⁰

The nature of student samples which are relatively convenient, inexpensive, and accessible¹²⁶ is also important to consider. Although there is often strong reasoning to target college students, the convenience of student samples places the onus on researchers to consider the population to which their research generalizes. Recent commentary among social scientists reflects this, with studies revealing student populations differ significantly from the general population with respect to their attitudes, along with more fundamental processes like visual perception and cooperation.^{127,128} This relates to how physical activity researchers sample participants, to the extent that convenience sampling with college students may limit generalizability and increase the risk of bias.¹²⁹ Thus, the approach to sample and represent college student samples is critical to explore.

Third, examining physical activity determinants is an important prerequisite for the design of relevant, effective, and scalable policies and multi-component programs that increase physical activity across society.¹³⁰⁻¹³² While there are multiple, and interacting, determinants of physical activity, including intrapersonal, interpersonal (social and cultural), organizational, community, physical environment, and policy factors,⁴⁰ socio-demographic characteristics are one factor that physical activity varies based upon.¹³³ Physical activity tends to follow a social gradient, with those less advantaged tending to be less physically active, and more likely to experience the adverse health outcomes associated with inactive lifestyles.¹¹² Thus, examining

physical activity disparities based on socio-demographic characteristics, such as gender and race/ethnicity,¹⁹ is crucial to informing policies and programs that account for the influence of socio-demographic characteristics on behaviors.^{134,135} Considering the measurement and reporting of socio-demographic characteristics is especially critical within college student samples that are predominately ‘WEIRD’ - Western, Educated, Industrialized, Rich, and Democratic.”¹³⁶

A contemporary, or current, review of the literature is needed to guide ongoing research practices concerning student physical activity participation and health,^{137,138} and ultimately begin to generate quality evidence that can inform successful attempts to increase student physical activity. Thus, the purpose of the present review is to examine: (1) study design and quality, (2) physical activity measurement, and (3) assessment of, and analyses of differences based upon, socio-demographic characteristics within the contemporary college student physical activity literature. In doing so, this review offers the most encompassing perspective of college student physical activity research to date.

Methods

This scoping review was undertaken according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses protocol.¹³⁹ A comprehensive search strategy and selection process identified contemporary sources that report original research studies examining college student physical activity behaviors that have been conducted since the World Health Organization (WHO) released the first global guidelines on physical activity and health that included recommendations regarding both aerobic physical activity and muscle-strengthening activity in June 2010.¹⁴⁰ A critical note is the publication time range included when selecting articles. Only research conducted from 2011 onwards was included in order to review research that has been conducted since the WHO’s recommendations on physical activity and health.¹⁴⁰

Search Process

A systematic search was conducted in October 2019 using queries developed for several databases, including: ERIC (ProQuest), PubMed (MedLine), Sports Discus (EBSCOHost), and Web of Science (Clarivate) to ensure that all sources were identified. The search strategy and queries were reviewed and approved by a reference librarian. Strategies were uniquely designed relative to each database, and integrated controlled vocabulary for databases (e.g., MeSH terms for PubMed).

Three search term groups were included in search strategies. The first group used terms concerning college/university/higher education samples. The second group search included the term student, and similar terms, to specify the student population in addition to the context. Finally, the third group used terms relating to physical activity. Regarding search filters, the search was restricted to English only. The full search strategies are located in Appendix A.

Source Selection

Following the database search, sources were aggregated within a database manager (EndNote). Next, duplicates were removed using The Systematic Review Assistant-Deduplication Module (SRA-DM), which has been shown to be a reliable program to remove duplicate records with excellent sensitivity and specificity.¹⁴¹ Remaining duplicates were removed using EndNote software de-duplication function,¹⁴² and manually during abstract and title review. The lead and second authors screened the remaining sources at the level of title and abstract to exclude ineligible courses. The screening process was managed through the web application Rayyan QCRI.¹⁴³ From a sub-sample of 662 doubly-coded articles, screeners agreed on 99% of decisions. After discussing discrepancies, the remaining titles and abstracts were screened.

Source selection was guided by the inclusion and exclusion criteria detailed in Table 2.1 that were established to acquire a comprehensive list of sources examining college student physical activity behaviors. Although only research published in English was considered for inclusion, no restrictions were placed on location.

With respect to participants, only sources that included college, university, or post-secondary students were included – including both traditional 2-year and 4-year institutions. Studies were excluded if the sample included exclusively individuals who were likely to have unique physical activity patterns (i.e., student-athlete populations), or if the sample included non-students, such as university staff or community members. Age restrictions were also applied beyond the student population criteria using the range of emerging adulthood (i.e., 18-24 years of age). Sources were included if the entire sample was within this range – or if the mean plus the standard deviation was below 24 years of age (i.e., no more than 15% of participants older than 24 years). These inclusion/exclusion criteria were selected to critically analyze literature focused on college student physical activity, focus conclusions on an important developmental period, and limit heterogeneity among sources.

Regarding the study design, quantitative behavioral observational, correlational, or longitudinal (non-intervention) studies that included physical activity as a core outcome or predictor were included. Experimental studies focusing on the effects of acute exercise or performance (e.g. physiological or biomechanical changes) among students were excluded, as were health-focused intervention studies given the potential bias associated with recruiting participants to such studies.¹⁴⁴⁻¹⁴⁶ Along similar lines, studies were excluded if they focused exclusively on a specific form of physical activity such as occupational physical activity, active transportation, or participation in a specific sport.

Data Extraction and Risk of Bias Assessment

All sources that met inclusion criteria proceeded to data extraction. Details regarding study characteristics, methods used to measure physical activity, and percentage of students meeting physical activity recommendations were extracted. In addition, details concerning whether socio-demographic characteristics were assessed, whether they were reported, and whether they were used to examine physical activity disparities and, if so, the nature of the

association (i.e. statistically significant or not) were extracted. The lead author extracted information using a standardized critical appraisal tool (see Appendix B) and entered data into a Microsoft Excel spreadsheet.

Sources were also reviewed to address risk of bias in relation to study methods and reporting using an adapted coding tool. The six item tool is available in Appendix C, and was developed based on quality assessment criteria adapted from those commonly used in social sciences.¹⁴⁷⁻¹⁵⁰ A Cohen's κ ¹⁴³ was computed for a sub-sample of 10 sources, and found to reach acceptable reliability ($\kappa = 0.88$; 93.3% agreement). The lead author coded remaining articles, flagged instances of uncertainty regarding coding, and later discussed with co-authors to arrive at a consensus.

Analyses

Sources were primarily analyzed descriptively, by reporting the frequency and distribution of studies in relation to each key aspect within the code sheet. When reporting frequencies, sources were grouped in certain occasions based on the physical activity measurement tool that was employed, considering the substantial heterogeneity in behavioral measures.

Results

The initial searches retrieved 22,126 sources following deduplication, which were screened at the level of title and abstract followed by a full-text review of 1,187 sources. Ultimately, 488 were identified and proceeded to qualitative synthesis. Figure 2.1 details the flow of articles through the review process according to PRISMA guidelines.¹³⁹ Citations for all 488 sources included in this review are listed in Appendix D.

Study Characteristics

The majority of sources were cross-sectional in design ($n=446$, 91.4%), with a number of longitudinal studies as well ($n=42$, 8.6%). With exception of a single dissertation, all were peer-

reviewed journal articles. Most studies ($n=405$, 83.0%) employed convenience sampling, with some utilizing random ($n=65$, 13.3%) or purposive ($n=16$, 3.3%) sampling, and singular studies using cluster and non-probability sampling.

One hundred and four studies (21.3%) reported information necessary to determine response rate. The median response rate was 89.5% with an IQR of 69.3% to 93.5%. There was substantial variability in sample sizes, with a median of 356.5 participants with an IQR of 189 to 707. Only a small number of studies ($n=65$, 13.3%) reported conducting power analyses.

Just over half of studies ($n=254$, 52%) reported whether funding was received, among which more than half received federal/national ($n=94$, 37.0%), state/provincial/regional ($n=17$, 6.4%), or internal ($n=61$, 24.0%) funding, with about a third receiving no funding ($n=82$, 32.3%). The location in which studies were conducted is displayed in Figure 2.2. It is evident that much of the college student physical activity research published in English originates from North America, in particular the United States ($n=153$). Research conducted in Africa, the Caribbean, South America, South Asia, and South-east Asia is largely attributable to the work of one group of researchers, and there is a dearth of research beyond that conducted by this group in these areas. Several regions, such as Scandinavia and the Middle East are also worth noting for the lack of college student physical activity research.

Studies were coded regarding theoretical frameworks identified by the authors as having guided the research question. Some studies were underpinned by theoretical frameworks ($n=69$, 14.1%). Among these studies, self-determination theory was the most common ($n=26$, 37.7%), followed by social cognitive theory ($n=18$, 26.1%), and the theory of planned behavior and transtheoretical model which were each used in 12 (17.4%) studies.

Upwards of 80 studies concerning college student physical activity are published each year on average based on the number of studies published from 2017 to 2019 (Figure 2.3). The apparent upward trend in number of studies in Figure 2.3 is attributable to the exclusion of studies

that included data collected prior to 2011. Based on studies that reported a data collection date ($n=259$), the average time from collection to publication exceeded two years (2.7 ± 1.5 years), with more than a quarter ($n=72$, 27.7%) taking four or more years to be published.

The majority of studies were determined to have relatively poor quality. Only 141 (29.5%) received a score between four and six, indicating that study design or reporting lacked several characteristics that protect from bias (Table 2.2).

Regarding common quality items that went unreported, few studies reported using inclusion/exclusion criteria ($n=91$, 18.6%), and roughly a third reported information regarding the setting of the study ($n=157$, 32.4%). Less than half of studies reported sufficient information when describing the characteristics of participants ($n=212$, 43.4%). In many instances, this was attributable to failing to report an average age along with the variance.

Perhaps given the availability of validated self-report physical activity measures, most studies reported adequate details on the measurement of aerobic physical activity ($n=415$, 85.0%), and measured physical activity in a manner conducive to determining whether aerobic physical activity recommendations were met ($n=380$, 77.9%). Nevertheless, 94 studies (19.3%) measured physical activity in a manner that did not allow the variance of physical activity to be reported. Typically, this was the case in studies using physical activity measures that were unvalidated and which used binary or ordinal measurement scales.

Physical activity

Among the studies that reported the percentage of students meeting aerobic physical recommendations ($n=133$) based on the selected criteria (600 weekly MET-mins, 150 min of MVPA/week, 30 min of MPA at least five days/week, or meeting CDC, ACSM, or WHO recommendations) the median number of students meeting physical activity recommendations was 58.1% with an IQR of 45.6% to 77.4%. Among the studies that reported the number of

students that meet muscle-strengthening recommendations ($n=8$), the median number of students meeting recommendations was 47.8% with an IQR of 43.3% to 55.7%.

Physical activity measurement. Aerobic physical activity was assessed exclusively in most studies ($n=432$, 93.2%), with muscle-strengthening activity assessed exclusively in only two studies (0.4%), and both aerobic and muscle-strengthening activity assessed in 31 studies (6.4%).

Among the studies that assessed muscle-strengthening activity, all but one assessed muscle-strengthening activity in manner that would allow determination of students meet recommendations. Among studies that assessed aerobic physical activity, most used exclusively self-report measures ($n=445$, 92.4%), with 21 studies (4.3%) using exclusively objective measures, and 20 studies (4.1%) using both self-report and objective measures. Among the 41 studies that used objective measures, accelerometers were the most common ($n=31$, 75.6%), followed by pedometers ($n=8$, 19.5%) and other measures ($n=2$, 4.9%). As depicted in Figure 2.4, the use of objective measures has not increased over the past decade.

A wide range of self-report measures were used to assess physical activity. The most common was the International Physical Activity Questionnaire (IPAQ, $n=163$, 35.0%), followed by the Godin Leisure-Time Exercise Questionnaire (GLTEQ, $n=45$, 9.7%) and Global Physical Activity Questionnaire (GPAQ, $n=25$, 5.4%). Six studies (1.3%) assessed physical activity using the National College Health Assessment (NCHA) items, and four (1.1%) using ecological momentary assessment (EMA).

Other studies used a variety of measures, many of which were author-developed or not supported by a reference in the methods. These studies were categorized based on whether they assessed frequency, intensity, or duration. Trends in self-report measures of aerobic physical activity are depicted below in Figure 2.5, with polynomial trendlines plotted. The use of physical activity questionnaires, i.e. the IPAQ and GPAQ, appears to be increasing, while the use of the GLTEQ is declining. The use of non-validated measures that assess frequency, intensity and

duration remains steady over time, and the use of measures that do not assess frequency intensity and duration appear to have leveled off.

Socio-demographic characteristics

Before reporting the examination of socio-demographic characteristics within the literature, it is worth noting the types of students that were included in studies. The majority of studies included students from the general student body, with no extra inclusion criteria or specification ($n=316$, 64.8%). The next most common type of participants were students studying medicine or a related field ($n=85$, 17.4%), followed by first-year students in general ($n=41$, 8.4%), students enrolled in a course that involved a physical activity component ($n=29$, 5.9%), and students enrolled in wellness type courses ($n=17$, 3.5%).

Various socio-demographic characteristics were assessed and reported-on within studies. Age and sex were the only characteristics assessed by the majority of studies, with race/ethnicity the next most commonly assessed characteristic in 33.4% of studies (Table 2.3). Frequency of measuring and reporting any socio-demographic characteristics decreased beyond race/ethnicity (i.e., sexual orientation, year of study, socioeconomic status). Only 5.5% of studies examined differences in physical activity based on age, and sex (i.e. men vs. women) was the only other characteristic of which more than 5% of studies examined physical activity disparities. Physical activity differed based on sex in ~80% of studies in which this disparity was examined, whereas differences were more mixed based on all other characteristics. Additional analyses indicate that examination of disparities is not improving over time.

Discussion

A review of the physical activity literature pertaining to college students is long overdue. To the authors' knowledge, this review is the largest ever conducted on this topic. While the size of this review limits the ability to go into study details, it provides a broad overview of how college student physical activity behaviors are being studied.

Surveillance of physical activity participation among emerging adults and physical activity disparities are necessary to support planning, monitoring, and evaluation of any interventions. A high volume of studies examining college student physical activity continue to be published annually, but there remains a great deal of room for improvement with respect to study design, physical activity measurement and reporting, and examination of disparities based on socio-demographic characteristics. The following discussion highlights the key learning lessons from this review and recommendations for future research. The most notable findings to emerge concern trends in measurement, as well as the lack of reporting regarding disparities in physical activity.

Although the primary goal of this review was not to provide an epidemiological snapshot of college student activity levels, the aggregation of studies provided an opportunity to examine the proportion of students who meet physical activity guidelines. The current review found that more than 40% of students did not meet aerobic recommendations, and more than half did not meet muscle-strengthening recommendations. These findings are concerning as they are based on self-reported measures and pertain to meeting what is a fairly low level of activity with respect to aerobic physical activity recommendations. Such findings highlight the need for development and evaluation of cost-effective population-level interventions that promote physical activity and health among emerging adults.

Study design

Findings demonstrate the majority of research is conducted using convenience sampling methods, and that it is predominantly conducted at post-secondary educational institutions located in North America. This greatly limits the generalizability of findings to the general student population, and students residing in countries outside of North America. In addition to conducting more research in countries outside of North America, researchers should employ random sampling techniques to reduce the limitations associated with convenience sampling, such as

omission and inclusive biases. If convenience sampling is employed, the response rate should be reported, preferably using CHERRIES.¹⁵¹

Regardless of the sampling technique, researchers should assess age, gender identity, race, and sexual orientation of participants and report these characteristics in full. The third iteration of the American College Health Association NCHA provides a good example of items that assess the aforementioned socio-demographic characteristics.¹⁵² Researchers examining students outside of United States, even in more racially or ethnically homogenous contexts, should still assess the composition of their sample in a manner that allows comparisons to be made between advantaged and disadvantaged groups and determination of sample representativeness. Researchers should also comment on the representativeness of the sample in comparison to the population, if possible, and report any inclusion/exclusion criteria.

Physical activity measurement and reporting

Despite the superior accuracy and reliability of objective physical activity measurement methods,^{122,123} this review found that there has not been an increase in their use during the time period from 2011 to 2019. However, while the convenience and affordability of self-report measures mean that they will likely remain the most common method of physical activity measurement, findings also demonstrated that there is much room for improvement with respect to the use of valid and reliable physical activity measures and reporting of physical activity methods and results.

Researchers should strive to use measures that allow determination of whether participants meet aerobic activity recommendations, which provides a standard to compare the sample against and to compare to target populations. Furthermore, activity measures should allow for calculation of physical activity volume (i.e. assess the frequency, intensity, and duration of physical activity). Although these aims could be achieved through several measures, the IPAQ or GPAQ are the most widespread measures that can achieve these aims. The apparent increase in

the use of the IPAQ/GPAQ is promising and provides another incentive to use such measures so that they can compare findings with those in the contemporary literature.

There were nevertheless limits to the scope of activities measured, with most studies evaluating aerobic activities. With respect muscle-strengthening activity, there is clearly a need for both further research and greater measurement consistency. In the absence of an objective measure, it is recommended that researchers assess muscle-strengthening activity using items similar to those used by the Behavioral Risk Factor Surveillance System (BRFSS) and the NCHA. Regardless of the methods used, methods should be reported according to the physical activity questionnaire reporting checklist,¹⁵³ as should results with the addition of the number of participants meeting the aerobic and muscle-strengthening guidelines which should be specified.

Physical activity disparities

Future researchers should also acknowledge that physical activity varies based on socio-demographic characteristics,¹³³ including gender identity, race/ethnicity, and sexual orientation. As explained above in relation to sampling, these characteristics are absolutely vital for describing a given sample and for putting samples into ‘context’ alongside target populations. Nevertheless, reporting is likely not enough to advance best practices – additional research is needed to examine how sociodemographic characteristics intersect to predict physical activity behavior. As such, researchers should either examine disparities based on these, and other, characteristics, and/or include them as covariates/controls when conducting analyses. Adopting an intersectional approach has proven valuable in previous research concerning physical activity.^{154,155}

Conclusion

In summary, this review found that many college students do not meet physical activity recommendations, demonstrating the need for the implementation of policies, programs and practices designed to promote physical activity among students. Comparison of findings between

studies would be greatly improved with the adoption of valid and reliable measures of physical activity, including muscle-strengthening activity, as well as employing random sampling techniques to reduce the biases associated with convenience sampling. Finally, socio-demographic characteristics should be assessed in all studies and used report on disparities, or lack thereof, in in physical activity regardless of the statistical significance or consistency with the literature. Taking the aforementioned steps will help guide the field forward and have the potential to eventually facilitate and implementation and evaluation of policies, programs and practices designed to promote college student physical activity.

Table 2.1: Inclusion/exclusion criteria

	Inclusion	Exclusion
Language	English	Non-English
Date range	Data 2011 onwards	Data collected before 2011 Exclusively student athlete samples
Population	College students	Exclusively non-traditional student samples Sample exceeding specified age criteria Exclusively occupational
Core outcome variable	Physical activity and/or exercise	physical activity, active transport, or specific sport
Study design	Quantitative behavioral observational, correlational, or health intervention	Experimental, acute physical activity, performance/outcome focused
Source type	Peer-reviewed publications, dissertations, and theses	Conference abstracts and proceedings

Table 2.2: Study quality

Study Quality	n	%
0	17	3.5
1	36	7.4
2	104	21.3
3	187	38.3
4	93	19.1
5	42	8.6
6	9	1.8

Table 2.3: Assessment of, and analyses of physical activity disparities based upon, socio-demographic characteristics

	Not applicable	Not assessed	Assessed - Differences not examined	Non-statistically significant findings	Statistically significant findings
				%	
Age	0.0	9.8	84.8	3.3	2.0
Sex	14.5	2.3	57.4	4.3	21.5
Gender identity	0.0	99.2	0.6	0.0	0.2
Race/ethnicity	2.0	66.6	27.9	1.2	2.3
Sexual orientation	0.0	99.4	0.4	0.2	0.0
Religion	0.0	96.7	2.9	0.0	0.4
Year of study	10.7	60.7	24.8	2.3	1.6
Academic area/field	9.0	70.9	15.4	1.4	3.3
Academic performance	0.0	93.9	3.9	1.2	1.0
Socio-economic status	0.0	88.8	16.0	1.6	0.6
Living situation	1.8	79.3	16.2	1.0	1.6

Note. Characteristics were deemed as 'not applicable' if a study focused on a specific section of the student population (e.g. women, African Americans, first-year students, medical students, or students residing in university accommodation) thus preventing analyses of physical activity disparities based on the characteristic

PRISMA 2009 Flow Diagram

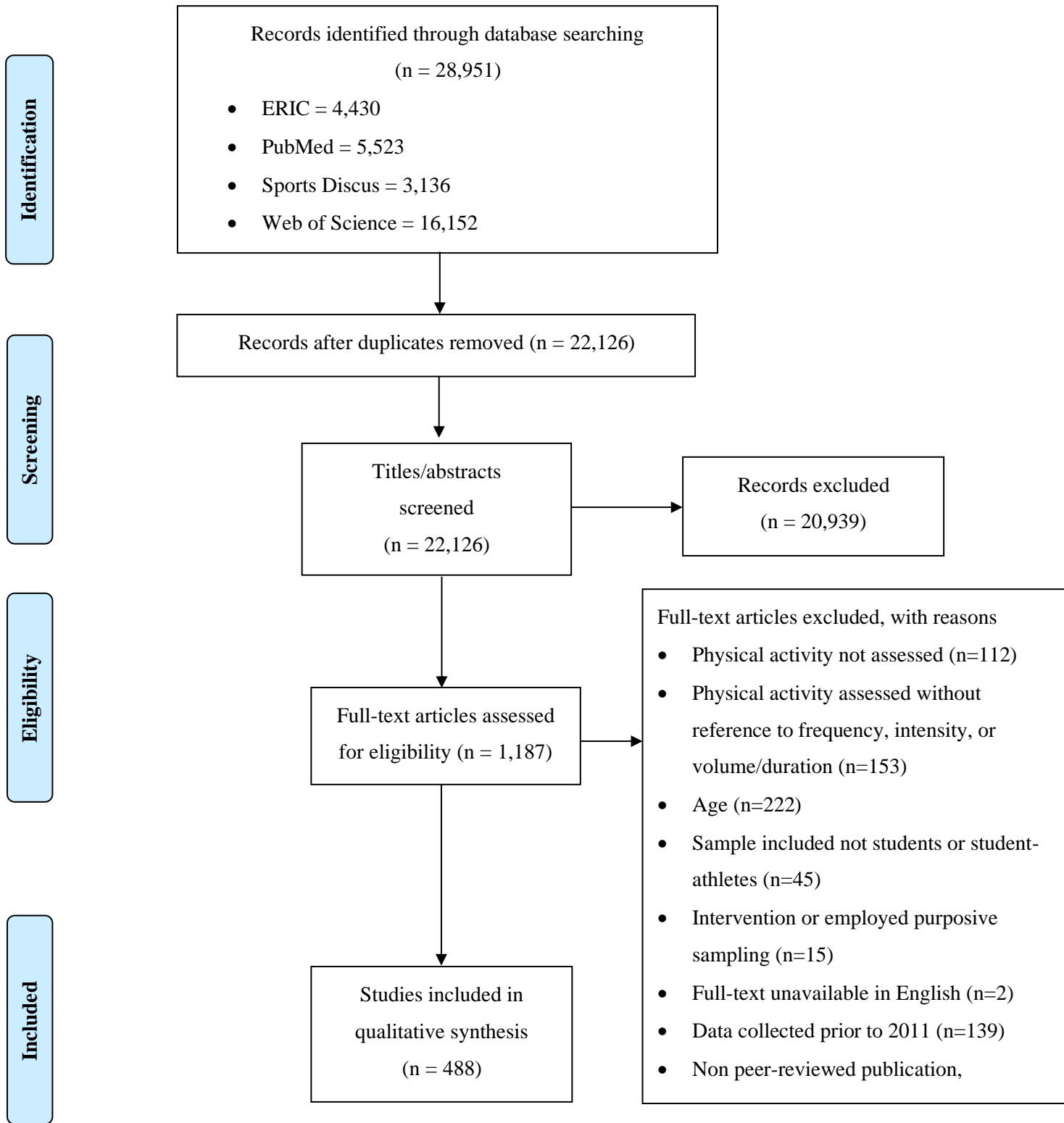


Figure 2.1: Study Flow Diagram

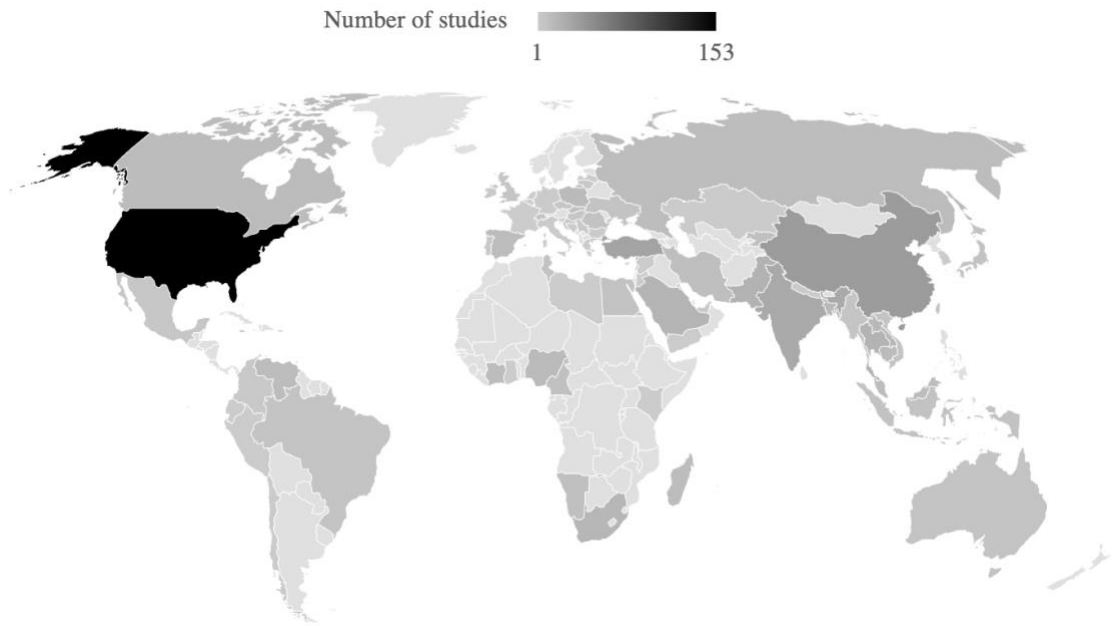


Figure 2.2: Distribution of global college student physical activity research

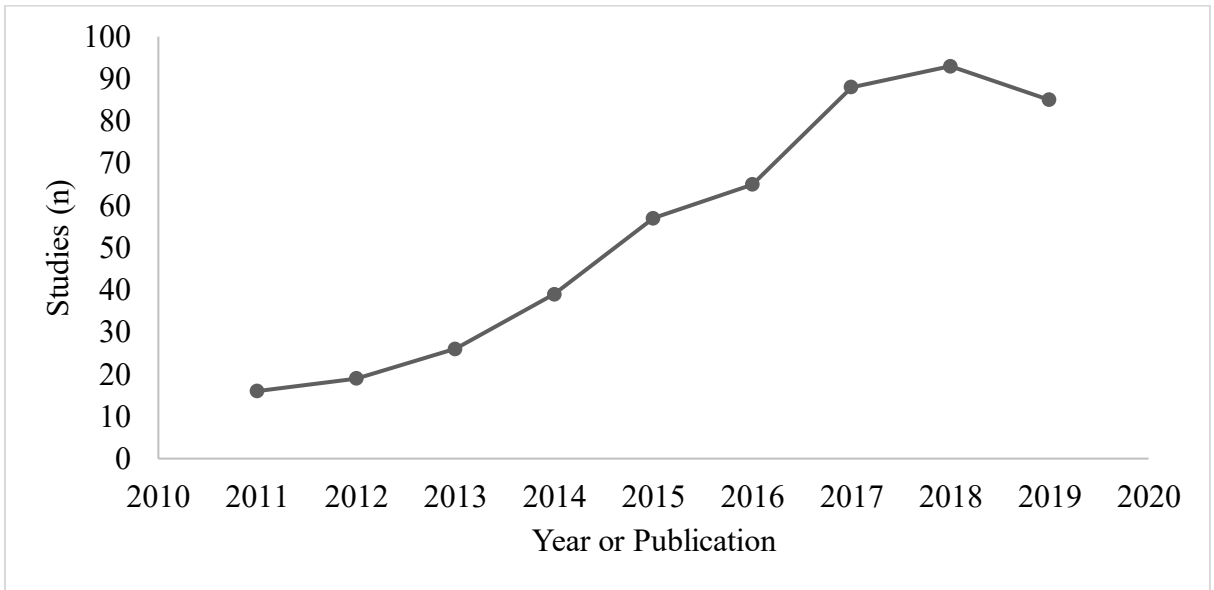


Figure 2.3: Distribution of studies published over time

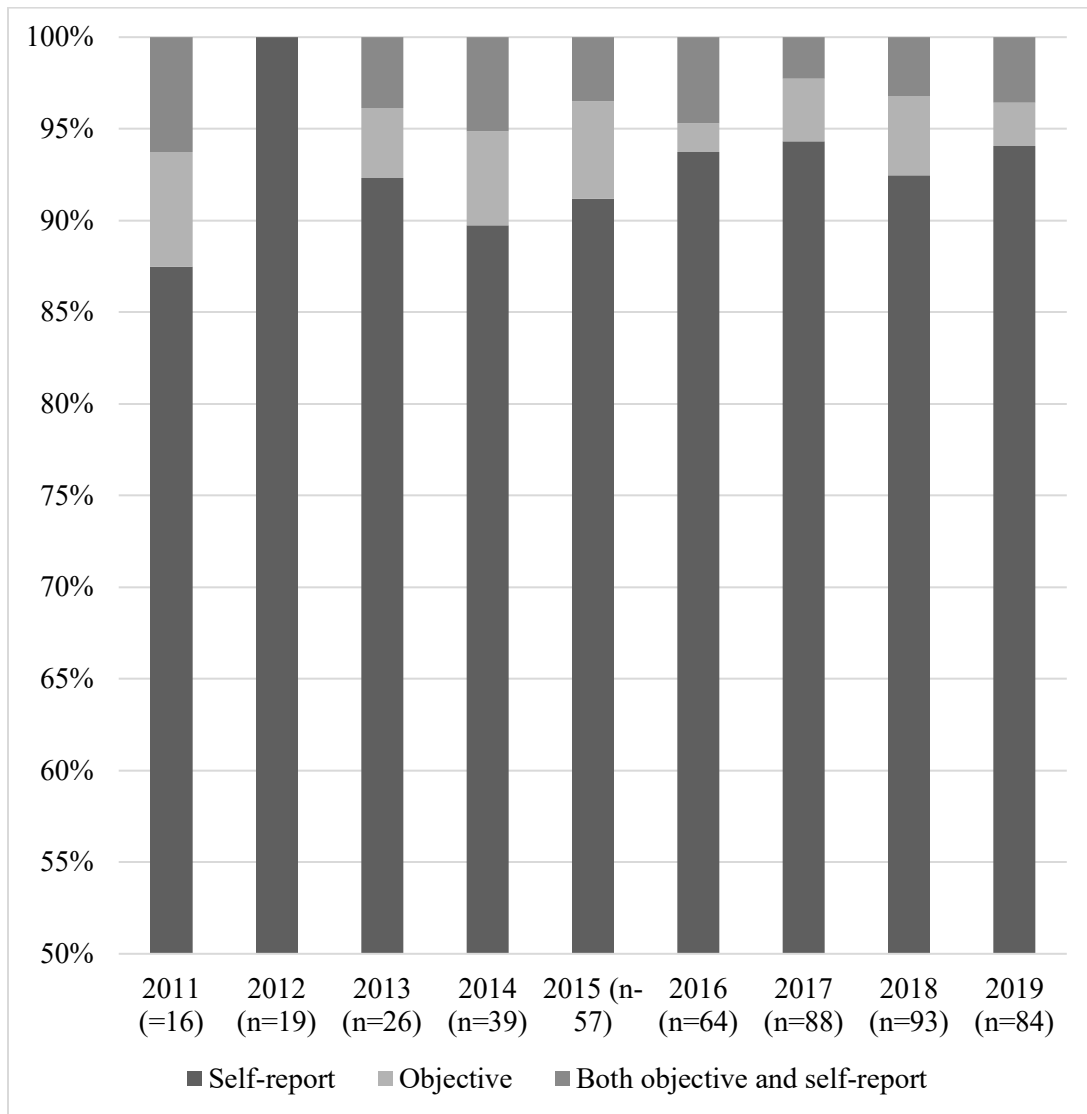


Figure 2.4: Trends in aerobic physical activity measurement

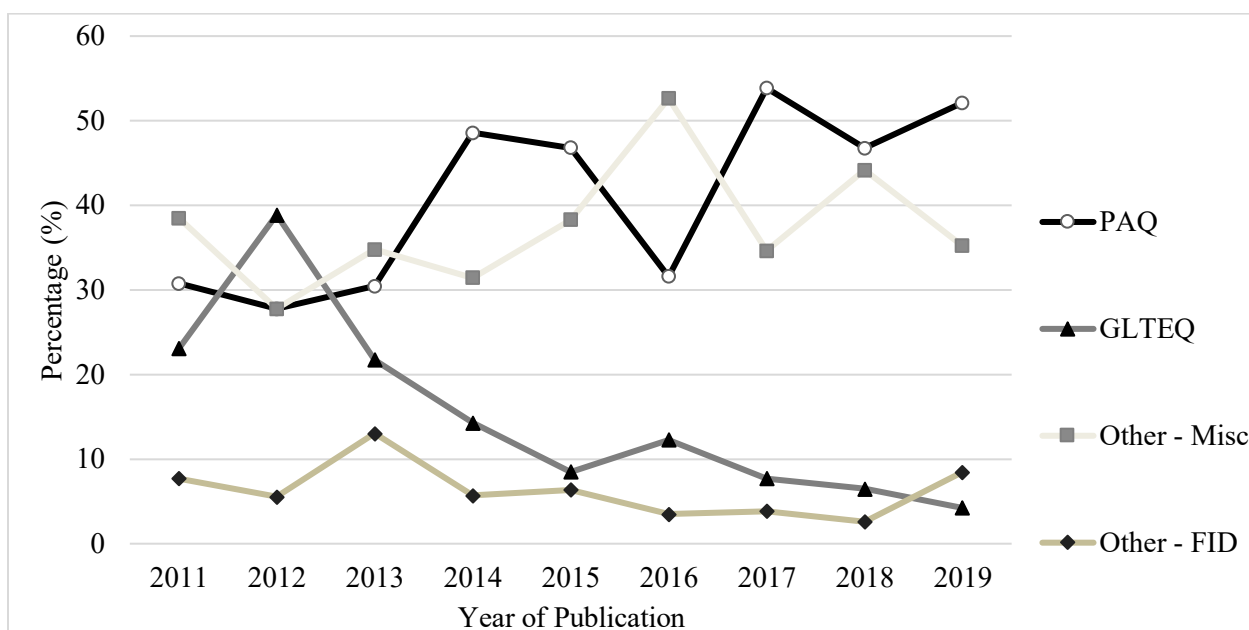


Figure 2.5: Trends in self-report measures of aerobic activity

Notes. PAQ = Physical activity Questionnaire; GLTEQ = Godin Leisure-Time Exercise Questionnaire; Other FID = Other measures that assessed the Frequency, Intensity, Duration (FID) or physical activity

Chapter 3

College student aerobic and muscle-strengthening activity: The intersection of gender and race/ethnicity among United States students

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Abstract

Objective: To adopt an intersectional approach to examine differences in aerobic and muscle-strengthening participation based on the intersection of gender and race/ethnicity among college students. **Methods:** Data from the American College Health Association National College Health Assessment collected between 2015 and 2018 were analyzed. Differences in the prevalence of meeting activity recommendations based on the intersection of gender and race/ethnicity were computed and displayed graphically. Odds of meeting activity recommendations were determined by calculating odds ratios controlling for age, year of enrollment, sexual orientation, and health status. **Results:** Aerobic and muscle-strengthening activity differed significantly between races within genders, and between genders within races. With minor exceptions, men were more likely to meet aerobic and muscle-strengthening activity recommendations than women of the same race/ethnicity. Disparities based on race varied considerably between genders. **Conclusions:** The intersection of gender and race/ethnicity should be considered when examining and addressing physical activity disparities.

Introduction

It is well established that physical activity is beneficial to physical and mental health.¹³³ Thus, addressing physical activity disparities is imperative to addressing health inequities. Like health outcomes, physical activity varies based on socio-demographic characteristics, with those less advantaged tending to be less physically active, and consequently more likely to experience the adverse health outcomes associated with inactive lifestyles.¹¹² To reduce levels of physical inactivity and improve health, cost-effective population-level interventions are needed.¹⁵⁶ Appreciating physical activity disparities is important to inform targeted changes to policies and practices that account for the potential influence of socio-demographic characteristics on behaviors.^{134,135} Gender identity and race/ethnicity are two such characteristics that should be accounted for.

Gender identity refers to one's internal perception of their gender and may not correspond with their sex (male, female) assigned at birth.¹⁵⁷ Gender and sex are commonly confused and used interchangeably within the physical activity literature, but regardless of conceptualization the majority of studies have examined physical activity disparities based on sex, with research pertaining to transgender/non-binary individuals lacking.¹⁵⁸ As far as physical activity disparities based on gender, cis-gender men tend to be more aerobically active than cis-gender women over the course of the lifespan,^{10,19,159-162} while existing evidence suggests that aerobic activity is lower among non-binary/transgender individuals than cis-gender individuals.^{163,164} With respect to muscle-strengthening activities, cis-gender men are more active than cis-gender women,^{19,159-162} while research is lacking concerning differences between cis-gender and gender minorities.

As with gender, physical activity disparities based on race/ethnicity are also evident.^{19,159-162,165} However, in part due to differing measures of race/ethnicity and physical activity, disparities vary considerably based between aerobic and muscle-strengthening activity, and

between children/adolescents and adults in the United States (US) based on analyses of nationally representative data. Among adults, the only consistent results were that more non-Hispanic (NH) Whites meet aerobic activity recommendations than Asians, NH Blacks and Hispanics; and, that Indigenous/Native adults tend to be more active than NH White, Hispanic, and Asian adults.^{19,161} Among children/adolescents, NH Whites participated in more aerobic and muscle-strengthening activity compared to NH Blacks^{160,162} and Hispanics,¹⁶² and racial disparities more evident among women compared to men.^{160,162} Disparities are attributable to a variety of intrapersonal, interpersonal, cultural, environmental, policy factors.¹⁶⁶⁻¹⁶⁹ This is consistent with the socio-ecological model that posits there are various, and interacting, influences on health behaviors such as physical activity, and conceptualizes multiple levels of influence: intrapersonal (e.g. demographic (gender, race/ethnicity, etc.) psychological (self-efficacy, motivation, etc.) , interpersonal (e.g. social support (friends, family, etc.), social environment, etc.), environment (e.g. location and design of recreation facilities, sidewalks, bike lanes, outdoor exercise amenities, etc.), and policy (e.g. recreation facility rules and policies, federal legislation (e.g. Title IX), etc.).⁴⁰

However, physical activity disparities are typically examined based on single socio-demographic characteristics, a monistic approach that is flawed as such characteristics cannot be treated as mutually exclusive categories of experience and analyses.¹¹⁴ Consequently, the intersectional disparities cited above had to be inferred through interpretation of reported results highlighting the need for an intersectional approach that recognizes that socio-demographic characteristics do indeed connect or interact, and therefore potentially influence health behavior disparities. An intersectional approach has the potential to better examine the nature of disparities, or inequalities, in comparison to the traditional monistic approach.¹⁷⁰ Intersectionality offers a framework for considering how inequities are apparent in different populations.¹⁷¹ Intersectionality is underpinned by three principles (simultaneity, multiplicativity, and multiple

jeopardy). Simultaneity suggests that all individual-level socio-demographic characteristics must be investigated given all are present and potentially meaningful.¹⁷² Multiplicativity refers to the notion of examining the connections, or interactions, between socio-demographic characteristics.¹⁷² Multiple jeopardy pertains to the idea that additive analyses are unable to account for the complexity of the interactions between socio-demographic characteristics.

Post-secondary institutions are an ideal setting in which to intervene and equip students with the skills and knowledge to set them on a positive lifestyle trajectory given nearly half of emerging adults in the US pursue post-secondary education,¹⁷³ and this period in life is a sensitive time for the adoption of healthy behaviors.¹⁷ In addition, the disparities by sex and race/ethnicity in aerobic and muscle-strengthening activity observed in the wider population are evident among college students^{88,174-176} highlighting the need to address these disparities in this population.

An intersectional approach to examining physical activity disparities has proven valuable in the past,¹⁵⁴ but has yet to be adopted in a young-adult or college student population, consider gender identities beyond men and women, consider races beyond White and those of color, or examine muscle-strengthening activity disparities. Thus, the purpose of this study was to examine the intersection of gender and race/ethnicity as they pertain to meeting aerobic and muscle-strengthening activity recommendations among a sample of US college students.

Methods

Data from the American College Health Association (ACHA) National College Health Assessment (NCHA) collected between Fall 2015 and Fall 2018 from institutions located in the United States were included in the analyses.¹⁷⁷ Data were deidentified prior to being released by the ACHA for analyses. The NCHA collects data from college students from upwards of 80,000 students each academic year.

Measures

Participant characteristics

Age. Age was assessed to the nearest year.

Gender. Participants specified their sex assigned at birth (female or male) and their gender identity (woman, man, trans woman, trans man, genderqueer, or another identity), which were used to categorize each participant as either a cis-gender woman or cis-gender man. Unless stated otherwise, in the results and discussion cis-gender men and cis-gender women are referred to as men and women respectively

Race/ethnicity. Participants specified their race by selecting all that apply from the following options in response to how they usually describe themselves (White; Black; Hispanic or Latino/a; Asian or Pacific Islander; American Indian, Alaskan Native or Native Hawaiian; Biracial or Multi-racial; or other). Participants were categorized into those who identify as: NH White; NH Black; Hispanic/Latinx; NH Asian or Pacific Islander; NH Indigenous (American Indian, Alaskan Native or Native Hawaiian); NH Biracial or Multiracial; or NH other.

Sexual orientation. Participants specified their sexual orientation by selecting which of the following terms best describes their sexual orientation (asexual, bisexual, gay, lesbian, pansexual, queer, questioning, same gender loving, straight/heterosexual, or another identity). These same categories were used for analyses.

Year in school. Participants specified their year in school as: first year undergraduate, second year undergraduate, third year undergraduate, fourth year undergraduate, fifth year or more undergraduate, graduate or professional, not seeking a degree, or other

Enrollment status. Participants specified their enrollment as: full-time, part-time, or other

Health status. Participants specified their health status by responding to the question “How would you describe your general health?” with: excellent, very good, good, fair, poor, or I don’t know.

Physical activity behaviors. Participants responded to the following three questions regarding how many of the past seven days they did the following (0 to 7 days):

- Do **moderate-intensity** cardio or aerobic exercise (caused a noticeable increase in heart rate, such as a brisk walk) for at least **30 minutes**?
- Do **vigorous-intensity** cardio or aerobic exercise (caused large increases in breathing or heart rate, such as jogging) for at least **20 minutes**?
- Do 8-10 **strength training exercises** (such as resistance weight machines) for 8-12 repetitions each?

For aerobic physical activity the existing NCHA physical activity requirements variable that is based on the 2007 American College of Sports Medicine and American Heart Association guidelines¹⁷⁸ was used to allow researchers to compare findings with past and future research using the NCHA dataset. For muscle-strengthening activity participants were categorized into those who did/not meet muscle-strengthening activity recommendations (≥ 2 days/week) based on the 2018 national physical activity guidelines¹³³.

Statistical analyses

All analyses were conducted using SPSS Version 25.0 (IBM, Armonk, NY). Before exclusion the sample was comprised of 358,543 participants. Those who were not cis-gender, full-time non-varsity athlete, undergraduate students aged ≤ 24 years, as well as those who provided insufficient data to determine whether they met both physical activity and muscle-strengthening activity recommendations were excluded ($n = 142,567$). Analyses were conducted on the remaining participants ($n = 215,976$). Adjusting for multiple comparisons, the significance levels for all analyses were set at $p \leq .001$ and confidence intervals at 99.9%.

Descriptive statistics were computed to characterize the data. Differences in the prevalence of meeting aerobic and muscle-strengthening recommendations based on the intersection of gender and race/ethnicity are displayed graphically. To quantify the magnitude of disparities based on the intersection of gender and race/ethnicity a series of logistic regression analyses were conducted to determine odds ratios, with cis-gender men and NH white serving as

the referents. Age, sexual orientation, year in school, as well as health status were controlled for in analyses. Further analyses with this dataset included the intersection of gender and sexual orientation, and differences between those identifying as cis-gender and transgender. These results fell beyond the scope of this study and are reported elsewhere.^{155,179} The likelihood of meeting activity recommendations relative to the referent group was calculated. Results for participant groups with cell sizes less than five were excluded from those reported.

Results

Participant characteristics

The mean age of participants was 19.99 ± 1.51 years. The majority of participants identified as cis-gender women, NH White, and straight/heterosexual. The majority of participants perceived reported their health status as good, and a similar number of participants were upper and lower classmen (Table 3.1).

Trends in physical activity disparities

Differences in the raw prevalence of individuals meeting activity recommendations in comparison to the population average between intersecting genders and races are depicted for aerobic and muscle strengthening activity in Figures 3.1a and 3.1b respectively. On average, 45.7% of students met aerobic recommendations, and 34.7% met muscle-strengthening recommendations. Overall, more men met aerobic and muscle-strengthening recommendations compared to women. The same was true regardless of race/ethnicity for muscle-strengthening activity, but more NH White and Indigenous women met aerobic activity recommendations than men of some races/ethnicities. Beyond this, it is evident from Figures 1a and b that physical activity varied based on the intersection of gender and race/ethnicity. For example, a similar number of NH White (51.0%) and NH Black (50.4%) men met aerobic activity recommendations, whereas considerably less NH Black women (35.6%) met aerobic activity recommendations

compared to NH white women (46.7%). Subsequent analyses examine the statistical significance and magnitude of such disparities.

Between-race/ethnicity, within-gender disparities

Among men, the only significant disparity in aerobic activity found was that NH Asian or Pacific Islander men were less likely to meet recommendations than NH White men. By contrast, Hispanic/Latino, NH Asian or Pacific Islander, NH Indigenous, NH Biracial or Multiracial men were significantly more likely to meet muscle-strengthening recommendations than NH White men. Among women, NH Black, Hispanic/Latina, and NH Asian or Pacific Islander women were less likely to meet aerobic and muscle-strengthening recommendations relative to NH White women. NH other cis-gender women were also less likely to meet aerobic recommendations than NH White women, whereas NH Indigenous women were more likely to meet muscle-strengthening recommendations than NH White women (Table 3.2).

Between-gender, within-race/ethnicity disparities

NH White, NH Black, Hispanic/Latina, NH Asian or Pacific Islander, and NH Biracial or Multiracial women were less likely to meet aerobic and muscle-strengthening recommendations compared to men. Though, magnitude of differences varied considerably between races and aerobic and muscle-strengthening activity, with disparities greater in relation to meeting muscle-strengthening recommendations. NH indigenous and NH other women were less likely to meet muscle-strengthening recommendations compared to men, whereas no differences were observed in relation to aerobic physical activity (Table 3.3).

Discussion

Findings demonstrate that the intersection of gender and race/ethnicity influence participation in aerobic and muscle-strengthening activity among college students, reinforcing that gender and race/ethnicity should be accounted for when examining and promoting physical activity. The physical activity behavior disparities found in this study have the potential to inform

interventions and changes to policies and practices that account for the influence of gender and race/ethnicity on physical activity and provide equitable opportunities to participate in aerobic and muscle-strengthening activity and consequentially reduce disparities.

Comparing the findings of this study with the those reported in the literature is hampered by inconsistent measurement of race/ethnicity between the NCHA dataset and national data, as well as the lack of delineation by gender when comparing differences in activity based on race/ethnicity among adults. Regardless, after controlling other variables, it is evident that intersection of gender with race/ethnicity has contrasting effects on male and female college students. Findings were relatively consistent with those observed among children/adolescents, with minimal meaningful differences in aerobic activity found among men, and minority men of some racial groups more likely to meet muscle-strengthening recommendations compared to NH White men.^{160,162} Also consistent with previous findings among children/adolescents, women of minority racial/ethnic groups were less likely to meet aerobic, and in particular, muscle-strengthening recommendations in comparison to NH white women and men of the same race/ethnicity.^{160,162}

Gender, race/ethnicity, and other socio-demographic characteristics should be measured when examining physical activity to further understanding of physical activity disparities (inequities) based on socio-demographic characteristics. The sheer magnitude of some of the disparities evident based on the intersection of gender and race/ethnicity is cause for concern. For example, NH Black women were 158% less likely to meet muscle-strengthening recommendations in comparison to NH Black men of whom only 45.5% met recommendations. Thus, participant characteristics should be reported in detail, and disparities in health behaviors and outcomes based on the intersection of socio-demographic characteristics should be examined. Moreover, that there appear to be physical activity disparities based on the intersection of gender and race/ethnicity has practical implications. As such, those interested in physical activity

promotion, from personal trainers and fitness instructors through college administrators and policy makers, should understand that gender and race/ethnicity intersect to influence student physical activity behaviors, and therefore tailor approaches and revise policies and practices accordingly. Evidence of effective physical activity promotion interventions among college students is largely lacking at present.^{36,37} However, improving access to places for physical activity is recommended,¹⁸⁰ and considering socio-demographic characteristics when attempting to design inclusive environments and implement and enforce inclusive policies that facilitate equitable access is crucial. Beyond those interested in physical activity promotion, findings have practical implications for those interested in promoting student health in general given the well between physical activity and physical and mental health and wellbeing.¹³³

This study is not without limitations. One is the measurement of physical activity, in particular aerobic physical activity, using self-report categorical variables. Also, aerobic physical activity items are worded to determine whether individuals meet decade old physical activity recommendations¹⁷⁸ and fail to account for the fact that individuals may accumulate sufficient levels of moderate and/or vigorous physical activity on less than the recommended number of days/week. Thus, findings regarding aerobic physical activity should be interpreted with an element of caution. Another limitation is the lack of heterogeneity of racial groups (Asian or Pacific Islander; American Indian, Alaskan Native or Native Hawaiian; and, Biracial or Multi-racial), as well as the inability, due to small cell sizes, to include non-binary/transgender individuals in analyses. Finally, pertaining to multiple jeopardy, analyses were unable to account for the complexity of the interactions between gender and race/ethnicity. The limitations associated with the measurement of physical activity and socio-demographic characteristics have largely been addressed by the revised NCHA survey.¹⁵² Data collected using this revised iteration of the NCHA should allow for more nuanced analyses of the interactions between gender and race/ethnicity.

In summary, findings reaffirm the value of adopting an intersectional approach to examining physical activity disparities,¹⁵⁴ and highlight the need for a similar approach to be adopted in future. Various interacting factors influence physical activity,⁴⁰ of which gender and race/ethnicity are just two, and all levels of influence must be targeted in order to achieve sustainable behaviors change³⁹ in keeping with simultaneity. With respect to multiplicativity, further research is clearly needed to determine the reasons underpinning the reported disparities based on the connections, or interactions, between socio-demographic characteristics and to identify ways in which they can be reduced.

It is clear that further research is required into the physical activity disparities based on the intersection other of socio-demographic characteristics with one another, as well as interpersonal/community/environment/policy factors⁴⁰ to determine the reasons underpinning the reported disparities, and to identify ways in which they can be reduced. Research should also be conducted in other populations and in relation to other health behaviors and outcomes. It is no longer justifiable to treat socio-demographic characteristics as mutually exclusive categories of analyses and experience.

Table 3.1: Participant characteristics

	n	%
Gender		
Cis-gender men	63958	29.6
Cis-gender women	152018	70.4
Race		
NH White	132548	61.4
NH Black	9228	4.3
Hispanic/Latinx	31840	14.7
NH Asian or Pacific Islander	25004	11.6
NH Indigenous	769	0.4
NH Biracial or Multiracial	13938	6.5
NH Other	2649	1.2
Sexual orientation		
Straight/heterosexual	177602	82.2
Asexual	7834	3.6
Bisexual	14223	6.6
Gay	3624	1.7
Lesbian	2200	1
Pansexual	3232	1.5
Queer	1517	0.7
Questioning	4230	2
Same gender loving	90	0
Another identity	1424	0.7
Year in school		
First year undergraduate	62245	28.8
Second year undergraduate	50881	23.6
Third year undergraduate	51277	23.7
Fourth year undergraduate	41745	19.3
Fifth year or more undergraduate	9828	4.6
Health status		
Excellent	23660	11
Very good	81200	37.6
Good	76541	35.4
Fair	29674	13.7
Poor	4901	2.3

Note. NH = Non-Hispanic

Table 3.2: Likelihood of meeting activity recommendations between-race/ethnicity within-gender (Referent - NH White)

		Aerobic					Muscle-strengthening				
		Likelihood (%)	OR	99.9% CI		p	Likelihood (%)	OR	99.9% CI		p
				Lower	Upper				Lower	Upper	
Referent - NH White											
Cis-gender men	NH Black	-1.6	0.98	0.85	1.14	0.722	6.4	1.06	0.92	1.24	0.178
	Hispanic/Latino	0.1	1.00	0.92	1.08	0.981	25.5	1.26	1.16	1.36	< 0.001
	NH Asian or Pacific Islander	-15.1	0.87	0.80	0.94	< 0.001	12.1	1.12	1.03	1.22	< 0.001
	NH Indigenous	26.5	1.27	0.78	2.06	0.113	68.6	1.69	1.03	2.76	< 0.001
	NH Biracial or Multiracial	0.5	1.01	0.90	1.12	0.892	18.0	1.18	1.05	1.32	< 0.001
	NH Other	-7.000	0.94	0.75	1.17	0.321	3.2	1.03	0.82	1.30	0.649
Referent - NH White											
Cis-gender women	NH Black	-52	0.66	0.6	0.72	< 0.001	-63.4	0.61	0.56	0.68	< 0.001
	Hispanic/Latina	-26.3	0.79	0.75	0.83	< 0.001	-10.9	0.90	0.86	0.95	< 0.001
	NH Asian or Pacific Islander	-40.4	0.71	0.67	0.75	< 0.001	-42.2	0.70	0.66	0.75	< 0.001
	NH Indigenous	27.2	1.27	0.96	1.68	0.005	34.5	1.35	1.01	1.80	0.001
	NH Biracial or Multiracial	-4.5	0.96	0.89	1.03	0.042	-1.7	0.98	0.91	1.06	0.458
	NH Other	-27.1	0.79	0.67	0.93	< 0.001	-18.2	0.85	0.71	1.01	0.002

Table 3.3: Likelihood of meeting activity recommendations between-gender within-race/ethnicity (Referent - Cis-gender men)

		Likelihood (%)	Aerobic				Muscle-strengthening				
			OR	99.9% CI		p	Likelihood (%)	OR	99.9% CI		p
			Lower	Upper		Lower	Upper				
Referent – Cis-gender men of same race/ethnicity											
	NH White	-2.4	0.98	0.96	1.00	0.001	-45.3	0.69	0.66	0.72	< 0.001
	NH Black	-72.7	0.58	0.49	0.69	< 0.001	-158.4	0.39	0.32	0.46	< 0.001
Cis-	Hispanic/Latina	-39.7	0.72	0.66	0.78	< 0.001	-99.6	0.50	0.46	0.55	< 0.001
gender	NH Asian or Pacific Islander	-38.9	0.72	0.66	0.79	< 0.001	-137.0	0.42	0.38	0.47	< 0.001
women	NH Indigenous	-13.3	0.88	0.49	1.58	0.481	-83.2	0.55	0.30	0.99	0.001
	NH Biracial or Multiracial	-16.7	0.86	0.75	0.98	< 0.001	-75.1	0.57	0.50	0.65	< 0.001
	NH Other	-39.3	0.72	0.54	0.95	0.043	-81.2	0.55	0.41	0.74	< 0.001

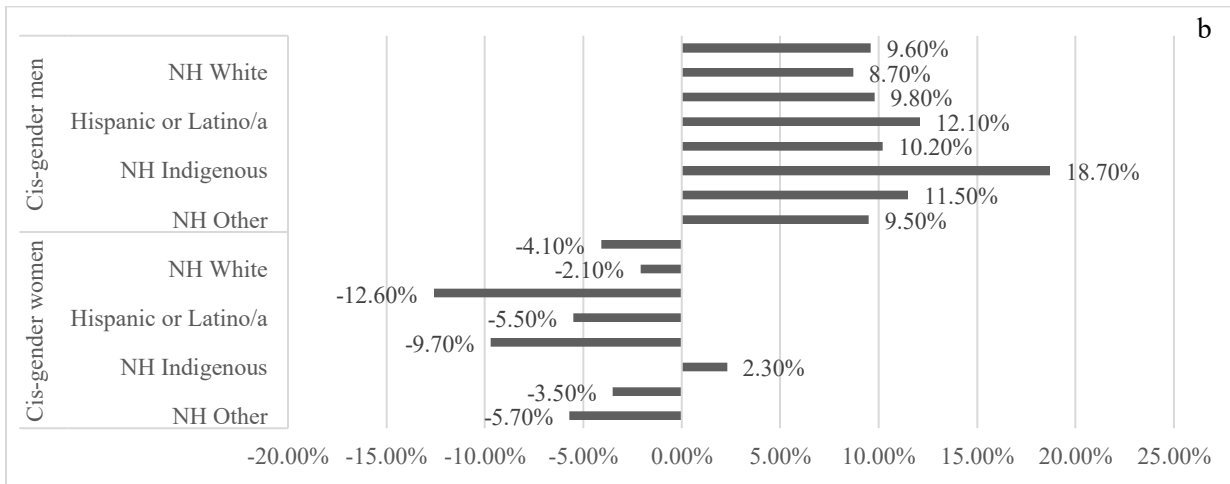
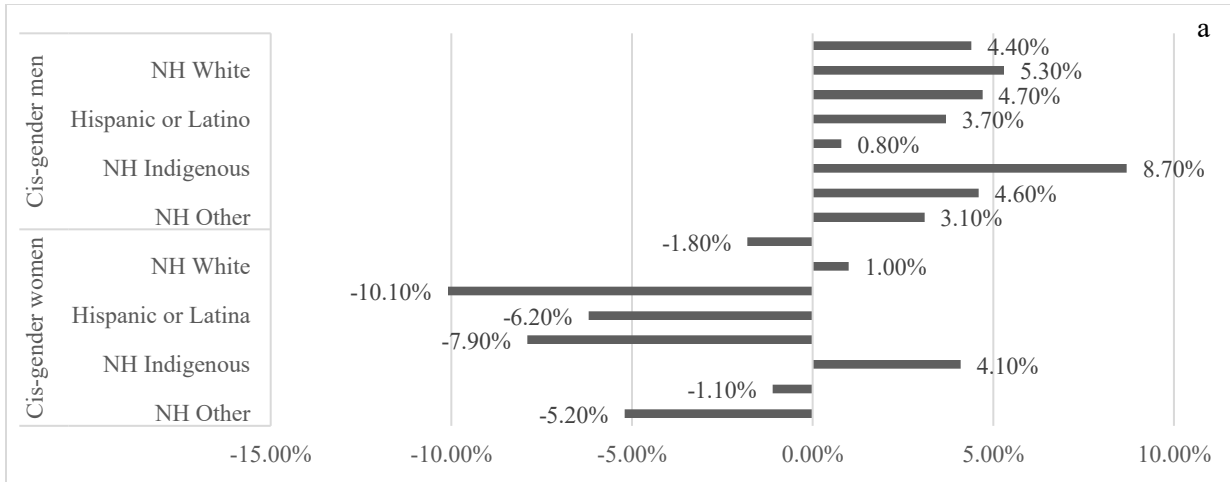


Figure 3.1 & 3.1b: Aerobic physical activity (a) and muscle-strengthening activity (b): Differences in prevalence based on the intersection of gender identity and race/ethnicity

Chapter 4

College student aerobic and muscle-strengthening activity: The intersection of gender and sexual orientation among United States students

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Abstract

The purpose of the study was to examine differences in aerobic and muscle-strengthening activity participation based on the intersection of gender and sexual orientation among cis-gender college students. Data from the American College Health Association National College Health Assessment collected between Fall 2015 and Fall 2018 were analyzed. Differences from the population average for meeting aerobic and muscle-strengthening activity (separately) recommendations were computed for each gender and sexual orientation intersection. The likelihood of meeting aerobic and muscle-strengthening activity (separately) recommendations were calculated using a series of logistic regression analyses to determine odds ratios controlling for age, year of enrollment, race/ethnicity, and health status. Overall, more men and those identifying as straight met activity (aerobic and muscle-strengthening) recommendations. Asexual and straight women were less likely to meet activity recommendations compared to men, and bisexual and questioning women were less likely to meet muscle-strengthening recommendations compared to men. Bisexual, pansexual, and questioning individuals were less likely to meet activity recommendations compared to straight individuals among both genders, as were queer and gay men and women who identified as pansexual or another identity. Men who identified as pansexual or another identity, as well as lesbian and queer women were less likely to meet muscle-strengthening recommendations compared to straight individuals. In summary, findings demonstrate that aerobic and muscle-strengthening activity participation disparities are evident

based on the intersection of gender and sexual orientation. The intersection of socio-demographic characteristics should be considered by researchers and physical activity promoters in order to better understand and address disparities.

Introduction

Tackling physical activity disparities is crucial to addressing health inequities given physical activity is beneficial to physical and mental health and wellbeing.^{1,133,181} Physical activity disparities, like health outcome disparities, vary based on socio-demographic characteristics, with those who are more advantaged tending to be more physically active and therefore less likely to experience the negative health outcomes associated with insufficient activity.¹¹² Cost-effective population-level approaches are necessary to increase physical activity and improve health,¹⁵⁶ and understanding physical activity disparities is important to ensure that changes to both policies and practices account for the influence of socio-demographic characteristics on behaviors.^{134,135} Gender and sexual orientation are two such characteristics that should be accounted for.

Physical activity disparities are commonly compared based on gender or sex, which are often used interchangeably in the physical activity literature. Gender identity concerns an individual's internal perception of their gender which may not correspond with their sex assigned at birth.¹⁵⁷ Cis-gender individuals identify as the gender consistent with their sex assigned at birth. The majority of the evidence indicates that cis-gender men participate in more aerobic^{10,19,159} and muscle-strengthening activity than cis-gender women.^{19,159}

Sexual orientation refers to an individual's emotional, romantic and/or sexual attractions to others, and their sense of identity based on these attractions.¹⁸² Unlike other socio-demographic characteristics such as sex, race/ethnicity, and socio-economic status, sexual orientation has only been considered in more detail in relation to health outcomes in the past couple of decades. Healthy People 2020 was the first time a goal pertaining to improving the health and wellbeing of individuals identifying as a sexual minority,¹⁸³ who tend to experience higher rates of physical (e.g. obesity) and mental health issues, was included. Both physical and mental health issues

could be treated and prevented via physical activity promotion,¹⁸⁴ in addition to addressing the societal and systemic discrimination that contribute to the aforementioned health issues.¹⁸⁵⁻¹⁸⁹

As a result of sexual orientation only emerging as a socio-demographic characteristic of interest relatively recently in comparison to gender and race/ethnicity, literature regarding physical activity disparities based on sexual orientation is lacking. A recent review found that engagement in physical activity varies based on the intersection of gender and sexual orientation.¹⁹⁰ Subsequent research involving adults,¹⁹¹ as well as research involving youth¹⁹²⁻¹⁹⁴ also show physical activity disparities based on the intersection of gender and sexual orientation. Among sexual minority men, body norms, thinness, muscularity, and stereotypes emerged as factors that influence physical activity, leading to the conclusion that physical activity appears to be aesthetically driven. Body norms and stereotypes also influence physical activity among sexual minority women, as did acceptance of diverse body types and homophobia.¹⁹⁰ A subsequent qualitative study concluded that an intersectional approach is needed to further examine the complexities of the sexual orientation and physical activity, and that safe spaces are crucial to sexual minority individuals participating in physical activity.¹⁹⁵

An intersectional approach acknowledges that socio-demographic characteristics intersect with one another, and therefore potentially impact health behavior disparities. By contrast, physical activity disparities tend to be examined using a monistic approach (i.e. based on single socio-demographic characteristics), which is not sound as such characteristics cannot be treated as mutually exclusive categories of experience and analyses.¹¹⁴ Intersectionality provides a framework to consider how inequities are discernible in different populations.¹⁷¹ An intersectional approach, which is underpinned by the principles of simultaneity, multiplicativity and multiple jeopardy, holds the potential to better examine the nature of disparities, or inequalities, in comparison to the conventional monistic approach.¹⁷⁰

Colleges are a great setting in which to set students on a positive lifestyle trajectory given close to half of US emerging adults seek post-secondary education,¹⁷³ and emerging adulthood is

an sensitive period in life for the adoption of healthy behaviors.¹⁷ In addition, disparities between sexes in aerobic and muscle-strengthening activity observed in the wider population are observed among college students^{88,174-176} demonstrating the need to address these disparities in this population. While research regarding disparities in physical activity based on sexual orientation among college students is lacking, evidence from the wider population suggests that disparities likely exist among college students as well.¹⁹⁰ Sexual orientation is rarely assessed when examining physical activity among college students, and even when assessed differences in physical activity based on sexual orientation are not examined by some^{176,196} in part due to an insufficient sample size.¹⁷⁶ In addition, when physical activity disparities based on sexual orientation have been examined, sexual orientation has been dichotomized into heterosexuals vs. sexual minorities with sex unaccounted for.¹⁹⁷

An intersectional approach to investigating physical activity disparities has demonstrated value in the past,¹⁵⁴ but has not yet been adopted in a young-adult or college student population, been widely used in relation sexual orientation with respect to physical activity, or been used to examine muscle-strengthening activity disparities. Thus, the purpose of this study was to examine the intersection of gender and sexual orientation as they pertain to meeting aerobic and muscle-strengthening activity recommendations among a sample of cis-gender college students studying in the US while adjusting for other socio-demographic characteristics that influence physical activity.

Methods

Data from the American College Health Association (ACHA) National College Health Assessment (NCHA) collected between Fall 2015 and Fall 2018 will be included in the analyses.¹⁷⁷

Measures

Participant characteristics

Age. Age was assessed to the nearest year.

Gender. Participants specified their sex assigned at birth (female or male) and their gender identity (woman, man, trans woman, trans man, genderqueer, or another identity), which were used to categorize each participant as either cis-gender men or cis-gender women. In the results and discussion cis-gender men and cis-gender women are referred to as men and women respectively unless stated otherwise. Participants with non-cisgender identities were excluded due to the small cell size when intersected with sexual orientation

Race/ethnicity. Participants specified their race by selecting all that apply from the following options in response to how they usually describe themselves (White; Black; Hispanic or Latino/a; Asian or Pacific Islander; American Indian, Alaskan Native or Native Hawaiian; Biracial or Multi-racial; or other). Participants were categorized into those who identify as: non-Hispanic (NH) White; NH Black; Hispanic/Latinx; NH Asian or Pacific Islander; NH Indigenous (American Indian, Alaskan Native or Native Hawaiian); NH Biracial or Multiracial; or NH other.

Sexual orientation. Participants specified their sexual orientation by selecting which of the following terms best describes their sexual orientation (asexual, bisexual, gay, lesbian, pansexual, queer, questioning, same gender loving, straight/heterosexual, or another identity).

Year in school. Participants specified their year in school as: first year undergraduate, second year undergraduate, third year undergraduate, fourth year undergraduate, fifth year or more undergraduate, graduate or professional, not seeking a degree, or other.

Enrollment status. Participants specified their enrollment as: full-time, part-time, or other.

Health status. Participants specified their health status by responding to the question “How would you describe your general health?” with: excellent, very good, good, fair, poor, or I don’t know.

Physical activity behaviors. Participants responded to the following three questions regarding how many of the past seven days they did the following (0 to 7 days):

- Do **moderate-intensity** cardio or aerobic exercise (caused a noticeable increase in heart rate, such as a brisk walk) for at least **30 minutes**?

- Do **vigorous-intensity** cardio or aerobic exercise (caused large increases in breathing or heart rate, such as jogging) for at least **20 minutes**?
- Do 8-10 **strength training exercises** (such as resistance weight machines) for 8-12 repetitions each?

For aerobic physical activity the existing NCHA physical activity requirements variable that is based on the 2007 American College of Sports Medicine and American Heart Association guidelines¹⁷⁸ was used to allow researchers to compare findings with past and future research using the NCHA dataset. For muscle-strengthening activity participants were categorized into those who did/not meet muscle-strengthening activity recommendations based on the 2018 national physical activity guidelines.¹³³

Statistical analyses

All analyses were conducted using SPSS Version 26.0 (IBM, Armonk, NY). Before exclusion the sample was comprised of 358,543 participants. Respondents who were not any of the following: cis-gender; full-time undergraduate students, non-varsity athletes, aged ≤ 24 years, as well as those who did not provide insufficient data to determine whether they met both physical activity and muscle-strengthening activity recommendations were excluded ($n = 142,567$). Analyses were conducted on the remaining participants ($n = 215,976$). Adjusting for multiple comparisons, the significance levels for all analyses were set at $p \leq .001$ and confidence intervals at 99.9%.

Descriptive statistics were computed to characterize the data. Differences in the prevalence of meeting aerobic and muscle-strengthening activity recommendations based on the intersection of gender and sexual orientation are displayed graphically. To quantify the magnitude of disparities based on the intersection of gender and sexual orientation a series of logistic regression analyses were conducted to determine odds ratios with cis-gender men and straight (heterosexual) serving as the referents. Age, race/ethnicity, year in school, as well as health status were controlled for in analyses. Further analyses with this dataset included the intersection of

gender and race/ethnicity, and differences between those identifying as cis-gender and transgender. These results fell beyond the scope of this study and will be reported elsewhere. The likelihood of meeting activity recommendations relative to the referent group was calculated. Results for participant groups with cell sizes less than five were excluded from those reported.

Results

Participant characteristics

The mean age of participants was 19.99 ± 1.51 years. The majority of participants identified as cis-gender women, NH white, and straight/heterosexual. The majority of participants perceived reported their health status as good, and a similar number of participants were in lower and upper years of undergraduate study college (Table 4.1).

Trends in physical activity disparities

Differences in the raw prevalence of students meeting activity recommendations in comparison to the population average between intersecting genders and sexual orientations are displayed for aerobic and muscle strengthening activity in Figures 4.1 and 4.2 respectively. Among all students, before separating by genders or sexual orientations, 45.7% met aerobic recommendations and 34.7% met muscle-strengthening recommendations. Overall, more men met aerobic and muscle-strengthening recommendations compared to women. The same was true regardless of sexual orientation for aerobic activity, but more same gender loving women met muscle-strengthening activity recommendations than men of a number of sexual orientations. It is clear from Figures 1 and 2 that physical activity varied based on the intersection of gender and sexual orientation. For example, the difference between straight and asexual individuals are far larger among men than women. Subsequent analyses examined the statistical significance and magnitude of such disparities.

Between-sexual orientation within-gender disparities

Among men, those identifying as bisexual, gay, queer, and questioning were less likely to meet activity (aerobic and muscle-strengthening) recommendations than those identifying as

straight. Men identifying as pansexual or another identity were also less likely to meet muscle-strengthening recommendations than those identifying as straight. Among women, those identifying as bisexual, pansexual, questioning, and another identity were less likely to meet activity recommendations than those identifying as straight. Women identifying as lesbian or queer were also less likely to meet muscle-strengthening recommendations than straight women (Table 4.2).

Between-gender within-sexual orientation disparities

Women identifying as straight or asexual were less likely to meet activity recommendations compared to men of the same sexual orientation, and women identifying as bisexual or questioning were less likely to meet muscle-strengthening recommendations compared to men. Differences between men and women for other sexual orientations were not statistically significant (Table 4.3).

Discussion

Findings establish that there are disparities in participation in aerobic and muscle-strengthening activity based on the intersection of gender and sexual orientation among US college students, supporting previous notions that gender and sexual orientation should be accounted for when examining physical activity disparities.^{190,195} This demonstrates that it is unjustifiable to dichotomize sexual orientation into straight vs. sexual minorities, as has been done when analyzing the same dataset with no difference in activity found.¹⁹⁷ Findings have the potential to inform changes to policies and practices that account for the potential physical activity disparities attributable to the intersection of gender and sexual orientation and provide equitable aerobic and muscle-strengthening activity participation opportunities and ultimately reduce disparities.

After controlling other variables and examining both between-sexual orientation within-gender and between-gender within-sexual orientation disparities it appears physical activity disparities based on the intersection of gender and sexual orientation vary between men and

women. No meaningful differences were found between those identifying as straight and those identifying asexual, whereas meaningful differences were found between heterosexual men and women and all other sexual orientations with respect to aerobic and/or muscle-strengthening activity. The main difference between men and women was that queer and questioning men were less likely to meet both aerobic and muscles-strengthening activity recommendations, while women of the same sexual orientations were only less likely to meet muscle-strengthening recommendations in comparison to those identifying as straight. In addition, gay men were less likely to meet activity recommendations and lesbian women were less likely to meet muscle-strengthening recommendations in comparison to straight individuals of the same gender. At a within-sexual orientation level, the most meaningful differences between men and women emerged between those identifying as heterosexual, asexual, bisexual or questioning.

Gender, sexual orientation, and other socio-demographic characteristics should be assessed when examining physical activity to improve understanding of how physical activity varies based on socio-demographic characteristics. Participant socio-demographic characteristics should be reported in full, and health behavior and outcome disparities should be examined based on the intersection of socio-demographic characteristics when feasible. Findings from the current study offer insights that have practical implications for physical activity promoters, from personal fitness instructors to administrators and policy makers. All individuals who desire to promote physical activity should appreciate that socio-demographic characteristics, such as gender and sexual orientation, intersect with respect to physical activity behaviors, and should therefore adapt approaches and update policies and practices accordingly.

Both colleges (specifically administrators and student affairs personnel) and students (specifically student government and members of the LGBTQ community) are crucial to achieving equity through proactively improving policies and practices. Colleges should acknowledge the intersection of gender and sexual orientation when actively evaluating campus recreation facility and program use, and provide campus recreation departments with the

necessary resources to provide initial and continuing cultural competency training.^{198,199} Members of college LGBTQ communities, in particular students, should be represented on boards/committees/groups that make decisions pertaining to physical activity (e.g. campus recreation, health services, institutional planning, even transportation services, etc.).

This study is not without limitations. The first is the assessment of physical activity using self-report categorical variables. In particular, aerobic physical activity was assessed using items that were worded to determine whether individuals meet since revised physical activity recommendations¹⁷⁸ and do not account for the fact that sufficient levels of moderate and/or vigorous physical activity can be accumulated on less than the recommended number of days/week. Thus, findings regarding aerobic physical activity should be interpreted with a level of caution. Comparing disparities by examining the interaction between gender and sexual orientation in relation to differences in a continuous outcome variable (e.g. min/week of physical activity) warrants consideration by future researchers. Another limitation was small cell sizes of sexual orientations, and the assumption that all participants are aware of, and willing to accurately report, their sexual orientation. In addition, small cell sizes prevented comparison of disparities based on the intersection of gender and sexual orientation among gender minorities (e.g. transgender men and transgender women). Furthermore, relating to multiple jeopardy, analyses do not account for the complexity of the interactions between gender and sexual orientation. In addition, analyses were restricted to examining disparities among cis-gender individuals, which is a limitation as evidence indicates that aerobic activity participation is lower among non-binary individuals compared with cis-gender individuals,^{163,164} and muscle-strengthening activity disparities are unclear.¹⁵⁸ Physical activity disparities based on the intersection of socio-demographic characteristics among gender minorities is a topic in need of further examination. The revised version of the NCHA survey largely addresses measurement limitations, both those pertaining physical activity and socio-demographic characteristics.¹⁵² Thus, improved analyses of the interactions between gender and sexual orientation should now be possible.

Conclusions

In summary, findings reinforce the value of adopting an intersectional approach to examining physical activity disparities,¹⁵⁴ and underline the importance of adopting an intersectional approach when addressing physical activity disparities. There are a multitude of interacting factors that impact physical activity,⁴⁰ of which gender and sexual orientation comprise merely two. Thus, in keeping with simultaneity, all levels of influence must be acknowledged and attended to if sustainable behaviors change is to be achieved.³⁹ Additional research is required into physical activity disparities based on the intersection other of socio-demographic characteristics with one another as well as interpersonal/community/environment/policy factors. Moreover, in line with further multiplicativity, future research is required to better understand the reasons underpinning disparities evident based on the connections between socio-demographic characteristics, in particular the unique factors that exacerbate or mitigate disparities,¹⁹² to inform intervention efforts.

It is no longer justifiable to treat socio-demographic characteristics as mutually exclusive categories of analyses and experience. Thus, further research should examine the differences in based on the intersection of socio-demographic characteristics, including gender and sexual orientation, in other populations and in relation to other health behaviors and outcomes. Such research is crucial in order to achieve equitable health outcomes among sexual and gender minorities.

Table 4.1: Participant characteristics

	n	%
Gender		
Cis-gender men	63958	29.6
Cis-gender women	152018	70.4
Race/ethnicity		
NH White	132548	61.4
NH Black	9228	4.3
Hispanic/Latinx	31840	14.7
NH Asian or Pacific Islander	25004	11.6
NH Indigenous	769	0.4
NH Biracial or Multiracial	13938	6.5
NH Other	2649	1.2
Sexual orientation		
Straight (heterosexual)	177602	82.2
Asexual	7834	3.6
Bisexual	14223	6.6
Gay	3624	1.7
Lesbian	2200	1.0
Pansexual	3232	1.5
Queer	1517	0.7
Questioning	4230	2.0
Same gender loving	90	0.0
Another identity	1424	0.7
Year in school		
First year	62245	28.8
Second year	50881	23.6
Third year	51277	23.7
Fourth year	41745	19.3
Fifth year or more (undergraduate)	9828	4.6
Health status		
Excellent	23660	11.0
Very good	81200	37.6
Good	76541	35.4
Fair	29674	13.7
Poor	4901	2.3

Note. NH = Non-Hispanic

Table 4.2: Likelihood of meeting activity recommendations between-sexual orientation within-gender (Referent – Straight/Heterosexual)

		Aerobic					Muscle-strengthening				
		Likelihood (%)	OR	99.9% CI		p	Likelihood (%)	OR	99.9% CI		p
				Lower	Upper				Lower	Upper	
Cis-gender men	Asexual	7.9	1.08	0.92	1.26	0.108	15.2	1.15	0.99	1.35	0.003
	Bisexual	-23	0.81	0.71	0.94	< 0.001	-66.7	0.60	0.52	0.70	< 0.001
	Gay	-50.4	0.67	0.59	0.75	< 0.001	-99.2	0.50	0.44	0.57	< 0.001
	Lesbian	81.8	1.82	0.10	33.63	0.500	5.40	1.05	0.07	16.97	0.95
	Pansexual	-24.4	0.80	0.56	1.15	0.045	-105.8	0.49	0.32	0.73	< 0.001
	Queer	-94.2	0.52	0.29	0.93	< 0.001	-265	0.27	0.13	0.56	< 0.001
	Questioning	-39.9	0.72	0.56	0.91	< 0.001	-99.6	0.50	0.38	0.66	< 0.001
	Same gender loving	-155.1	0.39	0.10	1.57	0.026	-1.3	0.99	0.28	3.46	0.973
	Another identity	-3.4	0.97	0.67	1.40	0.765	-54.1	0.65	0.44	0.96	< 0.001
Cis-gender women	Asexual	1.8	1.02	0.93	1.11	0.518	4.6	1.05	0.95	1.15	0.120
	Bisexual	-19.3	0.84	0.78	0.90	< 0.001	-28.4	0.78	0.72	0.84	< 0.001
	Gay	6.4	1.07	0.68	1.68	0.629	-4.0	0.96	0.59	1.57	0.795
	Lesbian	-14.3	0.88	0.76	1.01	0.003	-18.3	0.85	0.72	0.99	0.001
	Pansexual	-22.9	0.81	0.71	0.93	< 0.001	-41.4	0.71	0.61	0.82	< 0.001
	Queer	-13	0.89	0.74	1.07	0.031	-52.7	0.66	0.53	0.82	< 0.001
	Questioning	-31.8	0.76	0.67	0.86	< 0.001	-66.9	0.60	0.52	0.69	< 0.001
	Same gender loving	-15.1	0.87	0.36	2.10	0.600	29.5	1.30	0.53	3.19	0.345
	Another identity	-24.4	0.80	0.65	0.99	0.001	-38.7	0.72	0.57	0.92	< 0.001

Table 4.3: Likelihood of meeting activity recommendations between-gender within-sexual orientation (Referent – Cis-gender men)

		Aerobic				Muscle-strengthening					
		Likelihood (%)	OR	99.9% CI		p	Likelihood (%)	OR	99.9% CI		p
				Lower	Upper				Lower	Upper	
Cis-gender women	Straight/Heterosexual	-19.5	0.84	0.81	0.87	< 0.001	-70.1	0.59	0.57	0.61	< 0.001
	Asexual	-31.8	0.76	0.64	0.91	< 0.001	-94.6	0.51	0.43	0.62	< 0.001
	Bisexual	-13.3	0.88	0.76	1.03	0.007	-27.1	0.79	0.67	0.93	< 0.001
	Gay	40.6	1.41	0.88	2.25	0.017	18.3	1.18	0.71	1.98	0.282
	Lesbian	-105.8	0.49	0.03	9.11	0.418	-87.3	0.53	0.03	8.49	0.455
	Pansexual	-15.3	0.87	0.59	1.27	0.217	-12.4	0.89	0.58	1.37	0.376
	Queer	43.7	1.44	0.77	2.69	0.056	48.0	1.48	0.69	3.18	0.091
	Questioning	-12.5	0.89	0.68	1.17	0.155	-42.5	0.70	0.52	0.95	< 0.001
	Same gender loving	47.2	1.47	0.18	11.86	0.542	-51.5	0.66	0.10	4.56	0.479
Another identity	-37.9	0.73	0.47	1.12	0.015	-47.5	0.68	0.43	1.08	0.006	

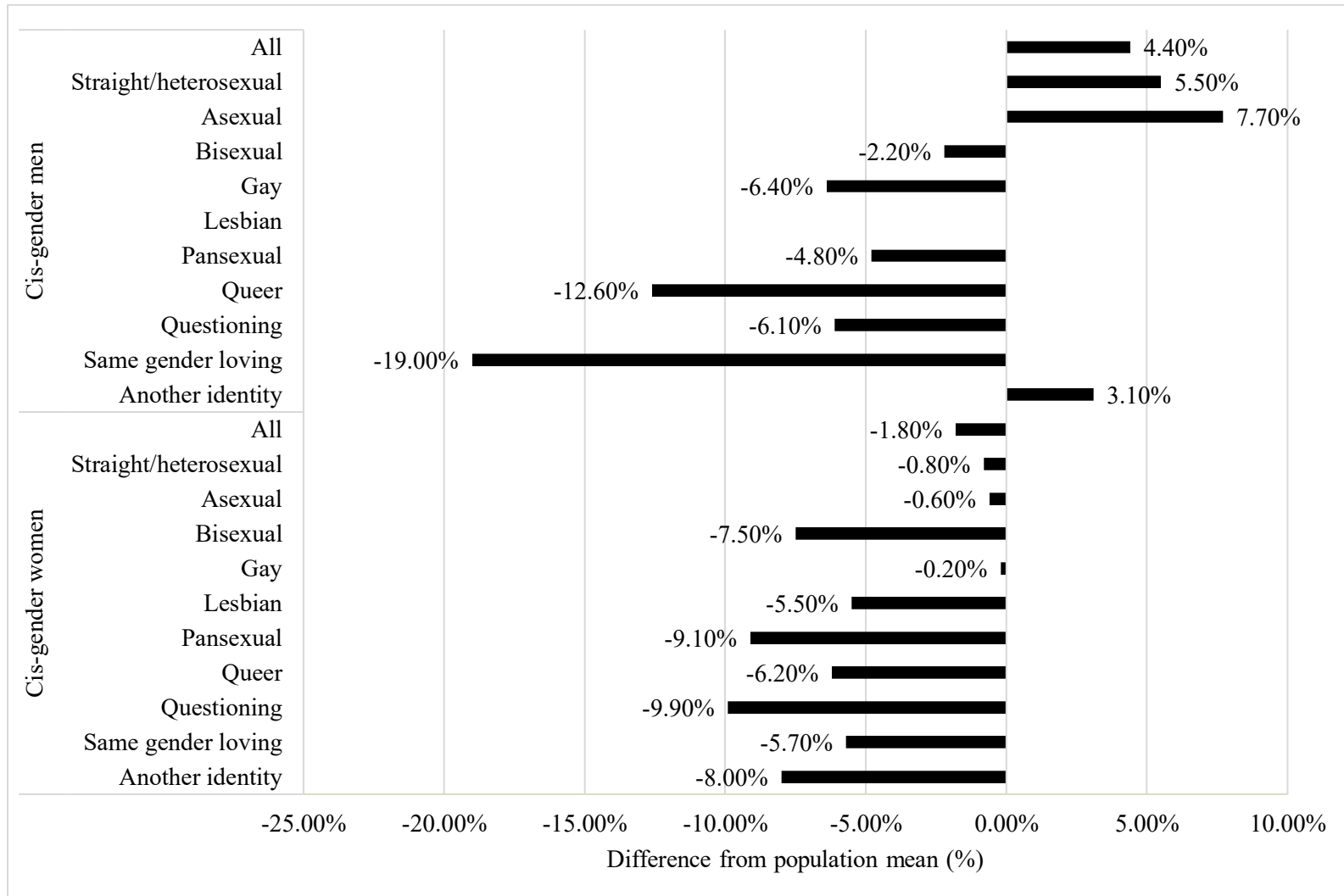


Figure 4.1: Aerobic physical activity: Differences in prevalence based on the intersection of gender and sexual orientation

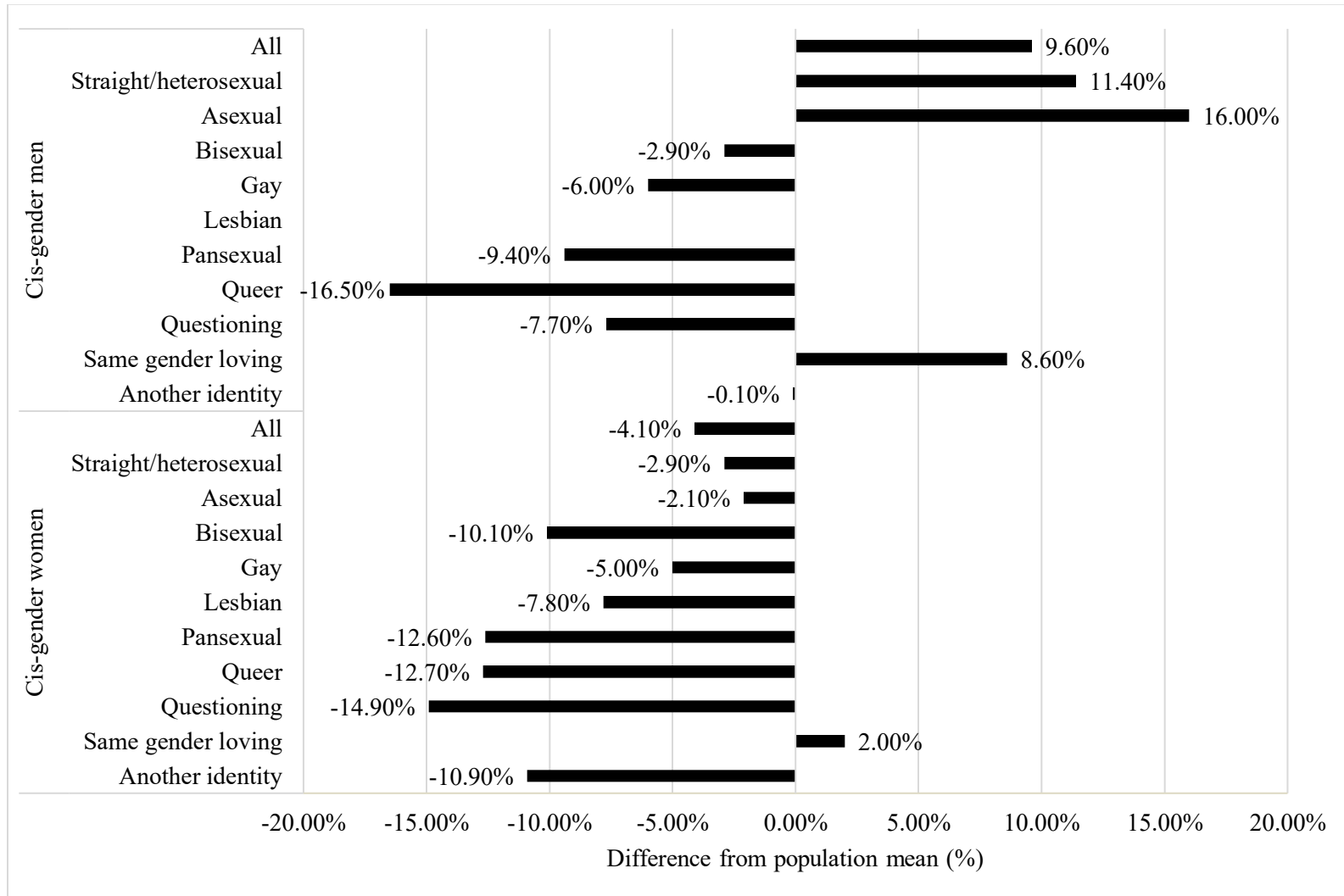


Figure 4.2: Muscle-strengthening activity: Differences in prevalence based on the intersection of gender and sexual orientation

Chapter 5

College student aerobic and muscle-strengthening activity: Disparities between cis-gender and transgender United States students

Oliver W. A. Wilson., Bethany A. Jones., & Melissa Bopp

Abstract

Objective: To examine aerobic and muscle-strengthening activity disparities among college students adjusting for other socio-demographic characteristics (age, race/ethnicity, sexual orientation). **Methods:** ACHA NCHA data collected between Fall 2015 and Fall 2018 were analyzed using chi-square tests for independence and odds ratios. **Results:** Cisgender women were significantly less likely to meet aerobic and muscle-strengthening activity recommendations compared to cisgender men. Trans men and trans women were less likely to meet aerobic and muscle-strengthening activity recommendations compared to cisgender peers. Differences were also revealed among trans individuals, with trans women more and less likely to meet aerobic and muscle-strengthening recommendations respectively compared to trans men. **Conclusions:** Considerable aerobic and muscle-strengthening activity participation disparities exist between cisgender and transgender emerging adults. The unique constraints that transgender college students experience in relation to both aerobic and muscle-strengthening activity participation require further examination to ensure the provision of equitable opportunities to be physically active.

Introduction

While physical activity disparities based on sex, i.e. between men and women, have been widely examined, disparities between transgender (i.e., those who experience incongruence between their gender assigned at birth and gender identity) and cisgender individuals have received less attention. Physical activity is beneficial for both physical¹ and mental health²⁰⁰⁻²⁰² and thus offers a means to improve the mental health of transgender and non-binary individuals who tend to have poorer mental health compared to cisgender individuals.^{203,204}

Physical activity and sport participation research involving transgender individuals is severely lacking,¹⁵⁸ and has been limited by small sample sizes. Much of the existing literature has focused on sport participation, in which transgender individuals tend to be constrained by specific barriers associated with their identity, including discriminatory behaviors and policies.^{205,206} While less research has focused on physical activity disparities, transgender individuals have consistently been found to be less active than cisgender individuals.^{163,164} Prior research has also focused on adults, with emerging adult focused research lacking²⁰⁷ despite the importance of this time in life for establishing healthy behaviors.¹⁷ In addition, little research has examined disparities in muscle-strengthening activity, which is potentially more impacted by the aforementioned discriminatory behaviors and policies compared to aerobic activity^{205,206} as participation often requires equipment more so than aerobic activity.

In addition to sex, college student physical activity disparities have been reported based on a number of other socio-demographic characteristics such as race/ethnicity,^{88,176} sexual orientation,¹⁵⁵ and year of study.^{208,209} Physical activity disparities based on race/ethnicity and sexual orientation tend to follow a social gradient, with those most advantaged (i.e. cis-gender, non-Hispanic white, and heterosexual) tending to be the most physically active.¹¹² With respect to year of study, physical activity tends to decline during college, consistent with the trend observed as age increases.¹⁰ Thus, the purpose of this study was to examine aerobic and muscle-strengthening

activity disparities among college students controlling for other socio-demographic characteristics that influence physical activity (age, race, sexual orientation, etc.).^{10,19,190}

Methods

Data from the American College Health Association (ACHA) National College Health Assessment (NCHA) collected between Fall 2015 and Fall 2018 were included in the analyses.¹⁷⁷

Measures

Participant characteristics

Age. Age was assessed to the nearest year.

Gender identity. Participants specified their gender identity as either man, women, trans man, trans woman genderqueer, or another identity. Those who identified as genderqueer or another identity were excluded due to small cell sizes.

Race/ethnicity. Participants specified their race by selecting all that apply from the following options in response to how they usually describe themselves (White; Black; Hispanic or Latin/a; Asian or Pacific Islander; American Indian, Alaskan Native or Native Hawaiian; Biracial or Multi-racial; or other). Participants were categorized into those who identify as: NH white; NH black; Hispanic/Latinx; NH Asian or Pacific Islander; NH Indigenous (American Indian, Alaskan Native or Native Hawaiian); NH Biracial or Multiracial; or NH other.

Sexual orientation. Participants specified their sexual orientation by selecting which of the following terms best describes their sexual orientation (asexual, bisexual, gay, lesbian, pansexual, queer, questioning, same gender loving, straight/heterosexual, or another identity). These same categories were used for analyses.

Year in school. Participants specified their year in school as: first year undergraduate, second year undergraduate, third year undergraduate, fourth year undergraduate, fifth year or more undergraduate, graduate or professional, not seeking a degree, or other

Enrollment status. Participants specified their enrollment as: full-time, part-time, or other

Health status. Participants specified their health status by responding to the question “How would you describe your general health?” with: excellent, very good, good, fair, poor, or I don’t know.

Physical activity behaviors. Participants responded to the following three questions regarding how many of the past seven days they did the following (0 to 7 days):

- Do **moderate-intensity** cardio or aerobic exercise (caused a noticeable increase in heart rate, such as a brisk walk) for at least **30 minutes**?
- Do **vigorous-intensity** cardio or aerobic exercise (caused large increases in breathing or heart rate, such as jogging) for at least **20 minutes**?
- Do 8-10 **strength training exercises** (such as resistance weight machines) for 8-12 repetitions each?

For aerobic physical activity the existing NCHA physical activity requirements variable that is based on the 2007 American College of Sports Medicine and American Heart Association guidelines¹⁷⁸ was used to allow researchers to compare findings with past and future research using the NCHA dataset. For muscle-strengthening activity participants were categorized into those who did/not meet muscle-strengthening activity recommendations based on the 2018 national physical activity guidelines.¹³³

Statistical analyses

All analyses were conducted using SPSS Version 26.0 (IBM, Armonk, NY). Before exclusion the sample was comprised of 358,543 participants. Those who were not full-time non-varsity athlete undergraduate students aged ≤ 24 years, as well as those who provided insufficient data to determine whether they met both physical activity and muscle-strengthening activity recommendations were excluded (n=141,214). Analyses were conducted on the remaining participants (n=217,329). Adjusting for multiple comparisons, the significance levels for all analyses were set at $p \leq 0.001$ and confidence intervals at 99.9%.

Descriptive statistics were computed to characterize the data. Differences in the prevalence of meeting aerobic and muscle-strengthening recommendations between gender identities were examined using chi-square tests for independence. Given chi-square tests for independence do not allow determination of between which groups disparities exist logistic regression analyses were conducted. Logistic regression analyses were conducted given chi-square tests for independence do not allow between which groups there are disparities. Factors known to influence physical activity among college students (age, sexual orientation, year in school, and health status) were adjusted for in analyses. Regression analyses were conducted both with and without weighting the gender identity independent (predictor) variable. Weighting, whereby the number of participants in the underrepresented group is increased, was conducted to reduce the limitation of the small number of trans individuals. Further analyses with this dataset included the intersection of gender identity and race/ethnicity, as well as the intersection of gender identity and sexual orientation, as well as. These results fell beyond the scope of this study and are reported elsewhere.^{155,179}

Results

Participant characteristics

The mean age of participants was 20.0±1.5years. The majority of participants identified as cisgender women, NH white, and straight/heterosexual. The majority of participants perceived reported their health status as good, and a similar number of participants were upper and lower years of study in college (Table 5.1).

Differences in meeting activity recommendations between gender identities

Chi-square tests for independence revealed that the number of students meeting activity recommendations differed significantly between gender identities. Less trans men and women met aerobic activity recommendations than cisgender men and women, and less cisgender women

met recommendations compared to cisgender men $\chi^2 (3 n = 217,239) = 3759, p < 0.001, \phi_c = 0.058$ (Figure 4.1).

Similarly, less trans men and women met muscle-strengthening recommendations compared to cisgender men and women, and less cisgender women met recommendations compared to cisgender men, $\chi^2 (3 n = 217,239) = 723, p < 0.001, \phi_c = 0.131$ (Figure 4.2).

Adjusted odds ratios reporting differences in the likelihood of meeting aerobic activity recommendations are displayed in Table 5.2. Weighted analyses revealed that trans men were less likely meet recommendations compared to cisgender men. Though trans women were less likely to meet recommendations compared to cisgender women, the difference was not statistically significant. Cisgender women were significantly less likely to meet recommendations compared to cisgender men. Trans women were more likely to meet recommendations compared to trans men, though the difference was not statistically significant.

Adjusted odds ratios reporting differences in the likelihood of meeting muscle-strengthening activity recommendations are displayed in Table 5.3. Though trans men and women were less likely to meet recommendations compared to their cisgender peers, differences were not statistically significant. Cisgender women were significantly less likely to meet activity recommendations compared to cisgender men. Trans women were less likely to meet recommendations compared to trans men, though the difference was not statistically significant.

Discussion

Findings indicate that there are considerable aerobic and muscle-strengthening activity participation disparities based on gender identity among college students (emerging adults). Non-parametric analyses indicated that the prevalence of meeting aerobic and muscle-strengthening recommendations differed between gender identities but did not allow conclusions as to between what groups differences were statistically significant. Computation of odds ratios provided further detail concerning which differences between gender identities were statistically significant, while

controlling for other factors known to influence student physical activity. While not all differences were statistically significant, the absence of a statistical significant difference does not imply the absence of a meaningful difference.

Trans individuals were less likely to meet activity recommendations, though these differences were not statistically significant with the exception of aerobic activity among men. Though not statistically significant, the direction of the disparity among trans individuals between men and women was different for aerobic and muscle-strengthening activity. Consistent with previous findings among students, cisgender men were found to be more active than cisgender women.^{155,174,210-212} That differences involving trans individuals were not statistically significant may be attributable to a number of factors. Though weighting analyses helped to mitigate the limitation of a small (relative to cisgender individuals) number of trans individuals to a certain extent, this is still a limitation that may impact analyses. In future, purposive or oversampling of trans individuals would help increase the representation of trans individuals and alleviate this limitation. While valuable, controlling for socio-demographic characteristics such as sexual orientation lowered the alpha value by increasing the number of multiple comparisons. Finally, participants were emerging adults and therefore much younger than participants in previous studies. Thus, they are at a stage in life where they potentially have more freedom to explore their identity, which may mean that their identity has less of an impact on behaviors such as physical activity that, by virtue of physiological adaptations resulting from participation, can influence one's appearance and therefore how individuals are perceived by others.

Regardless, findings demonstrate the need for further research concerning physical activity disparities based on gender identity, and to understand how interpersonal/community/environment/policy factors⁴⁰ influence such disparities in this population and setting. Such research is necessary due to the apparent need to inform and justify

policies and practices that ensure the provision of equitable opportunities to be physically active and thereby reduce disparities in physical activity and associated health outcomes.

This study is not without limitations, one of which is the use of self-report categorical variables to assess physical activity. In particular, aerobic physical activity items are worded to determine whether individuals meet somewhat dated physical activity recommendations¹⁷⁸ do not account for the fact that individuals may accumulate sufficient levels of moderate and/or vigorous physical activity on less than the recommended number of days/week. As such, findings regarding aerobic physical activity in particular should be interpreted with a degree of caution. Ideally continuous variables that differentiate between the volume (e.g. min/week) of moderate and vigorous aerobic physical activity would be used to examine differences. Similarly, differences in muscle-strengthening activity could be examined by analysing differences in the days/week individuals participated in such activities as opposed to whether they meet recommendations. Other limitations include the lack of heterogeneity of racial/ethnic groups. The limitations associated with the measurement of physical activity and race/ethnicity have been addressed, for the most part, by the revised NCHA.¹⁵² However, latest iteration of the NCHA survey does not overcome the limitations stemming from the small number of transgender individuals, the exclusion of non-binary identities as well as the lack of information regarding transgender student's stage of transition and whether they had disclosed their gender.²¹³ Future researchers should consider improving the quality of physical activity measures, including better measures regarding aspects related to transgender individuals' status of medical and social transitioning.

Conclusion

In summary, to the authors' knowledge this is among the first studies to examine gender identity disparities in aerobic activity among emerging adults, and muscle-strengthening among any age group. Regardless of some disparities not being statistically significant, it is evident that

there are disparities in aerobic and muscle-strengthening activity based on gender identity among emerging adults. Thus, gender identity should be considered by those conducting physical activity research, as well as those attempting to promote physical activity in future.

Table 5.1: Participant characteristics

	n	%
Gender identity		
Man	64363	29.6
Woman	152452	70.1
Trans man	397	0.2
Trans woman	117	0.1
Race		
NH White	133323	61.3
NH Black	9287	4.3
Hispanic/Latinx	32051	14.7
NH Asian or Pacific Islander	25162	11.6
NH Indigenous	774	0.4
NH Biracial or Multiracial	14062	6.5
NH Other	2670	1.2
Sexual Orientation		
Straight/Heterosexual	178209	82.0
Asexual	7931	3.6
Bisexual	14400	6.6
Gay	3700	1.7
Lesbian	2249	1.0
Pansexual	3378	1.6
Queer	1630	0.8
Questioning	4269	2.0
Same-Gender Loving	93	0.0
Another identity	1470	0.7
Year in school		
1st year	62677	28.8
2nd year	51214	23.6
3rd year	51578	23.7
4th year	41973	19.3
5th year or more	9887	4.5
Health status		
Poor	4969	2.3
Fair	29962	13.8
Good	77037	35.4
Very good	81569	37.5
Excellent	23792	10.9

Note. NH = Non-Hispanic

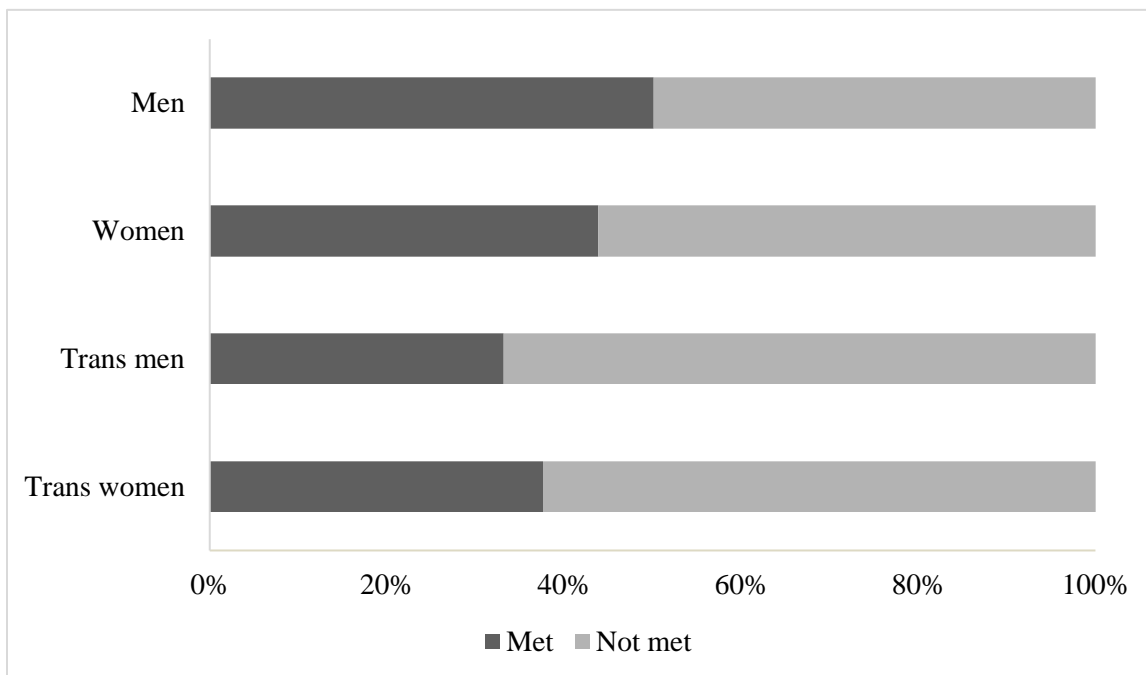


Figure 5.1: Differences in meeting aerobic activity recommendations between gender identities

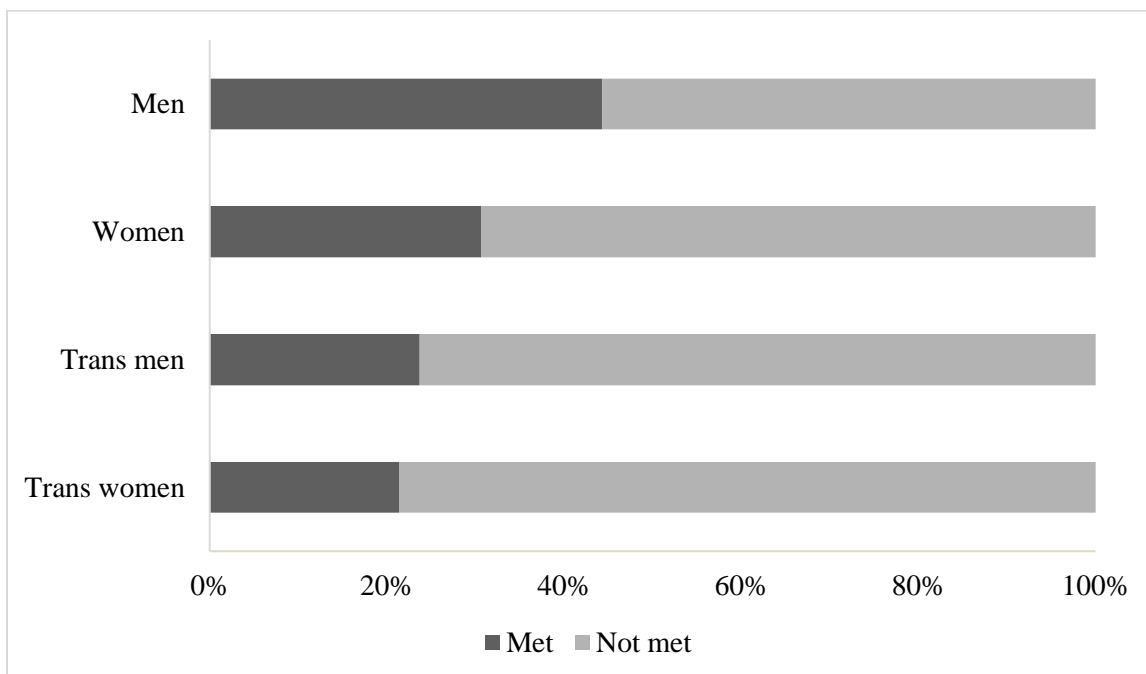


Figure 5.2: Differences in meeting muscle-strengthening activity recommendations between gender identities

Table 5.2: Unweighted and weighted adjusted odds ratios comparing likelihood of meeting aerobic activity recommendations between gender identities

	Unweighted					Weighted				
	Likelihood (%)	OR	99.9% CI		p	Likelihood (%)	OR	99.9% CI		p
			Lower	Upper				Lower	Upper	
Men only										
Cisgender Men - referent										
Trans Men	-28.7	0.78	0.53	1.13	0.027	-31.2	0.76	0.58	1.00	0.001
Women only										
Cisgender Women - referent										
Trans Women	-13.3	0.88	0.47	1.68	0.525	-13.3	0.88	0.56	1.39	0.369
Cisgender only										
Cisgender Men - referent										
Cisgender Women	-18.8	0.84	0.82	0.87	< 0.001	-18.8	0.84	0.82	0.87	< 0.001
Transgender only										
Trans Men - referent										
Trans Women	24.4	1.24	0.54	2.87	0.391	24.6	1.25	0.64	2.43	0.278
All										
Cisgender Men - referent										
Cisgender Women	-18.8	0.84	0.82	0.87	< 0.001	-18.8	0.84	0.82	0.87	< 0.001
Trans Women	-33.2	0.75	0.4	1.43	0.143	-33.9	0.75	0.52	1.08	0.010
Trans Men	-41.6	0.71	0.49	1.01	0.001	-43.7	0.70	0.58	0.84	< 0.001

Table 5.3: Unweighted and weighted adjusted odds ratios comparing likelihood of meeting muscle-strengthening activity recommendations between gender identities

	Unweighted				Weighted					
	Likelihood (%)	OR	99.9% CI		p	Likelihood (%)	OR	99.9% CI		p
		Lower	Upper	Lower		Upper			Lower	
Men only										
Cisgender Men - referent										
Trans Men	-22.5	0.82	0.54	1.24	0.110	-27.4	0.79	0.58	1.07	0.009
Women only										
Cisgender Women - referent										
Trans Women	-35.1	0.74	0.35	1.58	0.191	-35.1	0.74	0.43	1.27	0.064
Cisgender only										
Cisgender Men - referent										
Cisgender Women	-66.7	0.60	0.58	0.62	< 0.001	-67.2	0.6	0.58	0.62	< 0.001
Transgender only										
Trans Men - referent										
Trans Women	-32.0	0.68	0.26	1.81	0.194	-32.5	0.68	0.31	1.46	0.094
All										
Cisgender Men - referent										
Cisgender Women	-66.7	0.6	0.58	0.62	< 0.001	-67.2	0.60	0.58	0.62	< 0.001
Trans Women	-119.3	0.46	0.21	0.98	0.001	-122.7	0.45	0.29	0.70	< 0.001
Trans Men	-49.9	0.67	0.45	1.00	0.001	-55	0.65	0.53	0.79	< 0.001

Chapter 6

College women's perceptions of factors contributing to gender disparities/inequities in physical activity and campus recreation facility use in the United States

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Abstract

Purpose: The purpose of this study was to examine college women's perceptions of factors contributing to gender disparities in physical activity and campus recreational facility use, and to explore/identify strategies to address these barriers and provide more equitable student physical activity participation opportunities. **Methods:** Semi-structured interviews were conducted with female undergraduate students at a large Northeastern United States university. Qualitative data were analyzed using thematic analyses with the socio-ecological model used as a conceptual framework. **Results:** Women (N=18; 6 non-Hispanic White, 5 Black, 7 Asian American; M=20.6±1.2 years old) cited various intrapersonal, interpersonal, and environmental factors impacting their physical activity and campus recreation facility use due to their gender. Built environmental factors included facility proximity, facility layout and equipment, and crowdedness. Positive interpersonal factors included social support from friends, family, and significant others, while male peers negatively impacted women by making them feel uncomfortable/intimidated and even harassed. Intrapersonal factors limiting women's activity included a perceived lack of skills/competence/knowledge, lack of confidence, and self-consciousness. **Conclusions:** Findings indicate that colleges need to implement and enforce policies that achieve a cultural shift in the social environment to alleviate constraints as well as redistribute resources (e.g. re/constructing spaces and/or providing tailored instruction) to facilitate of negotiation of interpersonal and intrapersonal constraints by women and other

marginalized students. In doing so colleges can work towards ensuring that all students are provided with equitable opportunities to participate in physical activity and obtain the associated benefits.

Introduction

The physical and mental health benefits of physical activity are well-established.¹³³ Yet, many college students,²⁰⁷ in particular women,^{155,179} participate in insufficient levels of aerobic and muscle-strengthening activity. Physical activity (aerobic and muscle-strengthening) disparities based on socio-demographic factors such as gender, race/ethnicity, and sexual orientation are evident among students.^{155,179,214} Greater physical activity has long been associated with convenient access to recreational facilities;²¹⁵ and, the aforementioned physical activity disparities (inequities) tend to mirror those in the use of campus recreational facilities,^{52-55,57,216} comfort using campus recreational facilities,^{52,216,217} as well as use and comfort using specific spaces within facilities.²¹⁶ Campus recreational facilities are an important component of student physical activity promotion. Thus, understanding the factors contributing to disparities is paramount to providing equitable opportunities.

According to the socio-ecological model, physical activity is influenced by various factors that often interact with one another. These factors range from those more proximal to individuals, such as socio-demographic characteristics and other intrapersonal factors, to the social and built environmental, as well as more distal factors such as policies.⁴⁰ Beginning at the most distal level of influence, there appears to be a disconnect between what campus recreation departments “say” and what departments “do” with respect to the promotion of equity, diversity and inclusion.⁵⁹ The apparent absence of policies pertaining to harassment at many institutions,⁵⁹ when evidence from the wider community demonstrates such policies are needed,²¹⁸⁻²²⁰ is an obvious example of disconnect. Such policies are important for establishing a safe and inclusive environment, but the existence of such policies does not mean that they are enforced. This is evident with respect to Title IX, legislation meant to prevent discrimination based on sex,⁶⁰ which does not appear to be widely enforced with respect to the provision of equitable campus recreation opportunities.

The built environment, which encompasses facility location, facility design, as well as the type and orientation of equipment and other amenities within facilities, can also influence physical activity. For example, physical location is important, as proximity of facilities to one's place of residence can influence use and therefore activity levels. Students residing closer to facilities report greater physical activity,^{62,63} particularly women.⁶⁴ However, the presence and proximity of facilities does not necessarily mean that there is equal access to them, as facility access is influenced by interactions between various levels of influence.

Access, or membership, to campus recreational facilities is often included in mandatory student fees, such that all students can, in theory, access facilities.⁵⁹ However, provision of 'equal' access is insufficient to address the aforementioned disparities in physical activity and facility use. For one, while funding campus recreation facility membership via the mandatory student fee alleviates a financial constraint, numerous other constraints and factors must be addressed by institutions. This is evidenced by the widely reported gender differences in perceived/experienced constraints pertaining to student physical activity participation. College women have typically been found to perceive/experience greater intrapersonal (e.g. confidence, skills/knowledge, self-consciousness), interpersonal (lack of partners, lack of support), and environmental (e.g. crowdedness and/or accessibility of facilities) constraints compared to men.^{107,108,110,111} As with physical activity and campus recreation facility use gender inequities, inequities in constraints to recreational facility and/or space use also mirror those pertaining to physical activity, with perceived competence/knowledge, comfort, and self-consciousness evidently considerable barriers for college women.^{46,216,217,221} However, more nuanced understanding of how these factors interact with interpersonal and environmental influences on physical activity and campus recreational facility use is lacking.

The importance of social support with respect to physical activity among female college students is somewhat unclear. An absence of social support has been identified as a constraint to

physical activity among female college students.⁷⁹ However, other research has concluded that there is not strong relationship between social support and campus recreation facility use among college students,⁴⁵ or physical activity among Black college age women.⁷⁸ Evidence suggests that the source and type of social support may influence the relationship between support and physical activity among students.⁸⁰

In light of the current inequities in physical activity and campus recreation facility use, the purpose of this study was to examine diverse college women's perceptions of factors contributing to gender disparities in physical activity and campus recreational facility use. A secondary purpose was to explore/identify institutional strategies for addressing these barriers and providing more equitable opportunities for student physical activity participation.

Methods

Design

Data for this exploratory, cross-sectional, mixed-methods study were collected from a diverse group of cis-gender female college students at a university located in the northeast of the US via an online survey and one-on-one semi-structured interviews. This study focused on cis-gender non-Hispanic white, non-Hispanic Black, and non-Hispanic Asian women who were each compensated \$15. The Pennsylvania State University Institutional Review Board approved this study.

Recruitment

Participants were recruited through word of mouth via a dean of diversity and inclusion, relevant student clubs/organizations, and those who expressed interest in and/or participated in the study. Upon confirming via email that they met eligibility criteria, participants were sent a link to the online survey. Upon completing the survey, which also confirmed eligibility, an interview was scheduled. Eighteen women were recruited to participate, a sample size deemed adequate to permit a richly textured understanding of perceptions and experiences.²²²

Data collection

Survey. A short online survey (Qualtrics, Provo, UT) was used to assess socio-demographic characteristics and physical activity behaviors, and campus recreational facility use. The purpose of this survey was to act as a secondary screen for eligibility, to collect information to accurately characterize participants, and to reduce the length, and therefore cost and participant burden, of interviews.

Interviews. One-on-one semi-structured interviews were conducted by a trained female interviewer either in person or via teleconference (Zoom). The two interviewers participated in the development of the interview script and conducted multiple practice interviews with volunteers, one another, and other undergraduate research assistants making adjustments to the script and protocol. The interview guide was grounded in an ecological framework and addressed aspects of the different levels (e.g. socio-demographic [gender, race, ethnicity, sexual orientation, and religion], intrapersonal [self-confidence, skills/knowledge], interpersonal [social support, behavior of others], built environmental [facility location and layout, equipment], and policies) of influence on physical activity behaviors and campus recreational facilities,⁴⁰ as well as changes women would like to see to increase comfort, strategies they use to increase comfort, and advice they would give to female first-year students. The full interview guide is available as Supplemental File 1. Interviews were recorded and transcribed using Otter ai software (Otter ai, Inc, Los Alto, CA), with two undergraduate research assistants organizing transcripts and checking them for accuracy.

Analyses

Two independent coders (both trained female undergraduate research assistants) analyzed and coded data, with discrepancies in codes discussed and resolved using standard triangulation procedures.²²³ Transcripts were managed using Atlas software (ATLAS.ti Scientific Software Development, Berlin, Germany). Transcripts were analyzed using a thematic analysis approach; a

method used to identify, analyze, and report patterns of themes within qualitative data.²²⁴ The first author, two coders, and a fourth research assistant read and re-read transcripts to familiarize themselves with data and met to develop a codebook and define how data would be coded. Coders then independently coded transcripts and then meet to compare and discuss any coding discrepancies until reaching a consensus. Codes were categorized into broader themes that captured important concepts related to the research questions. Themes were described, and representative quotes were identified.

Results

Participant characteristics

The mean age of participants (N=18) was 20.6 ± 1.2 years. Per inclusion criteria, all identified as cis-gender women. Seven women identified as non-Hispanic Asian American, five as non-Hispanic Black, and six as non-Hispanic White. All but one woman (n=17), identified as heterosexual (straight) with one identifying as Bisexual. Most participants identified as Christian (n=10), four identified as agnostic, two as atheist, and one each as Hindu and Interfaith respectively. All but three women were Juniors or Seniors. The majority of women met aerobic activity recommendations (n=14), while less than half met muscle-strengthening recommendations (n=8). Seven women met both aerobic and muscle-strengthening recommendations. The majority of women (n=14) reported using campus recreational facilities on a weekly basis.

Socio-demographic factors

Religious/spiritual beliefs, race/ethnicity, sexual orientation, and gender each impacted women's physical activity to varying extents.

Religious/spiritual beliefs

With the exception of two Christians, all women reported that their religious/spiritual beliefs did not influence their physical activity behaviors. One White Freshman commented:

“Taking a body pump or Zumba class, some of the movements more not sexual but more, I don’t know the word, but I know sometimes that can be weird especially if I’m going with my friends that are Christian.” By contrast, the other Christian woman commented:

“Actually, I never thought it did until recently. I was at a Bible study, and someone brought up how as a Christian, I was like ‘OK, as a Christian we’re supposed to be physically active because our body is a temple of the Lord, and we’re supposed to treat our body to be special so they fit all the time, and feed our body the right food, because God wouldn’t want us to mistreat our body.’ And I was like ‘Oh, hey, this is a new perspective I never thought about it so I guess that should play a role to help me be more physically active’” (Black Junior).

While unrelated to their own religion, one woman referenced religion when responding to what the institution could do to increase physical activity:

“I know there’s a lot of students who culturally, or religiously need to have separate areas for them to feel comfortable to do physical activity. I think if that’s a barrier that’s something that universities should address because students should feel comfortable and also maintain their own cultural or religious standards” (Asian American Junior).

Sexual orientation

With the exception of two straight women and one bisexual woman, all others indicated that their sexual orientation did not impact their physical activity behaviors. The woman identifying as bisexual indicated that she received a lot of support from her boyfriend. While, according to her, identifying as bisexual did not influence her activity, she acknowledged that “maybe it would be different if I was dating a girl” (Black Senior). Among the women identifying as straight, sexual orientation influenced their behaviors given their attraction to men and there being a lot of men in the gym.

Race/ethnicity

When asked explicitly whether race/ethnicity influenced their physical activity or campus recreation facility use all non-Hispanic White and Asian American women reported their race/ethnicity did not. However, in further discussions three Asian women made comments to the contrary. One alluded to being the child of immigrants and being assimilated growing up as an Asian American, another commented that she saw few Asians using the facilities and attributed this to there being a small percentage of Asian students at the university, and a third indicated that she was driven to be fit and to avoid fitting in with the Asian American stereotype which she described as “unathletic”. Among Black women, only one directly responded to the question regarding race/ethnicity indicating that there was “a stereotype against Black people being athletic” which “ties back into the free weights areas because it’s mostly White males using up all the machines in that area and using all the free weights” (Black Senior). In addition, despite indicating that race/ethnicity did not influence her activity another Black woman also described being stereotyped and having to adapt:

“A lot of times I go to the gym and I will be the only African American there but that’s also because we’re at [University name blinded] and since it’s a PWI (predominately White institution) so that’s something that you just have to adapt to but I wouldn’t necessarily say influences my choices, necessarily. I do think a lot of times there is kind of stigma about we’re all athletic, or a lot of people ask me if I’m on a sports team or I’m here for sports or if I’m here for volleyball or here for basketball” (Black Sophomore).

Another Black woman indicated that her race/ethnicity did not impact her physical activity, but referred to a female Black peer that dislikes the gyms on-campus because “she feels like it’s too White.”

Gender

Being a woman was the most common socio-demographic characteristic impacting physical activity an campus recreation facility use, with all but two responding that being a woman negatively impacted their physical activity. When describing how being a woman

impacted their physical activity, women cited various intrapersonal, interpersonal, and environmental factors as described below.

Built environment

Multiple themes emerged relating to the built environment, which included facility proximity, as well as the interrelated themes of facility layout and equipment and crowdedness. For context, the campus on which this study was conducted has three different recreational facilities.

Facility proximity

Facility proximity impacted the physical activity behaviors of all women in this study, with choice of facility impacted by where women lived and, to a lesser extent, worked and studied.

Facility layout and equipment

The existence of three facilities with varying designs, layouts, amenities, and equipment led to comparisons between facilities. Comments pertaining to one building, 'facility A', were largely positive and included references to the bigger space and separate areas, in particular the weights areas located off of the indoor track. The following response compares two facilities, and is representative of multiple women's responses:

"I really like the layout of [facility A] because there are areas on the track where you can go to do some weights or some floor work that's away from everybody else. The cardio is off to the side which is nice, and it's not in an enclosed space so it's not smelly. I really hate the layout of the [facility B] the cardio room is so stinky and hot, and then the dumbbell area, where the, where the squat racks are I hate how it's like in a pit almost so it feels like if you're using the machines that are around it everyone can look down on you. There's no mirrors by the free weights so you really can't see like your form at all and like when you're doing your exercise, you're just like staring at the person across from you, that's on the other side of the weights and that's really uncomfortable" (White Senior).

As far as facility B, several women commented positively on there being a separate cardio room, though two others felt this area was crowded. The following is a quote from a woman describing why she likes the separate room in one facility compared to the layout and equipment in another facility:

“At [facility B] all the cardio machines, bikes, ellipticals and treadmills [are] in a different room, and then the weight training and stretching area is in another part. It's nice that when you go, everyone in that room is doing a similar type of physical activity, unlike in [facility C]. So [it's] a really easy way for me to simulate group exercise when I want to go on my own, like having [an] individual schedule but still have people around me doing the same thing” (Asian American Junior).

Multiple women described facility B as small and felt uncomfortable walking through the weights area to access other parts of the facility. One made the following comment regarding the layout:

“In [facility B] you walk through a bunch of weight machines to get to the cardio area. During that walk I'm hyperaware. People around will look at you as you walk past...I keep my eyes down cause I'm walking through all these super buff guys pumping iron and I'm just trying to get to the treadmill. I don't know why I feel like that, but that's definitely something I've noticed” (Asian American Junior).

Fewer women used and commented on the layout of facility C. One described it as more open than facility B, and another liked that the cardio area was located upstairs separate from the weights areas. However, another woman disliked that the cardio area overlooked the weights area which was very open and offered little privacy. With respect to privacy, women made comments regarding the orientation and location of equipment:

“The stair machine in [facility B] is the most stressful thing to me because everyone faces you. I don't know why, I can never find the will to do it at [facility C]. It's so intimidating because everyone is watching you clearly in that front central location at [facility B] but that's why I only do it at [facility C] because it's off to the side” (White Junior).

“In [facility C] when you first walk in, that corner there's mostly the machines. And I know that most of my girlfriends, we'll just stay in that corner because you can walk in without like anybody really seeing you, you don't have to walk past all of the free weight machines and everyone else working out. So a lot of the girls I know just stay in that little corner, because to get to the free weights you have to walk in front of everyone, which can be like kind of intimidating” (Asian American Senior).

Facility crowdedness

With the exception of two women, all others commented on facility crowdedness impacting their physical activity. Crowdedness was influenced by facility layout and equipment, and in many instances was tied to intrapersonal factors such as a lack of social support, self-confidence, perceived lack of skills/knowledge, and self-consciousness. The following quote embodies the feelings of many women:

“Since the facilities are so big and there are so many people there that can be really intimidating some days if I don't have a lot of self confidence in myself in terms of how I'm looking, or the exercises that I'm doing. I get really self-conscious whenever I want to try a new exercise because I'm not sure if my form is perfect, and I go alone so I don't have another person that's going to tell me or comment on what I'm doing. Since there's so many people there I feel like even if there's not eyes on you, it feels like there is so many eyes on you. So if I'm having a low confidence day then I'm definitely less inclined to work out in the facilities on campus” (White Junior).

Social environment

Family, friends, significant others, and male peers emerged as interpersonal factors influencing women's activity and recreation facility use.

Exercising alone

All but four women commented on exercising alone, with most common reasons due to convenience and/or fitting their schedule best as opposed to preference. For example, one Black Senior woman commented “It's easier to like plan schedule when I want to go. It becomes much harder when I try to plan [around] my friends' schedules.”

Friends

Friends were the most common source of social support and were a positive influence on women's activity, providing support, motivation, and accountability. However, there were some cases where support was lacking or friends were unsupportive. Some women also commented on having male friends (non significant others) to help support them to use the weightlifting areas of the gym:

“I usually do cardio by myself, but when I lift I usually go with one of my guy friends when I'm in the like free weights section. ... At the beginning, when I first started lifting, I didn't really know what I was doing. So I would bring my friends with me so they could make sure I was doing stuff right, but also I feel more comfortable with them there because most of the people in the free weights section are usually just guys. So whenever I go in there alone people look at me or I'll just be self-conscious about the weights that I'm using because, obviously I'm lifting a lot less than most of the guys. Really it's a comfort thing” (Asian American Senior).

Family

All but one woman reported that their family were supportive of their physical activity, though most referred to them providing support or being role models when they were younger as opposed to at present. The woman lacking support made the following comment:

“No one in my family works out, is physically very active, or does sports. My family's just not the athletic type. So that kind of was a little bit of a barrier I would say because they didn't really understand the whole workout thing” (Asian American Senior).

However, some women described what could be considered pressure from family, which included pressure from family members to exercise more, exercise less, or avoid losing weight.

Significant others

Though questions specific to significant others were not asked, four women described how their significant other impacted their physical activity. A White Junior described how she

supported her boyfriend by rebounding a basketball for him a couple of times a week. Another White Senior described how she and her boyfriend “work out as much as we can together” and how he had supported her to learn how to use equipment that she would not otherwise attempt to use. Similarly, another Asian American Senior commented “the first couple times I went to the gym, my boyfriend was with me and he was already active and, working out at the gym, showed me how to use everything and then after the first few times I felt like I knew how to use everything to the point where I felt confident enough to just go do it.” However, in contrast another Asian American Senior described how, despite his encouragement, her boyfriend had negatively impacted her activity, and how she feels self-conscious to exercise in front of him because he is “fairly fit.”

Male peers

Excluding family, friends, and significant others, the presence and behaviors of male peers impacted women’s activity, in particular the use of facilities and weights areas within facilities. The experiences of women ranged from discomfort to describing instances that could objectively be considered harassment. Representative quotes from two women describing experiences of being harassed are provided below:

“I’ve had weird situations where guys are just really creepy in the gym. ... I had this one time I was doing leg day and this guy came up and stood directly in front of me as I’m doing squats, not even like he was working out or anything. He just stood there and watched, and that’s one of those times [my boyfriend] wasn’t there, so it was really uncomfortable, and I ended up leaving the gym early [and] ended my workout early” (White Senior).

“Playing club volleyball last year we would practice in that room in the [facility A] that’s right across from the free weights, and there’s these glass windows so when you walk in to the lobby, we were in this room right here. And it’s where the basketball courts are right, and I have the glass panes and then the free weights and it was just so uncomfortable when they would stare at us or knock on the window or just weird things like that that just makes you uncomfortable. But I especially experienced in that as a freshman, my first semester I would not just go willingly put myself in that space, they’re literally staring at us with no remorse or knocking, or making like, just saying weird stuff.

And I was just like, no, that's just not an area I put myself in so I feel a lot of it has to do with my very first experience with that area that just makes me not even want to try to go in there" (Black Sophomore).

While another Asian American Senior commented "There have been creepy men and that can be an issue, sometimes it's just a fear." Though not all women described experiences of harassment, all but three commented on how male peers had negatively impacted their physical activity. Some described feeling intimidated, with a Senior White woman commenting: "gym intimidation is so real and it can be really hard when you walk into the gyms at [University name Blinded] and it's full of 60 frat guys, and you're the only female there." Along similar lines, other women described feeling intimidated to the extent that their activity was altered or prevented:

"A lot of us women feel that when we go to the gym, especially at [facility A] because I'm mostly going to be talking freshmen, and where the weights are and I am going. Before you go upstairs it's predominantly men. So I feel like a lot of us feel intimidated to even squat with the weights because it's all being used by the men, and it's just awkward. I don't think it limits, but I do think that a lot of people feel like maybe they wanted to squat or to do weights, but they feel like they maybe can't do that because it's just all men and they just have that idea that the men use that area of the gym" (White Freshman).

Even women who consider themselves to be confident described the impact that male peers had on their activity:

"I've been going to the gym for a while. Ever since early high school so I would consider myself to be a little bit more comfortable. But even with that being said I went to [facility C] past week. And it was just full of super muscular guys, and I wanted to try out some new exercises, but I really did feel so self-conscious that my form wasn't right or that it looked odd. So I think being a girl, being a woman, definitely sometimes makes me more uncomfortable especially for a lot of glute exercises can appear more suggestive" (White Junior).

Multiple women suggested, without any prompting, that the institution could offer separate spaces/times for women. The following is a representative quote:

“If there was a certain time that they cut off where it's like okay women are, kind of fine people can use this area is time out would be cool if it was an hour a day or something, or two hours or one day it will be, or something like that so that because I know a lot of my friends are like ‘I would totally do free weights but just like, I'm not comfortable with the atmosphere’. If there was a way that it could be all women or just less so packed with males, and they all look meatheads which is I won't say all that but essentially that's what it is, then that would make us more comfortable” (Black Sophomore).

Intrapersonal factors

A number of intrapersonal factors emerged as important influences on women's physical activity and campus recreational facility use. Perceived lack of skills/competence/knowledge was mentioned by all but one woman, lack of confidence was mentioned by all women, and all but five women mentioned self-consciousness mainly from using equipment, but also running and body image too. The following quotes are representative of these often-interconnected intrapersonal factors:

“The reason I only pretty much do the treadmill, the stair stepper, maybe the elliptical is because I know what I'm doing on those. But I'm not one of those people that can walk up to a new machine and just feel confident enough to read the instructions and do it because I always in my head think that I'm doing it wrong and people are judging me. So that definitely plays a role, like that confidence. Especially like coming in from high school I was always just part of a sports team, so I never went to the gym. I definitely have found transitioning from being on a team to then coming to college and trying to actually, work out at a gym to be so difficult. In that aspect I definitely lacked confidence with branching out at the gym” (White Junior).

“Mostly I like to go by myself because I think it's just a personal thing, I'm really insecure about people watching me work out. So I like being able to work on my own at my own pace, because sometimes I think you feel a little bit of pressure if you're with somebody who's better at running than you or can lift more than you to do that versus doing what you're comfortable with. So that's why I do things alone sort of when I'm running on the treadmill or I'm in the area where you can lift weights and stuff I like to go into my own corner and just do what I need to do and get out if that makes sense” (Asian American Freshman).

Discussion

Findings provide further evidence of gender inequities and indicate that female college students' campus recreation facility use, and therefore physical activity, is impacted by a variety of interconnected factors, intrapersonal through policy level. Seemingly inadequate policies are connected to the presence of various barriers. These barriers include the social and built environment as well as intrapersonal barriers, which are closely related participants being women and in some instances women's race/ethnicity, sexual orientation, and religion too.

Most barriers to physical activity and campus recreation facility use expressed by women in this study can be addressed by colleges at the policy level via implementation and enforcement of policies that achieve a cultural shift in the social environment to alleviate intrapersonal constraints as well as redistribution of resources (e.g. re/constructing spaces and/or providing tailored instruction) to facilitate of negotiation of interpersonal and intrapersonal constraints by women and other marginalized students.

From campus recreation departments, to institutions, and the federal level, policies are in place at a variety of interconnected levels. In a broad sense, the purpose of these policies is to ensure health and wellbeing of users of facilities. In some instances, facilities may ask users to sign and date a copy of facility rules/policies and acknowledge that they will agree to them, with users facing escalating levels of discipline depending on the repetition of degree of violations.²²⁵ Some women reported experiences that, objectively, appear to be gender based harassment based on both the accepted²²⁶ and the institution's own definitions.^{227,228} These alone raise questions regarding potential violations of departmental, institution, and federal (i.e. Title IX) policies and legislation. However, the additional experiences of intimidation that, in women's own words, interfere with and limit women's ability to participate in physical activity and benefit from using the institution's campus recreational facilities are indicative of a potentially more pervasive problem and what could be considered a hostile environment. Clarifying the applicability to Title

IX to campus recreational facilities and programs is long overdue,⁴⁸ and the findings from this study reinforce the need for such clarification immediately.

Findings pertaining to the behavior of male peers indicate a need for the implementation and enforcement of anti-harassment policies beyond Title IX. There also appears to be a need for anti-racist policies based on the comments of one Black woman that are indicative of multiple jeopardy, whereby various factors of an individual's identity (e.g. gender and race/ethnicity) can have unique multiplicative effects on the level of discrimination experienced.²²⁹ Similar comments were made by participants pertaining to religion and sexual orientation, but whether these are specific to women, or women or particular racial/ethnic groups is unclear. The intersection of gender with other socio-demographic characteristics may legally fall outside of the purview of Title IX. However, institutional policies typically encompass race, sexual orientation, and religion among other characteristics beyond solely gender as is the case for the institution at which this study was conducted.²²⁸ While sexual orientation and religion did not emerge as major factors in this study, they were touched upon and existing evidence demonstrates that there are disparities in college student physical activity based on the intersection of gender, race/ethnicity, sexual orientation, and religion.^{155,179,214,230}

With respect to harassment and discrimination, it would appear that more than simply clarifying Title IX and implementing policies is necessary. In addition to clarifying, implementing, and enforcing policies to eliminate and prevent discrimination, other steps should also be considered. With respect to campus recreation in particular, continuing education of permanent staff regarding cultural competence and identifying and addressing discrimination. Including mandatory diversity, equity, and inclusion training for casual staff is also worth considering. Addressing the apparent issue of harassment likely necessitates a broader campus wide approach at many colleges, as harassment is not unique to campus recreation facilities.

In addition to policies, the design of facilities and placement of equipment is another factor that can influence facility use according to both the American College of Sports Medicine (ACSM) and National Strength and Conditioning Association (NSCA).^{231,232} Involvement of those who will use facilities is imperative to ensure that the facility is tailored for those who use it. Demographics of users, such as age and gender, are also important to consider.²³¹ With respect to the built environment, consistent with previous research⁶²⁻⁶⁴ facility proximity emerged as an important factor that impacted women's recreational facility use. The layout of facilities and equipment also emerged as important factors closely linked with intrapersonal factors. Women's descriptions of male dominated areas of facilities are consistent with previous research that has described gendered lines, and masculine performances and energy crowding women out of spaces.²³³ Findings demonstrate a need for a cultural shift in the social environment within recreational facilities, and potentially beyond.

Provision of separate spaces for women and under-represented groups is an alternative suggested by some women that has been implemented elsewhere to accommodate students' cultural and religious standards.²³⁴ Women's praise of existing separate facilities and placement suggest that institutions could create a more comfortable space for some, but not all, women through thoughtful facility design and equipment placement and orientation. However, this would be somewhat counter for the tendency for similar types of equipment to be grouped together,²³¹ as well as the supposed need for clear sightlines for facility supervisors as recommended by ACSM and NSCA.^{231,232} At the same time, the safety and security of users should be considered when designing facilities, and supervision should vary based on the experience of users.^{225,232} Thus, in light of the findings from this study, when possible administrators may want to reconsider whether the design and equipment layout is truly best for all students who use or may want to use all areas of and equipment within facilities. A lack of partners to participate with and lack of social support emerged as themes in the current study, and are common physical activity

constraints reported by college women.^{107,108,110,111} Increasing the number of women comfortable using facilities and spaces would help to alleviate constraints pertaining to a lack of social support as well as the gendering of spaces.²³³

Assuming institutions take appropriate actions to improve the social and built environment, it appears that it will still be necessary to provide women with education/instruction regarding how to use equipment, both cardio as well as machine and free weights in particular. While using such equipment may appear to be intuitive and operation instructions are available for some equipment, actual in-person demonstration and instruction may help women to overcome a perceived lack of competence, skills, and knowledge. The assumption that institutions allocate resources in a manner that is in the best interests of all students upon whom they typically depend on for funding²³⁵ is both unwarranted and risky. Thus, diverse student representation and involvement with respect to the delivery of campus recreation programs and facilities, and physical activity promotion in general, is imperative to providing accountability.^{236,237} Students should be represented on committees and boards making decisions about facilities and programs operations, and contact details of student representatives should be accessible on campus recreation department websites.

This study is not without limitations. Many pertain to generalizability, and the inability to generalize findings to: other institutions'; racial/ethnic groups not included this study (e.g. Hispanic/Latinx, Indigenous, Pasifika, Middle eastern, etc.); other gender identities, including trans men, trans women, those identifying as non-binary, and even cisgender men; or, non-able-bodied students. In addition, as a whole, women included in this sample were relatively active and used recreational facilities more often compared to college women in general. The relatively small sample size means that saturation was not reached with respect to some themes, such as the intersection between gender and race/ethnicity. This and numerous other avenues of future research are worthy of exploration. These include the aforementioned groups not included in this

study, the experiences of students of certain religions, such as Muslim students, who may experience unique constraints, and survivors of sexual harassment/assault. Research among gender diverse and non-able-bodied college students is also lacking. Replication of this study at other institutions, both in the US and elsewhere, would provide valuable insight into the pervasiveness and magnitude of the issues identified.

Conclusion

In summary, findings indicate that in order to ensure that all students are provided with equitable opportunities to participate in physical activity institutions must implement and enforce policies that achieve a cultural shift in the social environment to alleviate intrapersonal constraints as well as redistribute resources to facilitate of negotiation of interpersonal and intrapersonal constraints by women and other marginalized students. Further research on other marginalized groups such as racial/ethnic, sexual orientation, and religious minorities is necessary to inform the development, implementation, and evaluation of changes to policies, programs and practices to promote physical activity among these groups.

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Chapter 7

Limitations

The limitations of this dissertation, and the manuscripts that it is comprised of, are summarized below. As demonstrated by the review (Chapter 2) the majority of contemporary student physical activity research has been conducted in the US. Thus, the other studies in this dissertation do not address the limitation of generalizability. However, while the findings of the qualitative study (Chapter 6) may not necessarily be generalizable outside of the US, US colleges are driven to become homogenous²³⁸ and there is evidence of homogeneity in campus recreation policies, programs, and practices.⁵⁹ Thus, it is reasonable to conclude that the constraints to physical activity participation and campus recreation facility use are not unique to women at one university. Nonetheless, this study is also limited by the exclusion of students based on gender identity and race/ethnicity, a lack of representation of students with minority sexual orientations, as well as other diversity with respect to other socio-demographic characteristics such as religious/spiritual beliefs and physical and intellectual dis/ability.

A limitation identified by the review (Chapter 2) that studies detailed in Chapters 3 through 5 addressed was examination of physical activity disparities (inequities) based on socio-demographic characteristics, particularly the intersection of characteristics. However, small cell sizes prevented more nuanced examination of inequities based on gender and sexual minorities, and the some of the items used to measure race/ethnicity measures were not heterogeneous, i.e. did not distinguish between distinctly different racial/ethnic groups (e.g. ‘Asian or Pacific Islander’). The latter limitation has since been addressed by the NCHA¹⁵²

Another limitation of Chapters 3 through 5 was the use of self-reported physical activity measures. The aerobic physical activity measure in particular is troublesome because it is framed around outdated physical activity recommendations¹⁷⁸ and does not account for students potentially accumulating sufficient levels of moderate and/or vigorous physical activity on less

than the recommended number of days/week. As with the limitations regarding race/ethnicity assessment, the revised version of the NCHA largely addresses these limitations.¹⁵²

While analyses used in Chapters 3 and 5 are an improvement upon the conventional monistic approach,¹⁷⁰ they fall short of truly honoring the principles of intersectionality (simultaneity, multiplicativity and multiple jeopardy) which can only be achieved using qualitative analyses. For example, Chapters 3 and 4 only account for two socio-demographic characteristics in identifying disparities, while Chapter 5 accounts for only one. Thus, analyses fall short of acknowledging all levels of influence in keeping with the principle of simultaneity. Another limitation of these Chapters is the inability to account for environmental and policy factors that impact physical activity. For example, do physical activity inequities among Black students vary between those who do/not attend HBCUs?

Chapter 8

Conclusions and Recommendations

The findings of this dissertation can be distilled into two conclusions. Firstly, it is untenable to ignore or treat socio-demographic characteristics as mutually exclusive categories when researching or promoting physical activity. Secondly, multiple levels of influence must be considered by those researching and promoting physical activity, as failure to appreciate and address any level of influence (socio-demographic characteristics, intrapersonal factors, interpersonal factors, environments, or policies) risks compromising attempts to reach and achieve meaningful conclusions and improvements in physical activity respectively. While conclusions pertain to US college students, findings may also benefit those interested in researching of promoting physical activity in students elsewhere as well as in other populations (children, adolescents, adults, the aged, etc.).

The review provided clarity regarding a number of aspects of the contemporary body of literature concerning college student physical activity. For one, there is much room for improvement with respect to the assessment, reporting, and examination of disparities based upon socio-demographic characteristics. Secondly, there is a need for more research from around the globe, as reliance on the US to produce generalizable and meaningful insights pertaining to inequities is flawed. Third, there is a need for more consistent and widespread use of better-quality physical activity measures, and the measurement of both aerobic and muscle-strengthening activity, the latter of which is rarely assessed. Beyond the specific benefits of muscle-strengthening activity, the nature of participation in muscle-strengthening activities means that holds potential to more clearly indicate evidence of inequities in the provision of physical activity opportunities (e.g. environments and policies)

While conclusions regarding the reasons underpinning physical activity cannot be drawn based on the findings or Chapters 3 through 6, they demonstrated that it is unjustifiable to treat

socio-demographic characteristics as mutually exclusive categories when researching and/or promoting physical activity. Whether at the macro or micro level, the intersection of socio-demographics with one another and other factors (intrapersonal, interpersonal, environmental, policy) that impact physical activity must be acknowledged by researchers and physical activity promoters alike if meaningful insights are to be generated and sustained changes in behaviors to be achieved. It is worth further exploring inequities in physical activity now that the revised NCHA survey includes improved measures of socio-demographic characteristics and physical activity that lend themselves towards more nuanced analyses, with the use of homogenous socio-demographic characteristic categories and treatment of physical activity as a continuous variable. Continuous variables would allow for interaction effects of two or more socio-demographic characteristics to be more easily examined, reported, and interpreted than can be achieved computing interaction terms using binary variables. The latter was not done in Chapters 2 through 4 due to the shortcomings of measures, avoiding exclusion of any groups, and the difficulty in reporting and discussing such interactions concisely. The studies that Chapters 2 through 4 have clear shortcomings, but provide evidence that failing to account for socio-demographic characteristics and the intersection of such characteristics, whether in research or promotion, is flawed.

Findings from the qualitative study (Chapter 6), as well as prior research,^{46,52,58,59,217,233} demonstrate the need for the implementation and enforcement of policies that achieve a cultural shift in the social environment to alleviate intrapersonal constraints as well as redistribute resources (e.g. re/constructing spaces and/or providing tailored instruction) to facilitate of negotiation of interpersonal and intrapersonal constraints by women and other marginalized students. In doing so universities can work towards ensuring that all are provided with equitable opportunities to participate in physical activity and obtain the associated benefits. While the values and policies stated by many colleges,⁵⁹ including the college that was the focus of Chapter

6.^{227,228,239} may create the illusion that institutions care about the provision of equitable physical activity opportunities, there is mounting evidence to the contrary, particularly in the US.

Findings from this dissertation indicate researchers and physical activity promoters in the US, as well as around the world, need to take action to provide equitable physical activity opportunities for all students regardless of their gender identity, race/ethnicity, sexual orientation, religion, ability. Both researchers and higher education institutions from around the world should begin to assess both aerobic and muscle-strengthening activity using measures that whether students are meeting recommendations can be determined. An array of socio-demographic characteristic including gender identity, race/ethnicity, race/ethnicity, sexual orientation, religion, dis/ability should also be assessed at the bare minimum. Institutions should collect and publicly report such data from their student body on an annual basis, and any data collected by researchers and/or institutions should be made available to external parties upon request given the minimal risk data sharing poses. Beyond gaining further insight into physical activity disparities based on intersecting socio-demographic characteristics in different contexts, further research regarding the reasons underpinning such disparities is crucial to informing the development of sustainable, cost-effective, population-level, culturally appropriate and tailored interventions that address factors from the policy level to the intrapersonal level to promote both aerobic and muscle-strengthening activity.

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Appendix A

Search Strategies

ERIC

(MAINSUBJECT.EXACT("Universities") OR MAINSUBJECT.EXACT("Colleges") OR ti(college OR colleges OR university OR universities OR "higher education") or ab(college OR colleges OR university OR universities OR "higher education")) **AND**
(MAINSUBJECT.EXACT("Undergraduate Students") OR MAINSUBJECT.EXACT("College Freshmen") OR MAINSUBJECT.EXACT("College Seniors") OR ti(student OR students OR undergraduate OR undergraduates OR graduate OR graduates OR freshman OR freshmen OR sophomore OR sophomores OR junior OR juniors OR senior OR seniors) or ab(student OR students OR undergraduate OR undergraduates OR graduate OR graduates OR freshman OR freshmen OR sophomore OR sophomores OR junior OR juniors OR senior OR seniors)) **AND**
(MAINSUBJECT.EXACT("Exercise") OR MAINSUBJECT.EXACT("Physical Activity Level") OR MAINSUBJECT.EXACT("Physical Activities") OR ti(exercise OR exercises OR "physical activity" OR "physical activities" OR "resistance training" OR "resistance-training" OR "strength training" OR "strength-training" OR "weightlifting" OR "weight-lifting" OR "weight lifting" OR walk OR walking OR jog OR jogging OR running OR swim OR swimming OR fitness OR aerobic OR exertion OR isometric OR endurance OR circuit OR "high-intensity interval" OR "high intensity interval" OR "high-intensity intermittent" OR "high intensity intermittent" OR "sprint interval" OR "stair climbing" OR "calisthenic" OR "calisthenics") OR ab(exercise OR exercises OR "physical activity" OR "physical activities" OR "resistance training" OR "resistance-training" OR "strength training" OR "strength-training" OR "weightlifting" OR "weight-lifting" OR "weight lifting" OR walk OR walking OR jog OR jogging OR running OR swim OR swimming OR fitness OR aerobic OR exertion OR isometric OR endurance OR circuit OR "high-intensity interval" OR "high intensity interval" OR "high-intensity intermittent" OR "high intensity intermittent" OR "sprint interval" OR "stair climbing" OR "calisthenic" OR "calisthenics"))

Select - English only

Select - article, conference proceeding, dissertations and thesis, government and official document, report, statistics/data report

PubMed

((("college"[TIAB] OR "colleges"[TIAB] OR "university"[TIAB] OR "universities"[TIAB] OR "universities"[Mesh Terms] OR "higher education"[TIAB]) AND ("student"[TIAB] OR "students"[TIAB] OR "students"[MeSH Terms] OR "undergraduate"[TIAB] OR "undergraduates"[TIAB] OR "graduate"[TIAB] OR "graduates"[TIAB] OR "freshman"[TIAB] OR "freshmen"[TIAB] OR "sophomore"[TIAB] OR "sophomores"[TIAB] OR "junior"[TIAB] OR "juniors"[TIAB] OR "senior"[TIAB] OR "seniors"[TIAB])) AND ("exercise"[MeSH Terms] OR "exercise"[TIAB] OR "exercises"[TIAB] OR "physical activity"[TIAB] OR "physical activities"[TIAB] OR "resistance training"[MeSH Terms] OR "resistance training"[TIAB] OR "resistance-training"[TIAB] OR "strength training"[TIAB] OR "strength-training"[TIAB] OR "weightlifting"[TIAB] OR "weight-lifting"[TIAB] OR "weight lifting"[TIAB] OR "walk"[TIAB] OR "walking"[TIAB] OR "jog"[TIAB] OR "jogging"[TIAB] OR "running"[TIAB] OR "swim"[TIAB] OR "swimming"[TIAB] OR "fitness"[TIAB] OR "aerobic"[TIAB] OR "exertion"[TIAB] OR "isometric"[TIAB] OR "endurance"[TIAB] OR "circuit"[TIAB] OR "high-intensity interval"[TIAB] OR "high intensity interval"[TIAB] OR "high-intensity intermittent"[TIAB] OR "high intensity intermittent"[TIAB] OR "sprint interval"[TIAB] OR "stair climbing"[TIAB] OR "calisthenic"[TIAB] OR "calisthenics"[TIAB])) AND (English[lang]))

SportDiscus

(DE "UNIVERSITIES & colleges" OR TI (college OR colleges OR university OR universities OR "higher education") OR AB (college OR colleges OR university OR universities OR "higher education")) AND (DE "UNDERGRADUATES" OR TI (student OR students OR undergraduate OR undergraduates OR graduate OR graduates OR freshman OR freshmen OR sophomore OR sophomores OR junior OR juniors OR senior OR seniors) OR AB (student OR students OR undergraduate OR undergraduates OR graduate OR graduates OR freshman OR freshmen OR sophomore OR sophomores OR junior OR juniors OR senior OR seniors)) AND (DE "PHYSICAL activity" OR DE "RESISTANCE training" OR TI (exercise OR exercises OR "physical activity" OR "physical activities" OR "resistance training" OR "resistance-training" OR "strength training" OR "strength-training" OR "weightlifting" OR "weight-lifting" OR "weight lifting" OR walk OR walking OR jog OR jogging OR running OR swim OR swimming OR

fitness OR aerobic OR exertion OR isometric OR endurance OR circuit OR "high-intensity interval" OR "high intensity interval" OR "high-intensity intermittent" OR "high intensity intermittent" OR "sprint interval" OR "stair climbing" OR calisthenic OR calisthenics) OR AB (exercise OR exercises OR "physical activity" OR "physical activities" OR "resistance training" OR "resistance-training" OR "strength training" OR "strength-training" OR "weightlifting" OR "weight-lifting" OR "weight lifting" OR walk OR walking OR jog OR jogging OR running OR swim OR swimming OR fitness OR aerobic OR exertion OR isometric OR endurance OR circuit OR "high-intensity interval" OR "high intensity interval" OR "high-intensity intermittent" OR "high intensity intermittent" OR "sprint interval" OR "stair climbing" OR calisthenic OR calisthenics))

Select - English only

Select - academic journal, conference paper, conference proceeding, government document, proceeding, report, and thesis or dissertation

Web of Science

(college OR colleges OR university OR universities OR "higher education") AND (student OR students OR undergraduate OR undergraduates OR graduate OR graduates OR freshman OR freshmen OR sophomore OR sophomores OR junior OR juniors OR senior OR seniors) AND (exercise OR exercises OR "physical activity" OR "physical activities" OR "resistance training" OR "resistance-training" OR "strength training" OR "strength-training" OR weightlifting OR "weight-lifting" OR "weight lifting" OR walk OR walking OR jog OR jogging OR running OR swim OR swimming OR fitness OR aerobic OR exertion OR isometric OR endurance OR circuit OR "high-intensity interval" OR "high intensity interval" OR "high-intensity intermittent" OR "high intensity intermittent" OR "sprint interval" OR "stair climbing" OR "calisthenic" OR "calisthenics")

Select - English only

Select - Article, early access, proceedings, meeting abstract, note, data paper, proceedings paper, correction

Appendix B

Critical Appraisal Tool Code Book

Study Characteristics

- Author
- Title
- Year (publication date)
- Data collection date
 - Year (text)
 - . – Not stated
- Source type
 - 1 – Journal
 - Note name of journal (text)
 - 2 – Thesis/Dissertation
- Location
 - 0 - Multiple
 - Country (coded – TBC)
 - Institution (text)

Design

- Design
 - 1 – Cross sectional
 - 2 – Longitudinal (observational)

Sampling procedures

- Sampling strategy
 - 1 – Convenience
 - 2 – Random
 - 3 – Purposive
 - 4 – Other
- Power analyses
 - . – Not stated

- 1 – Conducted
- Sample size (of analyzed sample)
 - N (text)
- Response rate
 - . – Not stated
 - State or calculate is possible (%)
- **Other**
- Funding received
 - . – Not stated
 - 1 – No funding
 - 2 – Internal
 - 3 – Provincial/state
 - 4 – Federal/national

- **Theoretical framework - Did the study cite a theoretical framework?**

A theoretical framework should be cited when attempting to examine the relationship between physical activity and psychological determinants. Exemplar theories include the theory of planned behavior, social cognitive theory, social-ecological model (etc.) – and the model should have been used to make decisions in the study (e.g., relationships to test).

- State - Yes (was the study grounded in, based on, or driven in any way by theory – if so note theory)
- 2 - NO

Physical activity measures

Overview

- 1 – Aerobic
- 2 – Muscle-strengthening
- 3 - Both

Aerobic

- Method
 - . – NA
 - 1 – Objective
 - 2 – Self-report
- Details

- If validated measure (e.g. IPAQ, GPAQ, GLETQ, PAR-Q, SDPAR, etc) - note measure
- If not validated measure – note what was being assessed (PA vs. sport) and which of the following were assessed:
 - F. Frequency
 - I. Intensity
 - D. Duration
- Percentage meeting physical activity recommendations
 - . – Not stated
 - Percentage
- Physical activity recommendations cited
 - . – Not cited
 - State recommendations

Muscle-strengthening

- Method
 - . – NA
 - 1 – Objective
 - 2 – Self-report
- Details
 - If validated measure (e.g. IPAQ, or NCHA, etc) - note measure
 - If not validated measure note which of the following were being assessed
 - F. Frequency
 - I. Intensity
 - D. Duration
- Physical activity recommendations cited
 - . – Not cited
 - State recommendations

Demographics

- . – Not assessed
- 0 – Not applicable
- 1 – Assessed, differences not examined
- 2 – Non statistically significant difference
- 3 – Statistically significant difference

- Age
- Year of study
- Sex
- Gender identity
- Race/ethnicity
- Sexual orientation
- Religion
- SES (income, parental income, parental education, etc.)
- Living situation
- Academic area/field
- Academic performance

Appendix C

Risk of Bias Tool

1. Inclusion criteria

Were the criteria for inclusion in the sample clearly defined?

The authors should provide clear (non socio-demographic) inclusion and exclusion criteria that they developed prior to recruitment of the study participants. The inclusion/exclusion criteria should be specified (e.g., absence of disease or pre-existing health condition) with sufficient detail and all the necessary information critical to the study

1 – Yes

2 – No

2. Setting (time and place)

Was the study setting described in detail?

The study setting should be described in sufficient detail so that other researchers can determine if it is comparable to the population of interest to them. The authors should provide a clear description of the population from which the study participants were selected or recruited, including and time (year) and location (specific institution(s)). Author affiliation and IRB/ethics approval were considered insufficient to determine study location.

1 – Yes (report both year and location)

2 – No (report neither year nor location)

3 – Unclear (report only one of year or location)

/ – Not applicable (If using a nationally representative dataset)

3. Participant characteristics

Were the participants characteristics described in detail?

The participants' characteristics should be described in sufficient detail so that other researchers can determine if it is comparable to their target population. The authors should provide a clear description of the participants' characteristics by describing the age (including variance), sex/gender, and at least one additional socio-demographic characteristic (e.g. race/ethnicity, sexual orientation, socio-economic status, etc.)

1 – Yes

2 – No

4. Physical activity measurement methods

Were the method(s) used to assess physical activity described in detail?

The method(s) used to assess physical activity should be described in sufficient detail so that they could be replicated in another study.

1 – Yes (Information from the methods or the results can be used to determine how physical activity was measured)

2 – No (Insufficient info reported, e.g. results report participants as being active less than three times, or three or more time/week without any specification of whether they participants reported how many times they were active, or whether they fell into which group)

5. Validity of physical activity measure* (If valid PA measure was not used)

Was the physical activity measure used valid?

The method(s) used to assess physical activity should be able to be used to determine whether or not participants met physical activity recommendations

1 – Yes (If duration, or frequency and duration are assessed, e.g. in a typically day how many minutes are you physically active, or in a typical week how many days are you physically active for at least 30min)

- This is always a yes if validated tool or measure is used

2 – No (If just frequency is assessed, e.g. how many days (or times)/week are you physically active?)

3 – Unclear (Insufficient information is available)

6. Reporting of physical activity variability

Was the variability of physical activity reported?

An estimate of variability in physical activity should be provided (e.g. SD, IQR)

0 – Not possible

1 – Yes

2 – No

Appendix D

List of Sources Included in Review

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VITA

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EDUCATION

- 2017-Present **Pennsylvania State University.** Ph.D. in Kinesiology (minor Higher Education), concentrating in Psychology of Physical Activity
- 2016 **Auckland University of Technology.** Auckland, New Zealand. Master of Sport and Exercise (First Class Hons)
- 2013 **University of Canterbury.** Christchurch, New Zealand. Bachelor of Sport Coaching

AWARDS

- 2020 **American Kinesiology Association.** Doctoral Scholar Award Recipient - Pennsylvania State University

SELECTED PUBLICATIONS

Published or In Press (of 31)

- Wilson, O. W. A.,** Colinear, C., Guthrie, D., & Bopp, M. (2020). Gender differences in college student campus recreational facility usage and comfort. *Journal of American College Health.* doi: 10.1080/07448481.2020.1804388
- Wilson, O. W. A.,** Garra, S. Papalia, Z., Bopp, M., & Bopp, C. M. (2020). Incorporating the American College of Cardiology/American Heart Association hypertension diagnostic criteria into metabolic syndrome criteria will significantly increase the prevalence of metabolic syndrome among college students. *Journal of Human Hypertension.* doi: 10.1038/s41371-020-0369-6
- Wilson, O. W. A.,** Kamara, K., Papalia, Z., Bopp, M., & Bopp, C. M. (2020). Changes in hypertension diagnostic criteria enhance early identification of at risk college students. *Translational Journal of the American College of Sports Medicine, 5,* (1) 1-5. doi: 10.1249/TJX.0000000000000114
- Wilson, O. W. A.,** Galascio, M., & Bopp, M. (2019). Freshmen weight and body composition change determinants: A scoping review. *Journal of American College Health.* doi: 10.1080/07448481.2019.1665053
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- Wilson, O.,** Vairo, N., Bopp, M., Sims, D., Dutt, K., & Pinkos, B. (2018). Best practices for promoting cycling amongst university students and employees. *Journal of Transport & Health, 9,* 234-243. doi: 10.1016/j.jth.2018.02.007

Under Review (of 21)

- Wilson, O. W. A.,** Bhuiyan, N., & Bopp, M. (Under Review). College women's perceptions of factors contributing to gender disparities/inequities in physical activity and campus recreation facility use in the United States
- Wilson, O. W. A.,** Panza, M., Evans, M. B., & Bopp, M. (Under Review). A scoping review on college student physical activity: How do researchers measure activity and examine inequities?