# Examining the Effects of Text Message and Competition-Based Interventions on Physical Activity, Self-Efficacy, Self-Regulation, Social Support, Incentive Motivation, and Mental Well-being among University Students

by

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A dissertation submitted to the Graduate Faculty of
Auburn University
in partial fulfillment of the
requirements for the Degree of
Doctor of Philosophy

Auburn, Alabama
August 5, 2023

Keywords: Physical activity, university student, text message, fitness competition, Social Cognitive Theory



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Abstract

**Background:** Compelling evidence highlights the importance of physical activity and its numerous benefits for both physical and mental well-being. However, physical activity levels remain low, particularly among university students. Several interventions have been designed and tested to target low physical activity levels among this audience, including text message interventions and fitness competitions.

**Objective:** The objectives of this study are: 1) To conduct a systematic review and meta-analysis of text message interventions targeting physical activity among university students from published literature, and 2) To assess and compare the effectiveness of text message interventions and a competition-based intervention in improving physical activity among university students, and evaluate participants' acceptability and experiences.

**Methods:** A structured, electronic search was conducted in October 2022, using PsycINFO, MEDLINE, SPORTDiscuss, CINAHL through the EBSCO interface and Web of Science, to select experimental studies focusing on text message interventions for physical activity. Studies in the same study design were included in several meta-analyses for different outcomes.

Second, students in three health professional programs were recruited in a three-group quasi-experimental study. The three groups included a control group ("Control"), a competition group ("DFFC), and a competition + text message group ("DFFC + text"). During the eight weeks of competition and four weeks of follow-up, participants were expected to complete two surveys (week-0 and week-8) and report their weekly moderate-to-vigorous physical activity (MVPA) minutes. Outcomes include Physical Activity, Mental Well-being, Self-Efficacy,

Incentive Motivation, Social Support, and Self-Regulation. One-way ANOVA, Repeated Measurement ANOVA, Paired t-test, and mediation models were used to test the effects of the two interventions. The relationship between outcomes variables were assessed by path analysis.

**Results:** Among 20 studies included in the systematic review, 15 (75%) were randomized controlled trials (RCTs), and 10 (50%) studies focused on university students younger than 30 or 35 years old. In the university setting, texts were commonly sent on a daily basis for 2-6 weeks and were incorporated into various physical activity programs. The meta-analyses of RCTs indicated that text message interventions resulted in significantly greater total metabolic equivalent of task (MET) ($n=3$, $SMD=0.67$, $p<0.001$). However, for the analysis of intervention effects on Body Mass Index, statistically significant differences were not observed in RCTs ($n=3$, $SMD=-0.15$, $p=0.08$).

Weekly MVPA minutes in the DFFC Group and DFFC + Text Group were significantly different compared to the control group (week 0-8), but there was no difference in MVPA minutes between the DFFC Group and DFFC + Text Group. From week-4 to week-8, participants in the DFFC + Text Group demonstrated a statistically significant increase in weekly MVPA minutes compared with week-1. Results of Repeated Measures ANOVA indicated that from week-1 to week-8, the effect of the competition was significant on weekly MVPA ($p<0.01$) between the Control Group and two intervention groups, and the influence of texting depended on time ($p=0.01$). A statistically significant difference in post-intervention Incentive Motivation was observed among the three groups. The effect of interventions was mediated by Self-Efficacy and Incentive Motivation. Path analysis identified that Self-Efficacy and Incentive Motivation have a medium direct and significant effect on Physical Activity. Both interventions were found to be satisfactory and acceptable by participants.

**Conclusions:** Positive effects of text message interventions on university students' Physical Activity have been observed in the literature for MET but not for other outcomes. Text message interventions with well-controlled designs are needed to further examine the associations and identify characteristics of effective texts among university students. In the quasi-experimental study, both competition-based and text message interventions were found to be feasible and acceptable in promoting physical activity among university students. Future work should focus on developing multimodal interventions grounded in behavior theories, while also investigating the long-term effects and generalizability through robust study designs.

# Acknowledgments

When I was planning to write this acknowledgement statement, I came across a tweet from Mr. Hugh Kearns, an internationally recognized public speaker, educator, and researcher, “Every day I am in awe of international students. Doing a PhD in your native language and home country is hard. Doing it in a non-native language, in a different country and different culture is so much harder. You are not stupid. You are legends.” This heartfelt message resonates with many, garnering 12,600 likes as of June 20, 2023, including one from me. I am deeply touched by the understanding and empathy extended towards international students; in the meantime, I feel extremely fortunate to have received dedicated support from so many people along the way.

First and foremost, I am sincerely grateful to my advisor, Dr. Brent I. Fox, for his invaluable guidance and unwavering support. It is a great honor and privilege that I was given the opportunity to work under his supervision. I would like to thank him for his patience, knowledge, expertise, empathy, and great sense of humor. Next, I would also like to extend my appreciation to my dissertation committee members, Dr. Salisa Westrick, Dr. Kimberly Garza, Dr. William M. Murrah, and Dr. Joshua C. Hollingsworth for their valuable comments which helped in designing and developing this project, and to my University Reader, Dr. Robin Gosdin Farrell, for her time and efforts on my dissertation.

I want to thank Auburn University, Harrison College of Pharmacy, and the Department of Health Outcomes Research and Policy. I would like to extend my gratitude to all faculty, staff members, and students who supported me throughout my PhD journey. Also, I would like to thank Dr. Jingjing Qian and Mrs. Adelia Grabowsky for their help in the systematic review and meta-analysis. Likewise, I want to thank Dr. Surachat Ngorsuraches and Dr. Matthew Loop for

their advice on statistical analysis. I would also like to thank Dr. Yi Zhao for serving as the second reviewer and second coder. Overall, I thank everyone who participated in this study.

I must also thank my family for their constant love and encouragement. I wanted to thank my parents for their exceptional support in enabling me, their only child, to study abroad. I haven't been able to go back home for about three years, but their support in my pursuit of my dreams remains steadfast. I would like to acknowledge my boyfriend, Fan Wu. He is always supportive, willing to listen, and encourages me when I am struggling. Also, I must thank my beloved pets, Paper and Diudiu, for their antics and noise they made during those late nights when I worked on my dissertation.

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List of Abbreviations

| | |
|---|---|
| ACSM | American College of Sports Medicine |
| AUCON | College of Nursing |
| BRFSS | Behavioral Risk Factor Surveillance System |
| CDC | Centers for Disease Control and Prevention |
| CINAHL | Cumulative Index to Nursing and Allied Health Literature |
| CI | Confidence Interval |
| DFFC | Deans' Fit Family Challenge |
| HCOP | Harrison College of Pharmacy |
| IPAQ | International Physical Activity Questionnaire |
| MEDLINE | National Library of Medicine's Bibliographic Database/Article Index |
| MET | Metabolic Equivalent of Task |
| MMAT | Mixed Methods Appraisal Tool |
| MPA | Moderate-Intensity Physical Activity |
| MVPA | Moderate-to-Vigorous Physical Activity |
| NWU | Nightly-Week-U |
| OSPAQ | Occupational Sitting and Physical Activity Questionnaire |
| PA | Physical Activity |
| PASB-Q | Physical Activity and Sedentary Behavior Questionnaire |
| PAR | Physical Activity Recall |
| PICOS | Population, Intervention, Comparator, Outcome, and Study Design |
| PRISMA | Preferred Reporting Items for Systematic reviews and Meta-Analyses |

| | |
|---|---|
| PTSD | Post-Traumatic Stress Disorder |
| RMSEA | Root Mean Square Error of Approximation |
| SCT | Social Cognitive Theory |
| SLIPA | Sedentary and Light Intensity Physical Activity |
| SMD | Standardized Mean Difference |
| SMS | Short Message Service |
| U.S. | the United States |
| VCOM | Edward Via College of Osteopathic Medicine |
| VPA | Vigorous-Intensity Physical Activity |
| WHO | World Health Organization |
| WHO-5 | World Health Organization Five Wellbeing Index |

# Chapter 1. Introduction

## 1.1 Background of the Problem

### 1.1.1 Physical Activity

Physical activity (PA) was defined as the "best buy" in public health by the epidemiologist Jerry Morris in 1994.[1] It is estimated that one in ten premature deaths can be prevented by getting enough physical activity.[2] The health benefits of physical activity are well documented, including a reduced risk of several chronic conditions such as cardiovascular disease, stroke, arthritis, hypertension, type 2 diabetes, and cancers.[3-9] By engaging in regular physical activity, significant improvement can be achieved in weight management, muscular fitness, cognitive function, immune system function, mental well-being, quality of life, and life expectancy.[2,10-15] As Dr. Ruth Petersen, the Director of the Division of Nutrition, Physical Activity, and Obesity from the Centers for Disease Control and Prevention (CDC) says, “if you could package physical activity into a pill, it would be the most effective drug on the market”.[2]

Based on the second edition of the Physical Activity Guidelines for Americans, adults are recommended to perform at least 150 minutes of moderate-intensity or 75 minutes of vigorous-intensity physical activity per week, or “an equivalent combination of moderate and vigorous-intensity aerobic activity,” as well as muscle-strengthening activities two or more days in a week.[16] According to the CDC, physical inactivity in adults refers to the absence of participation in any form of leisure-time physical activities (e.g., running, walking for exercise, or gardening) during the past month.[17] The overall prevalence of physical inactivity is 25.3% in United States (U.S.) population, and it is 30.7% in Alabamian adults.[15] Globally, 40%-50% of university students are physically inactive.[18-24]

### 1.1.2 Physical Activity Interventions

In light of the numerous benefits of physical activity and the prevalence of physical inactivity, effective interventions are needed to encourage the adoption and maintenance of active lifestyles in the U.S. population, particularly for university students who are at the age where sedentary behaviors are adopted.[25] Evidence suggests that various intervention strategies have been successful in promoting physical activity among different populations.[25-31] Fitness competitions, which use rankings, leader boards, status markers, incentives, and other competitive strategies, are widely implemented in working places, schools, and long-term care facilities.[32-35] Text messaging is well suited for public health interventions because of its popularity, enormous reach, low cost, and effectiveness in promoting health outcomes.[36-39] Through media coverage and promotion, educational programs, social support, and policy initiatives, community-wide campaigns are effective in increasing physical activity.[31,40-42] Institutions of higher education, such as universities and colleges, are ideal for implementing health promotion programs to engage large numbers of participants.[24,43,44]

### 1.1.3 Deans' Fit Family Challenge

To encourage students to be physically active, Auburn University holds the Deans' Fit Family Challenge (DFFC) each fall semester between the Harrison College of Pharmacy (HCOP), College of Nursing (AUCON), and Edward Via College of Osteopathic Medicine – Auburn (VCOM-Auburn). The DFFC is a 9-week annual health and wellness competition based on two metrics: cumulative minutes of exercise logged and cumulative number of total pounds lost from baseline to endpoint. Participants compete in teams of two within their college. Each team tracks minutes of meaningful activity using the ChallengeRunner app or website (challengerunner.com), submitting data weekly. Participants also provide self-reported weight

prior to and at the conclusion of the DFFC. Participants receive approximately weekly emails containing general information on physical activity and quality of life, an announcement of weekly winners for minutes exercised, and cumulative minutes throughout the DFFC. At the conclusion of the DFFC, individual winners are determined based on minutes of physical activity and weight loss. The winning college is determined based on a composite score that includes minutes of physical activity and weight loss.

Since 2019, 892 students, faculty, and staff have participated in the DFFC: 101 (11.39%) from AUSCON, 229 (25.82%) from VCOM, and 557 (62.80%) from HCOP (Figure 1.1). The average number of minutes logged per participant for each year was 1,458 in 2019, 2,027 in 2020, and 2,309 in 2021 (Figure 1.2). Since 2019, 278 participants reported losing 1,570 pounds, with 37 participants losing more than 10 pounds. VCOM won the DFFC in 2019, with an average of 30.38 activity hours and an average weight loss of 5.19 pounds per participant, and also won in 2021 with an average of 42.1 activity hours plus an average weight loss of 4.3 pounds per participant. In 2020, AUCON was the winning program with an average of 35.43 activity hours plus 2.6 pounds average weight loss per participant. Since 2019, an average of 93.3% of HCOP participants reported minutes in week 1, compared to 51% in week 9. Similarly, in 2021, 178 HCOP participants provided weigh-in data while 57 provided weigh-out data.

Figure 1.1 Number of DFFC Participants 2019-2021

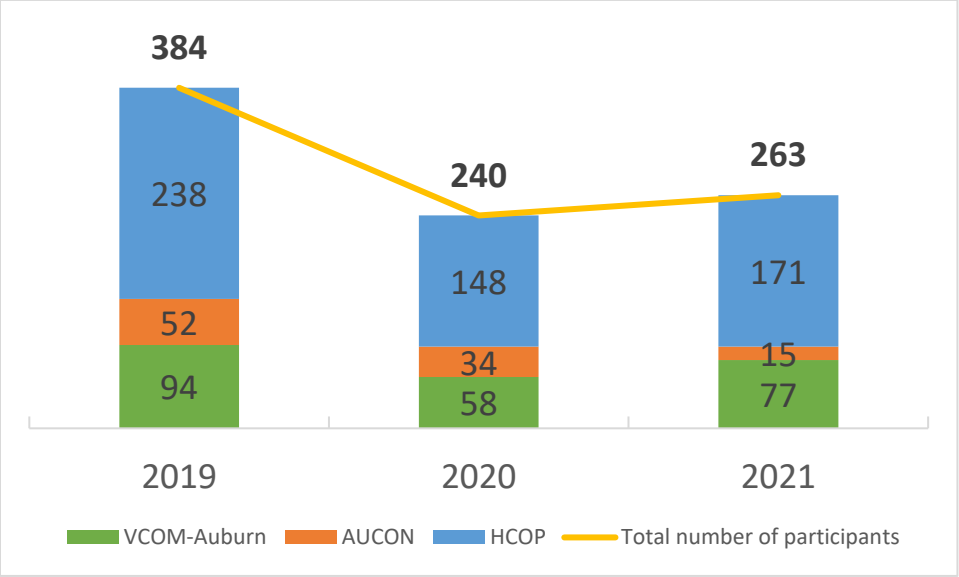
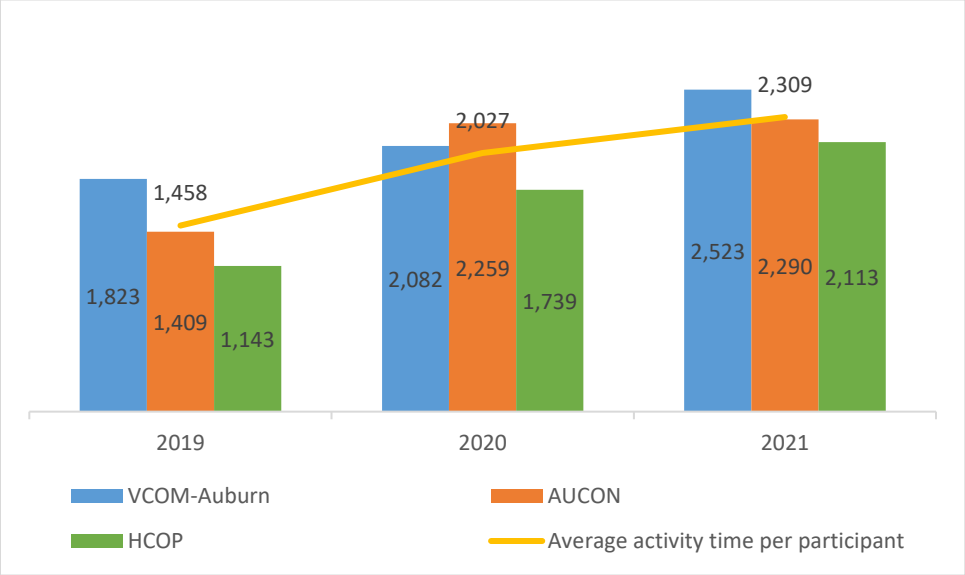



Figure 1.2 Average Activity Minutes Per Participant




The DFFC plays an important role in promoting physical activity among participating programs. However, participation wanes in minutes and weight reported each year, and the implementation of the DFFC has not been systematically evaluated. Motivational and retention

strategies targeting social cognitive determinants, such as self-efficacy, self-regulation, incentive motivation, and social support should be explored to enhance future design and execution of competition-based interventions among health professional students, faculty, and staff members.

### 1.2 Problem Statement and Purpose of the Study

Physical inactivity is the fourth leading cause of death globally.[9] However, participation in physical activity among the U.S. population is declining. Only 23.0% of U.S. adults meet the physical activity guidelines, while 26.0% of U.S. adults do not engage in any leisure-time physical activity.[15] Despite the importance of physical activity, there is a significant drop in physical activity participation and an increase in sedentary behavior among university students.[45] For university students, 30%-35% have overweight or obesity, and 40%-50% are physically inactive.[18-24] As a result, strategies to promote healthy lifestyles in university students are critical.[26] A tailored intervention that utilizes evidence-based solutions may be effective in addressing physical inactivity in this population.

The overarching objective of the proposed research is to assess and compare how text message interventions and a competition-based intervention impact university students' physical activity levels, mental well-being, and Social Cognitive Theory constructs. We hypothesize that both the text message intervention and the competition-based intervention will positively influence university students' Physical Activity, Self-Efficacy, Self-Regulation, Social Support, Incentive Motivation, and Mental Well-being. The first research question is, “What is the relevant evidence related to text message interventions targeting physical activity among university students?”. The second research question is, “What are the effects of text message interventions and competition-based interventions on university students’ physical activity levels, self-efficacy, self-regulation, social support, incentive motivation, and mental well-

being?" The third research question is, "What are participants' perceptions regarding their experience with and acceptability of text message interventions and competition-based interventions?"

### 1.3 Specific Aims

**Specific Aim 1:** To conduct a systematic review and meta-analysis of text message interventions targeting physical activity among university students from published literature.

This aim is to identify physical activity outcomes relevant to text message interventions among university students. A systematic review and meta-analysis were used to accomplish this purpose. We hypothesized that text message interventions are effective in improving physical activity among university students. Outcomes of physical activity relevant to university students were identified from the review, including physical activity scores, moderate-intensity physical activity (MPA) minutes, vigorous-intensity physical activity (VPA) minutes, moderate-to-vigorous physical activity (MVPA) minutes, walking minutes, weekly steps, and metabolic equivalent of task (MET). Five databases (APA PsycINFO, MEDLINE, SPORTDiscuss, CINAHL, Web of Science) were searched; the search ending with August 2022 publications. Additional articles were identified via a high sensitivity search on Google Scholar and hand-searching. Eligibility criteria included interventional studies exploring the effectiveness of university students participating in text messaging physical activity interventions. The Mixed Methods Appraisal Tool (MMAT), Version 2018,[46,47] was used to assess each article's quality concurrently with data extraction. Publication bias was presented using funnel plot asymmetry tests.[48] Meta-analysis was performed if at least three studies reported the same physical activity effectiveness outcomes.[49,50]

**Specific Aim 2: To assess and compare the effectiveness of text message interventions and a competition-based intervention in improving physical activity among university students, and evaluate participants' acceptability and experiences of the text message interventions and the competition-based intervention.**

Sub Aim 2.1: To conduct a quasi-experimental study to assess and compare the effectiveness of text message interventions and a competition-based intervention among university students.

Sub Aim 2.2: To evaluate participants' acceptability and experiences of text message interventions and the competition-based intervention.

A quasi-experimental design was employed to accomplish this aim. Eligibility criteria of participants included being an adult university student (≥18 years of age), the ability to speak and write English, and possessing a smartphone and a fitness tracker or smartwatch. During the eight weeks competition and four weeks of follow-up, they were expected to report their weekly MVPA via supporting apps to synchronize activity minutes to the ChallengeRunner app or manual data entry. Participants in the 2022 Deans' Fit Family Challenge competition were invited and randomly assigned to the competition intervention group or the competition plus text message intervention group. Students in HCOP, AUCON, and VCOM who did not enroll in the 2022 DFFC were invited as the Control group. Participants in the Control Group did not participate in 2022 DFFC nor receive text messages.

Repeated measures ANOVA was used to examine the effect of the two interventions. We also assessed if these parameters (mental well-being, self-efficacy, incentive motivation, self-regulation, and social support) influenced their PA. A path analysis was used to examine the

relationship between Physical Activity, Mental Well-being, Self-Efficacy, Incentive Motivation, Self-Regulation, and Social Support. The hypothesized relationships were informed by the Social Cognitive Theory. The independent variable was physical activity interventions (e.g., DFFC or DFFC plus text messaging) while the dependent variables were PA levels, Mental Well-being, Self-Efficacy, Incentive Motivation, Self-Regulation, and Social Support. A qualitative thematic analysis approach was used to analyze open-ended questions about participants' acceptability and experiences.

### 1.4 Study Significance

With health behaviors still under development during young adulthood, increased physical activity and improved health awareness help prevent vital health problems. However, there is limited literature on the health behavior of university students. This study has the potential to contribute to knowledge about this cohort. A systematic review of experiences of university students' physical activity will reveal the remarkable impact of physical activity engagement on individuals of this group. Also, by targeting the intervention in this study to university students, findings are expected to reveal the effects of competition-based physical activity interventions and cognitive variables on the physical activity of young adults. Results may be adapted for interventions for university students adopting other health behaviors.

Evidence has reported positive effects of text message interventions on promoting physical activity among various populations, including university students. However, there is no systematic review and meta-analysis focusing on the effect of text messaging on physical activity among university students. A systematic review and meta-analysis to synthesize the findings will qualitatively and quantitatively describe the effect of text messaging on physical activity among university students.

This study has the potential to improve university students' physical activity levels through the use of text messaging and a fitness competition. Even though fitness competition interventions have been found to be effective in promoting physical activity, they have not yet been compared with other interventions. Therefore, this study addresses a critical gap in literature.

There has been inconsistency in the field of health decision-making concerning the most effective types of physical activity interventions. Additionally, the role of fitness competitions in promoting physical activity among university students has not been studied. The outcome of this study yields valuable insight into implementing fitness competitions to promote physical activity, which may be adapted to school-based programs such as fitness campaigns and the general presentation of physical activity information to young adults.

Finally, although text messaging and competition-based physical activity interventions are widely implemented in campus settings, very few text message and competition-based physical activity strategies among university students are based on health behavior theory. In this study, both interventions are informed by the SCT model, which is an innovative approach.

### 1.5 Innovation

This study is innovative in five respects. First, data among university students *using text messaging* to promote physical activity is scarce. Aim 1 synthesizes the literature on those experiences to identify physical activity outcomes relevant to university students. Second, very few text messaging and competition-based physical activity interventions targeting university students are implemented based on health behavior theory. Third, there is a scarcity of research studies that specifically target university students, encompassing undergraduate, graduate, and professional students, with a majority of campus PA interventions primarily targeting

undergraduate students. This gap highlights the need for further research in understanding the comparative effectiveness of these different PA promotion approaches.

### 1.6 Organization of Dissertation

This dissertation consists of five chapters. The first chapter introduces the background of the problem, including the study's theoretical background. It also briefly describes the specific aims, methods, significance, and innovation. Chapter Two provides a comprehensive review of the literature and the theoretical framework. Chapter Three introduces the research approach for each aim, including the study design, setting, participant recruitment, data collection, outcomes, measures, and analysis. It also describes the potential challenges, limitations, and timeline of the study. Chapter Four reports the results of data analyses. Chapter Five includes a summary of results, a discussion of the findings, and implications for future research.

# Chapter 2. Literature Review

## 2.1 The Problem: Lack of Physical Activity

### 2.1.1 Definitions of Physical Activity and Recommended Physical Activity Levels

According to the World Health Organization (WHO), physical activity is defined as any bodily movement produced by skeletal muscles that require energy expenditure,[51] while exercise is a form of physical activity that is planned, structured, repetitive, and performed intending to improve fitness.[52,53] Physical activity includes all movement that occurs during one's leisure time, travel, and occupation, or education.[52,53] Exercise that involves large muscles moving rhythmically for a sustained period along with a high heart rate, such as hiking, running, and bicycling is known as aerobic exercise or endurance activity.[54-56] Resistance training, also known as muscle strengthening, involves large muscle groups moving against an applied force, such as heavy objects, resistance bands, or an individual's own weight.[57-59]

The metabolic equivalent of task (MET) is a unit of energy expenditure related to a specific activity.[60] According to the definition, a MET is the "ratio of the rate of energy expended during an activity to the rate of energy expended at rest".[59-62] One MET is equivalent to the rate of energy expenditure during rest, while 4 MET activities expend four times the energy used by the body at rest. Performing a 5 MET activity for 30 minutes is equal to 5 x 30 = 150 MET-minutes (or 2.5 MET-hours) of physical activity. Light-intensity physical activities are defined as non-sedentary behaviors with less than 3.0 METs and reaching 57% - 63% of maximum heart rate, such as cooking, light household chores, and walking at 2.0 miles per hour (2.5 METs); moderate-intensity physical activities (MPA) are 3.0-5.9 METs with 64% - 75% of maximum heart rate, such as walking at 3.0 miles per hour (3.5 METs); vigorous-intensity

physical activities (VPA) are greater than 6.0 METs with 76% - 95% of maximum heart rate, such as running at 6.0 MPH (10 METs). [59,60,62-64] Moderate-to-vigorous physical activity (MVPA) is any activity over 3 METs with at least 64% of maximum heart rate.[64] Table 2.1 contains examples of moderate-intensity activities and vigorous-intensity activities.[62]

Table 2.1. Different Aerobic Physical Activities[62]

| Moderate-Intensity Activities (3.0-5.9 METs with 64% - 75% of maximum heart rate) | Vigorous-Intensity Activities (> 6.0 METs with 76% - 95% of maximum heart rate) |
|---|---|
| • Walking briskly (2.5 miles per hour or faster)<br>• Recreational swimming<br>• Bicycling slower than 10 miles per hour on level terrain<br>• Tennis (doubles)<br>• Active forms of yoga (for example, Vinyasa or power yoga)<br>• Ballroom or line dancing<br>• General yard work and home repair work<br>• Exercise classes like water aerobics | • Jogging or running<br>• Swimming laps<br>• Tennis (singles)<br>• Vigorous dancing<br>• Bicycling faster than 10 miles per hour<br>• Jumping rope<br>• Heavy yard work (digging or shoveling, with heart rate increases)<br>• Hiking uphill or with a heavy backpack<br>• High-intensity interval training<br>• Exercise classes like vigorous step aerobics or kickboxing |

Physical activity recommendations have been developed over the last several decades and have varied among organizations. The CDC and the American College of Sports Medicine (ACSM) published suggestions in 1995 that U.S. adults need to accumulate at least 30 minutes of MPA on most days.[65] This recommendation was endorsed by the 2005 Dietary Recommendations for Americans and the 2015 U.S. Public Health Service's Surgeon General's Report.[66,67] In addition, the Institute of Medicine published recommendations addressing both dietary intake and physical activity to maintain a healthy weight and avoid undesirable fat accumulation , suggesting that adults should obtain at least 60 minutes of accumulated moderately intense physical activity each day.[68]

In 2007, the ACSM and American Heart Association recommended a combination of both aerobic and muscle strengthening activities to improve and maintain health.[69] The ACSM indicated that healthy adults need at least 30 minutes of aerobic moderate-intensity physical activity five times per week or 20 minutes of aerobic vigorous-intensity physical activity three times per week.[69] The 2008 Physical Activity Guidelines for Americans, published by the U.S. Department of Health and Human Services adopted this recommendation for U.S. adults.[59] In 2018, the U.S. Department of Health and Human Services published the second edition of the Physical Activity Guidelines for Americans,[62] suggesting that adults should perform at least 150 minutes moderate-intensity or 75 minutes vigorous-intensity physical activity per week, or "an equivalent combination of moderate and vigorous-intensity aerobic activity," as well as muscle-strengthening activities on two or more days in a week

According to the second edition of the Physical Activity Guidelines for Americans, there are four levels of aerobic physical activity: inactive, insufficiently active, active, and highly active (Table 2.2).[62]

Table 2.2. Levels of Physical Activity[62]

| | |
|---|---|
| Inactive | Not getting any moderate- or vigorous- intensity physical activity beyond basic movement for daily life activities. |
| Insufficiently active | Doing some moderate- or vigorous- intensity physical activity but less than the recommended criteria. This level is below the recommended guidelines for adults. |
| Active | Doing the equivalent of 150 minutes to 300 minutes of moderate-intensity physical activity a week. This level meets the critical guideline target range for adults. |
| Highly active | Doing the equivalent of more than 300 minutes of moderate-intensity physical activity a week. This level exceeds the critical guideline target range for adults. |

### 2.1.2 Benefits of Physical Activity

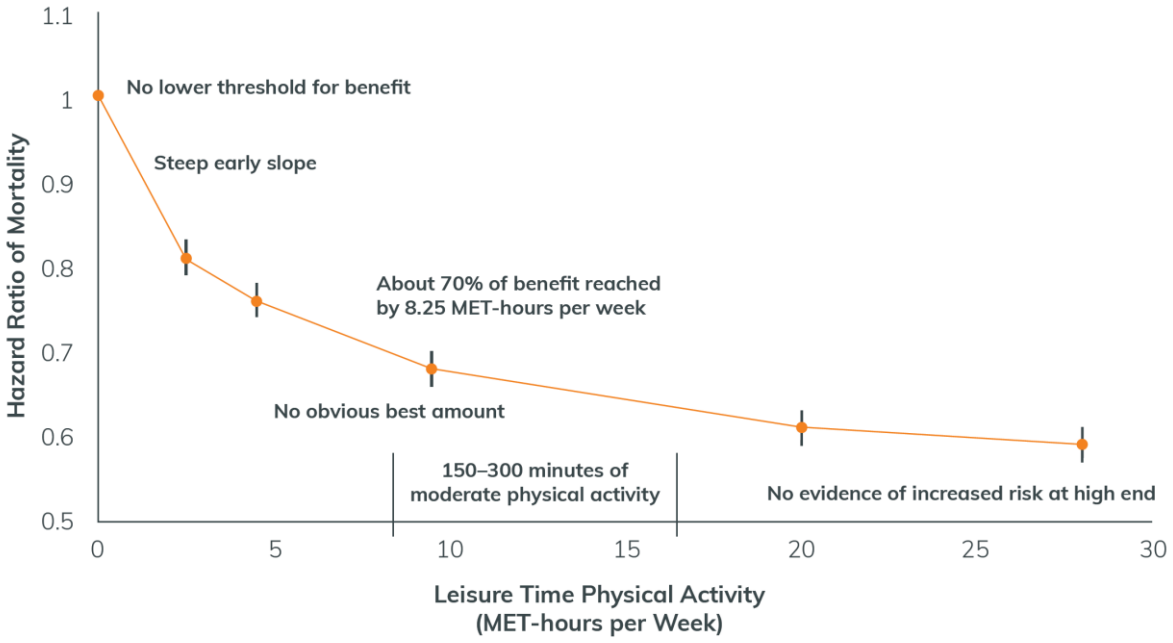
There is ample evidence to support that physical activity is beneficial among adults. An inverse correlation has been identified between the volume of physical activity and all-cause

mortality. Literature also indicates that regular physical activity decreases the risk of many health concerns, including cardiovascular diseases, type 2 diabetes, osteoporosis, obesity, cancer, and falls in older adults. Additionally, physical activity improves cognitive function, quality of life, and mental well-being. Each of these findings is addressed below.

#### 2.1.2.1 Lower Risk of All-Cause Mortality

Compelling evidence demonstrates that physical activity delays death from all causes. People who exercise about 150 minutes per week have a 20%-30% lower risk of all-cause mortality than physically inactive individuals (Figure 2.1).[70-72] Compared with people who did not meet the physical activity recommendation, those who engaged in recommended muscle strengthening activity (hazard ratio 0.89; 95% CI, 0.85 to 0.94) or aerobic activity (hazard ratio 0.71; 95% CI, 0.69 to 0.72) were at reduced risk of all-cause mortality; and even larger survival benefits were found in those engaged in both activities (hazard ratio 0.60; 95% CI, 0.57 to 0.62) (Figure 2.2).[73,74] Compared with being inactive, achievement of activity levels that approximate the recommendations for moderate activity or vigorous exercise was associated with a 27% (RR, 0.73; 95% confidence interval [CI], 0.68-0.78) and 32% (RR, 0.68; 95% CI, 0.64-0.73) decreased mortality risk, respectively.[75] Physical activity reflective of meeting both recommendations was related to substantially decreased mortality risk overall (RR, 0.50; 95% CI, 0.46-0.54).[75] A 2011 study found that a person's risk of death from any cause decreased by 4% for every additional 15 minutes of physical activity up to 100 minutes per day throughout the study.[10] Throughout the world, physical activity has helped reduce premature mortality.[76]

Figure 2.1. Relationship of Moderate-to-Vigorous Physical Activity to All-Cause Mortality[72]




Data were derived from 2018 Physical Activity Guidelines Advisory Committee. 2018 Physical Activity Guidelines Advisory Committee Scientific Report. Washington, DC: U.S. Department of Health and Human Services, 2018. The data analysis and conclusions in this study are those of the author and do not necessarily represent the official position of the Centers for Disease Control

### 2.1.2.2 Extend Expected Lifespan

Physical activity increases longevity.[77,78] Active adults tend to have longer telomeres (a repetitive DNA sequence to protect the end of a chromosome from being frayed or tangled), resulting in fewer years of cellular aging than their more sedentary counterparts.[79-81] Evidence from eight cohort studies indicated that regular physical activity is associated with a 0.4-6.9 years longer life expectancy.[82] A prospective cohort study of 416,175 individuals found that

people who performed 15 minutes a day or 92 minutes of physical activity per week extended their expected lifespan by three years compared to inactive people. An additional four years of life expectancy was gained by exercising for 30 minutes a day.[10]

#### 2.1.2.3 Lower Risk of Cardiovascular Disease

There is an association between physical activity and lower rates of cardiovascular disease. An increase from being inactive to achieving recommended physical activity levels was associated with lower risk of cardiovascular disease mortality and incidence by 23% (RR, 0.77; 95% CI, 0.71–0.84) and 17% (RR, 0.83; 95% CI, 0.77–0.89), respectively.[83] The greatest physical activity levels were associated with a significantly reduced risk of heart failure (pooled HR, 0.70; 95% CI, 0.67–0.73).[84] Compared with people reporting no leisure-time physical activity, individuals engaged in recommended physical activity had reductions in heart failure risk (pooled HR, 0.90; 95% CI, 0.87-0.92).[71]

#### 2.1.2.4 Lower Risk of Hypertension

Clinical trials have confirmed the favorable effects of exercise on blood pressure reduction. Among people with prehypertension, the impact of aerobic exercise training on blood pressure was significant for systolic and diastolic blood pressure, with net reductions of 4.3 mmHg and 1.7 mmHg reported, respectively.[8] Cornelissen and colleagues investigated significant pooled reductions in daytime blood pressure with net reductions of 2.2 mmHg for systolic blood pressure and 3.3 mmHg for diastolic blood pressure.[85] Findings from the ASUKI Step study suggested the goal of walking 10,000 steps/day could be effective in reducing blood pressure.[86]

#### 2.1.2.5 Lower Risk of Type 2 Diabetes

There is an association between higher levels of physical activity and a 20%-30% reduction in diabetes risk.[7] In men, vigorous physical activity is associated with a 40%-50% reduction in risk of diabetes.[87] An increase from being inactive to achieving recommended physical activity levels was associated with a lower risk of type 2 diabetes incidence by 26% (RR, 0.74; 95% CI, 0.72-0.77).[83] People who reported >10.4 MET-hours per week had a relative risk of diabetes of 0.59 (95% CI, 0.46-0.75) compared with those who were sedentary (≤2 MET-hours per week).[88] The benefit of physical activity in preventing type 2 diabetes are most remarkable in those at highest risk of the disease.[89]

#### 2.1.2.6 Lower Risk of Cancer Recurrence

Research shows that physical activity is safe and helpful for most people before, during, and after cancer treatment.[3-6] Physical activity has positive effects on reduced risk of cancer recurrence, physical functions, psychological outcomes, and patients' quality of life after cancer treatment, including breast cancer,[5,6] colorectal cancer,[90] prostate cancer,[91] colon cancer,[92] endometrial cancer,[93] esophagogastric cancer,[94] and lung cancer.[95]

#### 2.1.2.7 Improved Cognition

Physical activity can prevent or delay the onset of age-related cognitive impairment or dementia.[96,97] Studies provide evidence for physical activity to be associated with a modest reduction in relative risk of cognitive decline.[16,98] Physical activity is also a potent gene modulator that induces structural and functional changes in the brain.[11]

#### 2.1.2.8 Improved Quality of Life

There is an association between physical activity and improved quality of life.[12] Higher levels of PA are associated with improved quality of life (regression coefficient: 0.026-0.072).[99]

Evidence also demonstrates that physical activity improves well-being.[11,35,100] Higher levels of satisfaction and lower impact of COVID-19 on quality of life were related to higher total, vigorous, and moderate physical activity levels.[101]

#### 2.1.2.9 Improved Mental Well-being

It has been found that physical activity contributes to higher levels of norepinephrine and endorphin in the brain, boosting people's spirits and creating feelings of happiness and levity.[13,14] Therefore, physical activity has been associated with better mental health and emotional well-being, improved sleep, memory, and mood, and lower rates of mental illness, such as anxiety, depression, and post-traumatic stress disorder (PTSD).[102-105] Evidence shows that regular exercise can improve self-esteem, moderate social withdrawal, boost the immune system, and reduce the impact of stress.[100,106,107] For people with mental health diseases, physical activity boosts patients' mood, concentration, and alertness.[108-110] Researchers suggest that in addition to antidepressants and cognitive behavioral therapy, physical activity is an effective treatment for mild-moderate depression.[13,14,109] Exercise regularly can also prevent or avoid depression relapse.[14,102,107]

### 2.1.3 Risks and Costs of Physical Inactivity

Physical inactivity is detrimental to health, and research demonstrates the importance of avoiding inactivity. In 2012, Lancet Physical Activity Series Working Group indicated that physical inactivity is the fourth leading cause of death worldwide.[9] Decreased physical activity is a robust independent predictor of mortality among men[111] and women.[112] Low levels of physical activity are inversely correlated to rates of coronary heart disease and death compared to men with moderate to high levels of physical activity.[113] Not getting sufficient physical activity is a major cause of chronic diseases, as well as chronic diseases risk factors.[114] Lee and colleagues

estimated that 6% of the burden of disease from coronary heart disease, 7% (95% CI, 3.9-9.6) of type 2 diabetes, 10% (95% CI, 5.6-14.1) of breast cancer, and 10% (95% CI, 5.7-13.8) of colon cancer can be attributed to physical inactivity.[115,116] In 2008, physical inactivity caused 9% (95% CI, 5.1-12.5) of premature mortality, and more than 5.3 million of the 57 million deaths that occurred globally.[115,116]

Globally, over 533,000 deaths could be prevented every year if inactivity was reduced by 10%.[116] If inactivity was reduced by 25%, more than 1.3 million deaths could be prevented.[116] Estimates indicate that elimination of physical inactivity would increase the life expectancy of the world's population by 0.68 (95% CI, 0.41-0.95) years.[115,116] Every year, $117 billion in health care costs are related to low physical activity.[117]

### 2.1.4 Physical Inactivity Among the U.S. Population

Despite the many benefits of an active lifestyle, physical activity levels remain low in the U.S. Figure 2.2 and Figure 2.3 indicate the trends of U.S. adults and adults in Alabama meeting aerobic and muscle strengthening guidelines from the 2011-2019 Behavioral Risk Factor Surveillance System (BRFSS), respectively. In 2019, BRFSS indicated that only 23.0% (95% CI, 22.7-23.3) of U.S. adults achieved the recommend physical activity, which includes at least 150 minutes a week of MPA or 75 minutes a week of VPA and engage in muscle-strengthening activities on 2 or more days a week.[15] In Alabama, 17.0% of adults achieved the recommended physical activity levels (95% CI, 16.4-19.0).[15]

Figure 2.2. Percent of U.S. Adults Meeting Aerobic and Muscle Strengthening Guidelines 2011-2019[15]

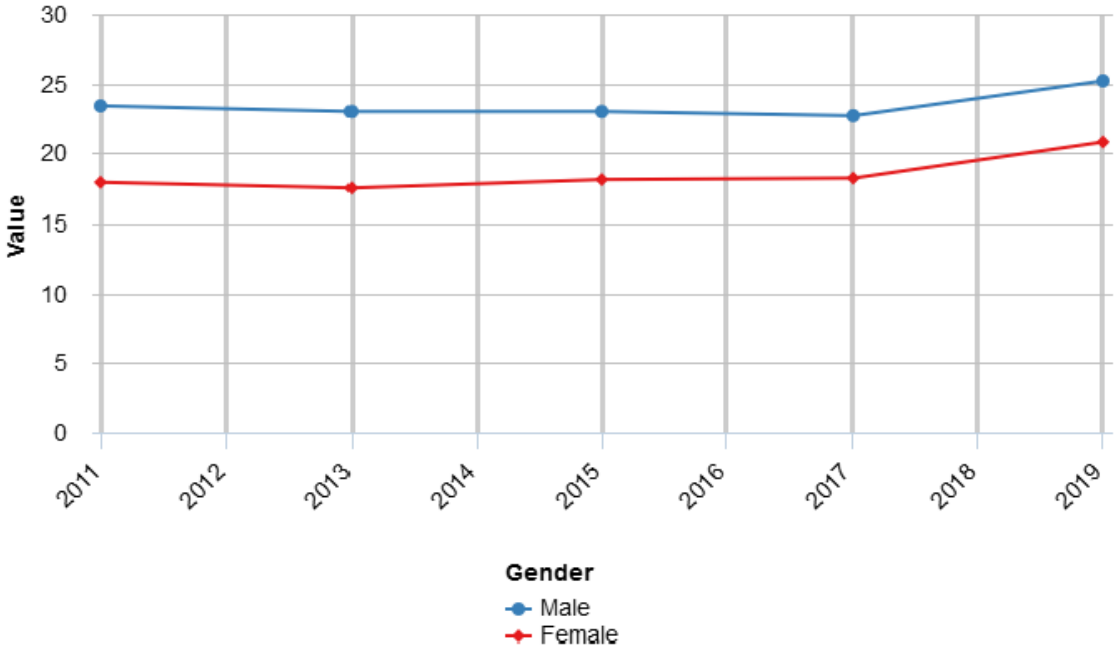



Figure 2.3. Percent of Alabama Adults Meeting Aerobic and Muscle Strengthening Guidelines 2011-2019[15]

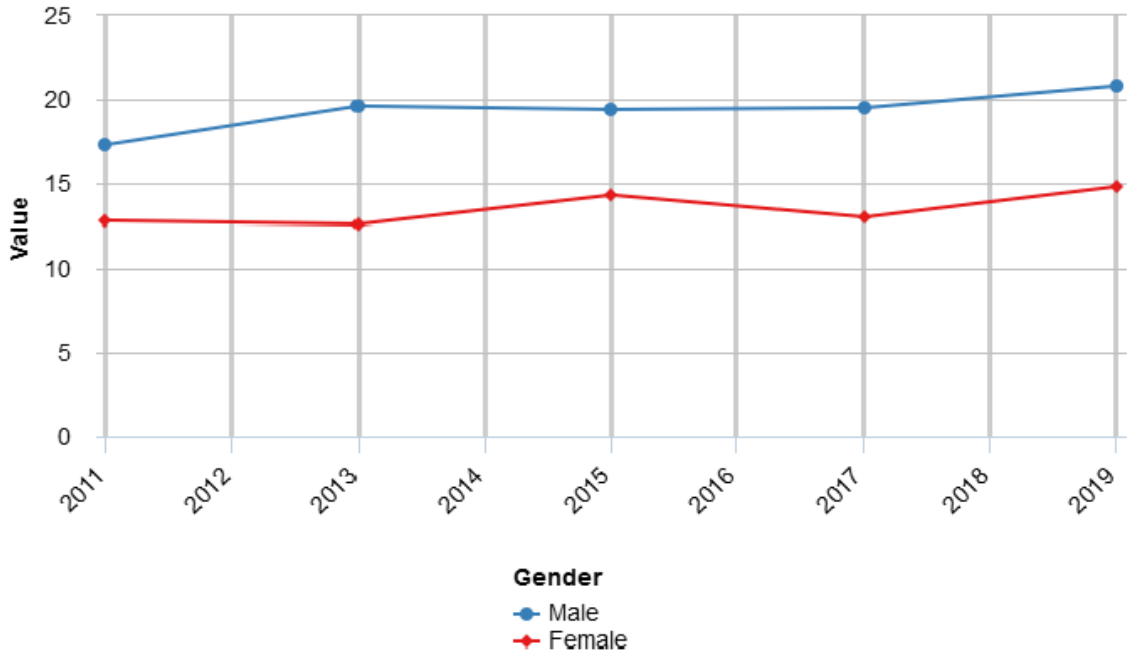


Figure 2.4 and Figure 2.5 indicate the trends of U.S. adults and adults in Alabama who engage in no leisure-time physical activity from the 2011-2019 BRFSS, respectively. It was reported that in 2019, 26.0% (95% CI, 25.7-26.3) of U.S. adults did not engage in leisure-time physical activity, compared to 31.5% (95% CI, 30.0-33.0) in Alabama.[15]

Figure 2.4. Percent of U.S. Adults Who Engage in No Leisure-Time Physical Activity 2011-2020[15]

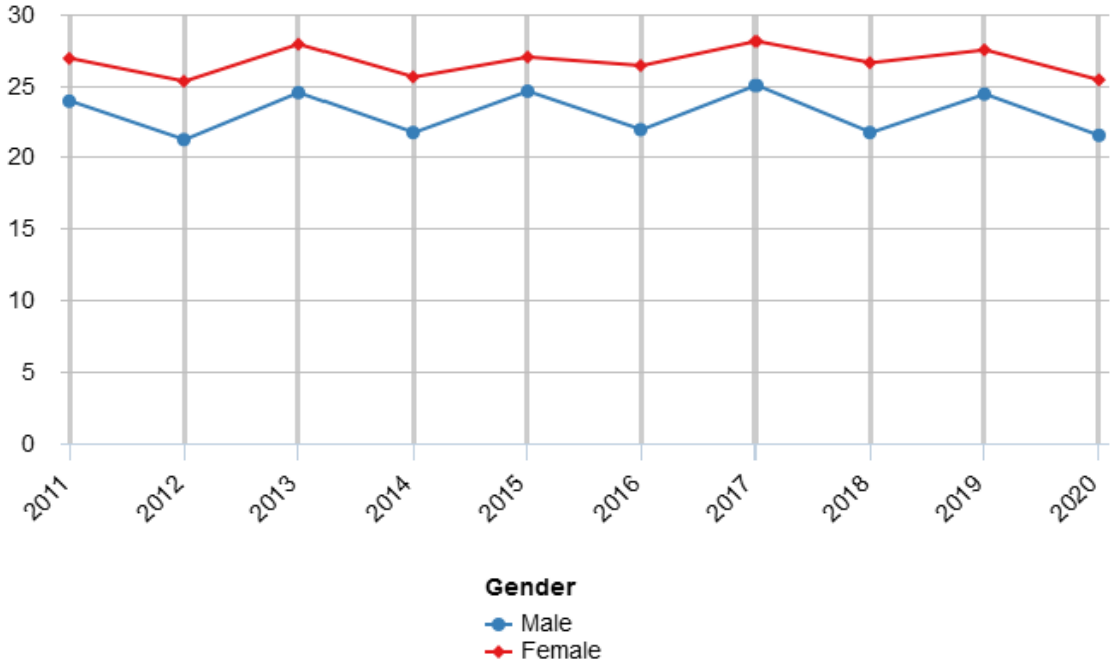
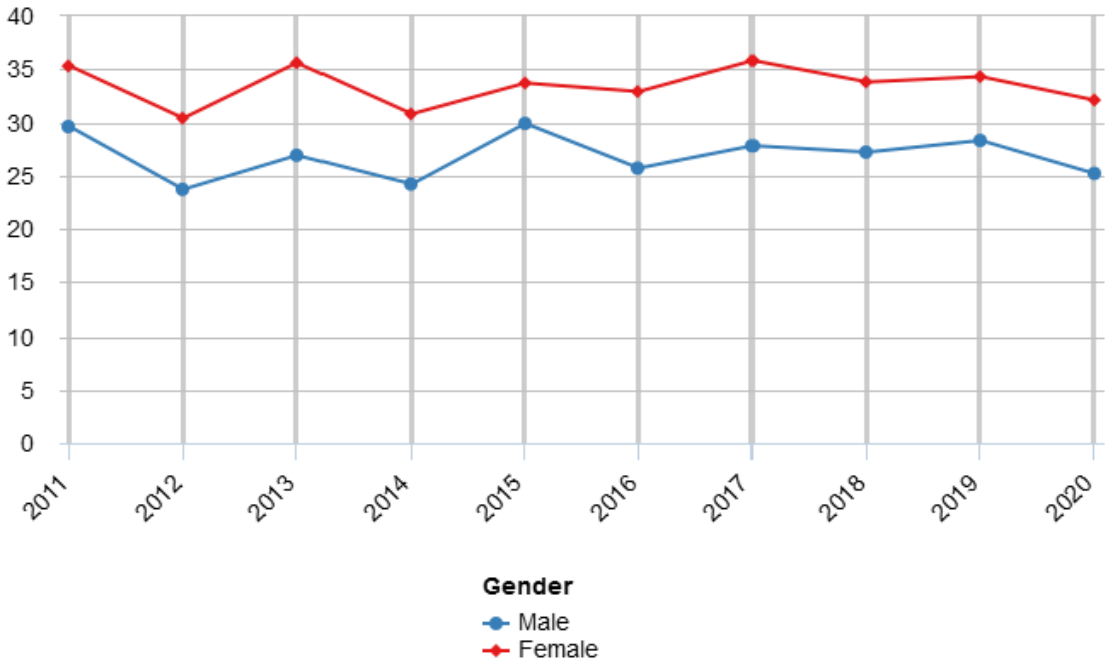


Figure 2.5. Percent of Alabama Adults Who Engage in No Leisure-Time Physical Activity 2011-2020[15]

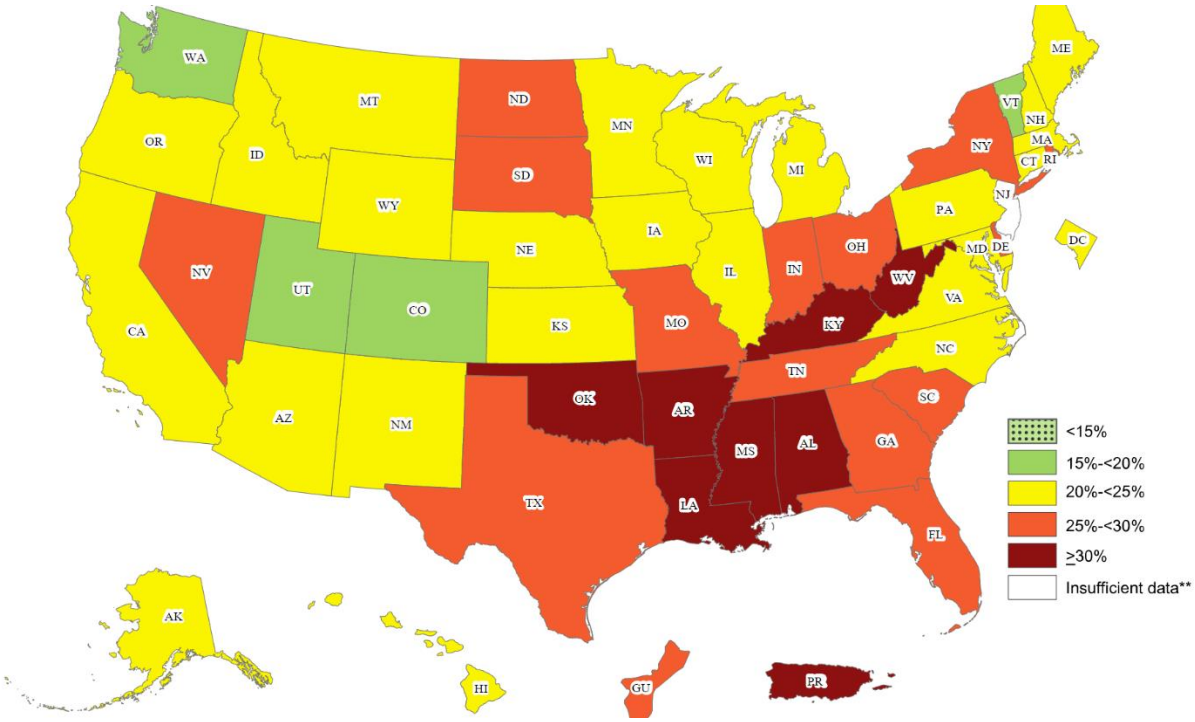



Data (Figure 2.2 – 2.5) were derived from https://www.cdc.gov/nccdphp/dnpao/data-trends-maps. The data analysis and conclusions in this study are those of the author and do not necessarily represent the official position of the Centers for Disease Control

Data from the 2017-2020 BRFSS (Figure 2.6) indicate that the overall prevalence of self-reported physical inactivity is 25.3% among U.S. adults. The lowest prevalence of physical inactivity was in Colorado (17.7%), and the highest prevalence was in Puerto Rico (49.4%).[15] Regionally, states in the South (27.5%) had the highest prevalence of physical inactivity, followed by the Midwest (25.2%), Northeast (24.7%), and West (21.0%). Seven states (West Virginia, Oklahoma, Louisiana, Alabama, Kentucky, Arkansas, a Mississippi) and Puerto Rico had a physical inactivity prevalence of 30% or more.[15] Between 2011 and 2019, the prevalence significantly declined in 12 jurisdictions (CA, CO, HI, KY, ME, MA, MO, OH, OK, OR, VA,

PR), and significantly increased in 11 jurisdictions (AL, KS, LA, MD, MN, MT, NC, TN, VT, WA, WV), and did not significantly change in 29 jurisdictions.[118] The absolute difference in prevalence ranged from an 8.6% increase in Tennessee to an 11.0% decrease in Kentucky.[118]

Figure 2.6. Prevalence of Self-Reported Physical Inactivity Among US Adults by State and Territory, BRFSS, 2017-2020[15]




Data were derived from https://www.cdc.gov/nccdphp/dnpao/data-trends-maps. The data analysis and conclusions in this study are those of the author and do not necessarily represent the official position of the Centers for Disease Control

### 2.1.5 Physical Inactivity Among University Students

According to 15 U.S.C. § 1637®(1) and 20 U.S. Code § 1001(a), the term "college student" refers to "an individual who is a full-time or a part-time student attending an institution

of higher education" which "provides an educational program for which the institution awards a bachelor's degree" or equivalent.[119,120] Typically, college students are always referred as undergraduate students across many studies,[18,21,22,45,101,121-132] while university students are referred as undergraduate students, graduate students, and professional students.[20,24,43,44,133-136] However, sometimes these two terms are used interchangeably.[19,101,137-140] Therefore, we use the term "university students" to represent our target population of individuals who are full-time or part-time students (including undergraduate, graduate, and professional students) attending a college, university, or similar institution offering an associate or higher degree.[141]

Physical inactivity among US university students is a significant public health concern. On average 30%-35%[18-21] of university students have overweight or obesity, and 40% to 50%[20,22-24] of university students are physically inactive. According to a study by Buckworth and Nigg, college students typically engage in sedentary behaviors 30 hours a week.[122] Only 30.6% of college students engaged in moderate-intensity physical activity on more than five days of the past week.[122] The Fall 2021 American College Health Association-National College Health Assessment found that only 39.7% of university students (40.2% for undergraduate student and 38.3% for graduate and professional students) met the recommendation for strength training and aerobic activity.[142] It is worth noting that compared with undergraduate students, the physical activity levels and behaviors of graduate and professional students have not been thoroughly studied.[128] This discrepancy could potentially be attributed to factors such as the larger population size of undergraduate students and the relatively shorter duration of graduate programs, limiting the available research opportunities and focus on this specific student group.

Physical activity during university years impacts habitual physical activity in adulthood, and consequently, has significant implications for short-term and long-term health

outcomes.[143,144] After transition from high school to university, one third of university students were inactive.[25,144] There is a growing trend among university students adopting a sedentary lifestyle with limited physical activity.[25,145] Compared with university students aged ≥ 20 years, university students aged ≤ 19 years were more likely to engage in aerobic exercise ($p < 0.01$) and strength training ($p < 0.02$).[146] After graduating from college, about half of college students did not engage in physical activities efficiently and reported reduced physical activity levels, and there may be a greater decline in physical activity among students with less ingrained physical activity habits.[147-149] Research on 233 undergraduate students found decreased physical activity levels during the transition from high school to college.[121] During high school, a majority of the students (65%) reported engaging in regular vigorous physical activity, with an additional 26% participating in moderate activity. However, during their college years, the percentage of students engaging in regular vigorous activity dropped to 38%, while only 20% reported participating in moderate physical activity.[121] Driskell and colleagues found that 47.8% of freshmen and sophomores reported aerobic activity participation at least three times weekly, compared to 42% of juniors and seniors.[150]

In summary, university students typically do not meet physical activity recommendations. Among university students, the likelihood of meeting recommendations declines with age, and females tend to be less likely to meet recommendations than males.[26,125,146]

## 2.2 A Potential Solution: Physical Activity Interventions

### 2.2.1 Competitions to Increase Physical Activity

Competition is defined as a rivalry where two or more parties strive for the same goal that cannot be shared, generally resulting in a victor.[151,152] The competition can be over the attainment of any exclusive goal, including recognition, awards, goods, status, and prestige.

Competition-based behavioral interventions are fitness or exercise programs that integrate rankings, leader boards, status markers, incentives, and other competitive strategies to increase physical activity.[153,154] Competitive environments motivate individuals to adjust their aspirations upward due to differences in goal attainment.[153] Competition has been shown to promote the motivation of physical activity among young adults who are competitive.[33,34,155,156] The dynamic process of comparing oneself to others enhances one's expectations for success, results in extra effort, and ultimately strengthens overall physical activity.[157,158]

Competition has been recognized to motivate individuals to better perform in various health behaviors, including physical activity.[32,33] A randomized controlled trial in the UK recruited 281 physically inactive adults and found a significant increase in steps for participants in the competition condition compared to the control group, due to increased goal importance, identified motivation, and intrinsic motivation.[159] In 2019, an 11-week online exercise program compared the causal effects of social support and social comparison.[153] The study demonstrated that social comparison was more effective for increasing physical activity and did not depend on other individual or team incentives.

Using fitness trackers, a study conducted in 2019 found that participants in the competitive gamification (using "game design elements in nongame contexts") group (adjusted difference, 920; 95% CI, 513-1328; $P < 0.001$), support group (adjusted difference, 689; 95% CI, 267-977; $P < 0.001$), and collaboration group (adjusted difference, 637; 95% CI, 285-1017; $P < 0.001$) had a significant increase in daily steps from baseline during the 24-week intervention.[160] During the 12-week follow-up, physical activity levels continued to be significantly increased in the competition group compared to the control group (adjusted difference, 569; 95% CI, 142-996; $P = 0.009$), while there was no significant improvement in the

support (adjusted difference, 428; 95% CI, 19-837; P = 0.04) and collaboration (adjusted difference, 126; 95% CI, −248 to 468; P = 0.49) groups. In 2020, a feasibility study in nursing home settings found that motivational climate and physical performance may be improved by physical activity contests.[34]

Competition may be beneficial to some individuals, but it can be detrimental to those who do not achieve their goals, feel pressured by competitors, or lose the competition.[159,161,162] In a competitive physical task, goals can also influence physical performance, such as mastering the task or winning.[162,163] In addition, participants' competitive orientation, which is defined as the desire to succeed in competitions, may impact how much effort they put into their rivals.[164] It is more likely that those with a more competitive behavioral orientation will put more effort into their competitions, whereas non-competitive individuals may find exercise less enjoyable even if they perform well.[165] Competing in rigorous physical activities could be difficult for uncompetitive individuals, particularly if these activities seem to be challenging.[166] Furthermore, compared to a virtual reality opponent, such as someone in an exercise game, individuals are more likely to put more effort into competing versus a “live” competitor.[167,168]

### 2.2.2 Mobile Text-Message Interventions

Text messaging is one of the most common methods of interpersonal communication, involving the creation and real-time exchange of alphanumeric messages.[36] With text messaging, mobile phone users can be reached via push technology,[169] which is supported by virtually all mobile phones. Increasingly, text messages are being used for interventions designed to improve healthy behavior.[37,170]

Text messages have been proven to be an effective method of delivering information to people.[171] First, the use of text messages is widespread and statistics show that as of 2021, 97%

of U.S. adults own mobile phones[172] Text messaging is the one of the most popular non-voice applications, and 75% of cell phone users send and receive text messages regularly.[171] Previous research indicated that 92% of college students texted during their class time.[173] On average, college students send 71.0 (SD = 86.4, range from 1 to 300) texts per day[174], and spend 14.35 hours each week texting.[175] Second, text messages can be sent automatically and asynchronously. Recipients have the option to choose whether and when to read or reply to their messages.[176] Additionally, text messaging is also relatively cost effective. Text messages do not incur a great deal of cost to wireless carriers and researchers because the technology involved is very simple.[177]

Text-based physical activity interventions are growing rapidly.[37,178] Evidence from systematic reviews[36,170,179-181] and meta-analyses[171,182,183] report the effectiveness of text message interventions to address physical activity, highlighting the important roles of interventions with tailored messages and varying frequency. Physical activity messaging is intended to educate or persuade individuals or groups, with the ultimate goal of increasing their physical activity levels. A scoping review of physical activity messaging in 2020 identified concepts which should be included in physical activity messaging: 1) emphasize short-term social and mental health outcomes; 2) tailored and targeted content to intended recipient(s); and 3) integrate formative research, psychological theory, and social marketing principles.[180] In 2021, Williamson and colleagues developed and revised a provisional Physical Activity Messaging Framework (PAMF) to assist physical activity message generation and assessment.[184] It includes three domains: 1) Who, when, what, and how to send texts and why; 2) the message contents; and 3) message format and delivery methods.

### 2.2.3 Website-Delivered Interventions

The internet is an innovative medium with interactive technologies, creating reach, availability, and opportunities for health behavior change.[185,186] Since 2000, there has been a more than 300% increase in internet usage globally.[118] Today, 50% of the global population is internet-connected, and more than 90% of Americans have internet access.[172] The popularity of the internet provides alternate means of health care services for individuals with physical disability or living in rural areas. Additionally, it produces chances to deliver health behavior interventions via the internet.[186] In recent years, online or website-based health behavior interventions for physical activity have become increasingly common, and have been reported to be effective.[186-190] Interventions varied in content, duration, and frequency among studies, but included education, self-monitoring, feedback, tailored information, self-management, personal exercise plans, and online communication between health care providers and patients.[190] However, it remains unclear whether website-based interventions are effective in promoting long-term physical activity levels.[185] Further evaluations are needed to optimize website-based interventions characteristics.[188,190]

### 2.2.4 Community Physical Activity Campaigns

Community-wide campaigns encompass large-scale, intensive, highly visible campaigns delivered to a large audience through various methods.[29] These campaigns may focus on overall health care, health behavior, or only focus on physical activity. An effective community campaign consists of building partnerships, delivering messages to a broad audience using multiple forms of media, and implementing programs as well as environmental and policy changes in concert.[29,31,41] Examples of community events in the U.S. include self-help fitness groups, physical activity counseling, marketing materials, and environmental strategies (Table

2.3). Evidence from systematic reviews also supports the effectiveness of community-based physical activity interventions.[31,40-42]

Table 2.3. Examples of Community Events in the U.S.

| Community Physical Activity Campaigns | Example | Description |
|---|---|---|
| Self-help fitness groups | Black Girls Run! (BGR!)[191] | This organization offers resources for African American women to join the health movement. BGR! aims to reduce the number of women suffering from chronic diseases caused by unhealthy diets and sedentary lifestyles. |
| Physical activity counseling | Parks Rx Program[192] | Parks Rx promotes communications with patients and health providers to discuss how to get active and use neighborhood facilities to practice physical activities. From July 2016 to May 2017, 7,360 adults and children received the "exercise as medicine" prescription. |
| Marketing Materials | Birmingham REACH for Better Health: Outdoor Physical Activity[193] | This campaign is aimed to inform residents of Birmingham, Alabama, of the availability of fresh produce and physical activity opportunities in the local area. The advertisement features a female African American tying her shoe before running. |
| Environmental Strategies | The Atlanta Beltline Eastside Trail[194] | The Beltline is a 22-mile paved trail which is great for exercise like running, biking, and walking. It is combined by trails, parks, rail transit, residential buildings, and commercial areas. |

### 2.2.5 University Campus-based Physical Activity programs

University and college settings are ideal for implementing health promotion programs to engage large numbers of participants.[24,43,44] The numbers of U.S. university students was 19 million in 2021, and there were 303,030 students in Alabama universities and colleges.[195] Campus-based programs are effective in refining students' exercise skills, competence, and interest in physical activity participation, which can promote an increase in physical activity levels (Table 2.4).[21,26,28,43,44,129] Students at universities and colleges are the ideal target population for lifestyle interventions because they have access to multidisciplinary health professionals, world-class facilities, and specialized researchers in a learning environment.[26,28]

Table 2.4. Examples of Campus-based Physical Activity Programs

| University Campus-based Physical Activity programs | Example | Description | Outcomes |
|---|---|---|---|
| Competitions to Increase Physical Activity | Fitbit Competitions to Increase Physical Activity in College Students[196] | 17 students from Texas A&M University were randomly assigned to either Fitbit or pedometer groups to assess if wearing a Fitbit watch and participating in weekly competitions via the app would increase weekly step counts as compared with a simple pedometer. | Fitbit participants were more motivated to engage in physical activities, while the pedometer group reduced their step count. The results confirmed that social and competitive aspects of a mobile app can be a powerful motivator for college students. |
| Mobile Text-Message Interventions | Daily Motivational Text Messages to Promote Physical Activity in University Students[136] | 103 college students from the University of California, Berkeley were recruited to receive different types of motivational messages. | Sending text message resulted in an increase in daily steps (729 step increase, $p = 0.012$), but this effect decreased with time. |
| Website-delivered Interventions | Web-based Physical Activity Course[197] | 233 college students were randomly allocated to a 10-week online course, a physical activity group, or a general health group. | Vigorous physical activity, self-regulation, and outcome expectancy significantly increased in the Web-based and physical activity course groups ($p < 0.01$). |

## 2.3 Motivation and Barriers of Physical Activity among University Students

### 2.3.1 Motivation of Physical Activity among University Students

Why do students start participating in physical activity? What motivates them to continue, or even increase their participation? Understanding why university students engage in physical activity is important for intervention efforts to encourage more active health behaviors.[198] Physical activity fulfills a variety of needs, and people are involved in physical activity for considerably specific and different reasons.[199] Published literature demonstrates that compared to the general population, university students have similar reasons for engaging in physical activity, but motivations differ between male and female.[125,198] Female students rated

weight management higher than male students, while male students rated competition, social recognition, and strength and endurance more critical.

Several intrinsic motivators drive physical activity among university students. Mullen and colleagues found that enjoyment from physical activities can increase exercise engagement and intentions,[200] and some physical activities are enjoyable and do not require extra incentives.[201,202] Kilpatrick's study demonstrated that enjoyment, appearance, weight management, and mental well-being were commonly reported motivations for engaging in PA and exercise among college students.[125] Alkhateeb and colleagues surveyed 417 university students in the Kingdom of Saudi Arabia and reported several reasons for practicing sports: appearance, weight management, strength gains, and avoiding illness.[135] Similarly, a qualitative interview of 20 German university students revealed five motivations: self-satisfaction, improving health, enjoyment, fitness, and study-life balance.[203] Other intrinsic motivations include daily routine, past PA habits, and personal preferences.[44]

Extrinsic motivators also served as influential factors in motivating university students to engage in physical activity. A study assessed the relationships between motivational climate and physical activity among university students in Spain and Romania.[204] The results demonstrated that university students are more likely to be motivated to engage in physical activity if the fitness practice is task-involved (e.g., improve leadership skills in sport) rather than ego-involved (e.g., pursuit of competition). In addition to differences in personal interests and goals, social support has been found to be a critical factor to increase physical activity among university students.[199] Common physical activity motives included group involvement and friendship, along with reasons related to competition, gaining skills, adventure, and fitness associated with body image.[125,135,198,203,205] Gaining friends and peers who share their experiences can allow college

students to engage in physical activities even outside the classroom or off campus.[44] Deliens and colleagues reported that pressure from parents, models, and peers also affect university students' PA.

### 2.3.2 Barriers to Physical Activity among University Students

College and university students face many barriers and challenges in balancing their academic studies, social life, and health. A substantial body of literature indicates that lower physical activity among university students has been attributed to individual (cost, health issues, self-regulation, time, and convenience), social (social support and monitoring), and environmental (neighborhoods, resources, weather, and communication) factors (Table 2.5). It has been demonstrated that a lack of concern for health leads to physical inactivity among university students. People who lead a healthy lifestyle are more likely to pay attention to exercise and persist with their habits.[139,206,207] In addition, some physical education curricula or campus physical inactivity campaigns cannot accommodate students who have inadequate physical skills and knowledge.[208]

Table 2.5. Barriers to Physical Activity Among University Students

| | |
|---|---|
| **Internal barriers**[126,134,145,203,204] | Lack of motivation |
| | Lack of skills and knowledge |
| | Lack of support |
| **Characteristics of the environment**[44,126,134,209] | Lack of access to appropriate facilities |
| | Unsafe neighborhoods |
| | Poor weather |
| | Lack of transportation |
| **Time associated with physical activity**[44,135,145,203] | Travel time to physical activity facilities |
| | Work and life balance |
| **Negative experience while engaging in physical activity**[126,129,134,205] | Chronic illness and disability |
| | Pain, discomfort, and harassment/bullying by peers/others |

## 2.4 Social Cognitive Theory Framework

It is acknowledged that the process of changing health behaviors is complicated and multifaceted, involving the interaction of various factors and feedback mechanisms. The process could result in delays in behavior change, adaptations to different interventions or strategies, competitive actions, and unexpected consequences that hinder or facilitate the desired changes. Feedback, both internal and external, plays a crucial role in shaping individuals' responses to their behaviors. [9,210] Therefore, embracing the complexity of the "entire system" is crucial for developing health behavior interventions, instead of focusing only on individual or environmental aspects.[206,211,212] In other words, physical activity interventions should address not only how people practice physical activity in specific environments, but also how changes in environments influence people's engagement in physical activity.[9] In this study, Social Cognitive Theory (SCT) will be applied to develop, deliver, and implement physical activity interventions.

Social Cognitive Theory (Figure 2.7) has been used to guide intervention design to increase the uptake of physical activity among university students. Proposed by Bandura in 1989, the SCT is a behavioral theory explaining people's behavior and the regulation thereof in a social context.[213] This theoretical framework explains "how people regulate their behavior through control and reinforcement to achieve goal-directed behavior that can be maintained over time."[214] The SCT began as Social Learning Theory (SLT) in 1978[215] and developed into the SCT in 1986.[213]

The SCT posits that human behavior results from the dynamic interplay of personal, behavioral, and environmental influences. [213,216,217] The core idea is that humans can alter and construct environments according to their individual needs and, meanwhile, could be influenced by their surroundings. [213,216,218] Table 2.6 shows the primary constructs of the social cognitive

theory, including self-efficacy, self-regulation, incentive motivation, social support, outcome expectations, collective efficacy, observational learning, facilitation, and moral disengagement.

Figure 2.7. Social Cognitive Theory[219]

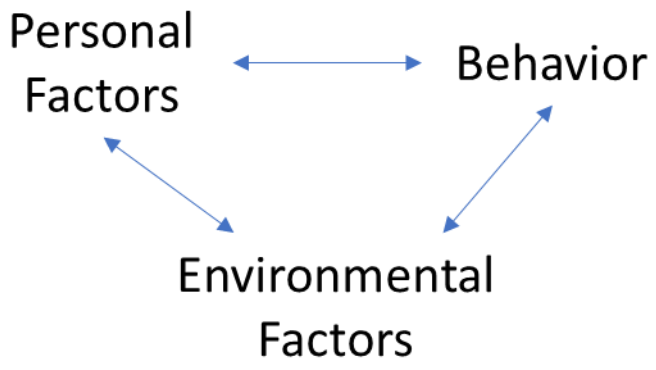



Table 2.6. Social Cognitive Theory Constructs

| Social Cognitive Theory Constructs | Definition | Description in Physical Activity Context |
|---|---|---|
| Self-efficacy | A person's confidence that he or she can perform a behavior | A person's confidence that they can do sufficient physical activity to meet the recommended guidelines |
| Self-regulation | Controlling oneself through self-monitoring, goal setting, feedback, self-reward, self-instruction, and enlistment of social support | Controlling oneself to perform sufficient physical activity through self-monitoring, goal setting, feedback, self-reward, self-instruction, and enlistment of social support |
| Incentive motivation | Using and misusing rewards and punishments to modify behavior | The use and misuse of rewards and punishments to modify physical activity behavior |
| Social support | Having friends, family, and other people, to turn to in times of need | Discussing physical activity, invitations to do physical activity, and celebrating the enjoyment of doing physical activity with peers, friends, family, and other people |
| Outcome expectations | Beliefs about the likelihood of the consequences from the behaviors that a person might choose to perform | Beliefs about the likelihood of beneficial consequences from physical activity |
| Collective efficacy | Beliefs about the ability of a group to perform certain actions | Beliefs about the ability of group physical activity |
| Observational learning | Learning to perform new behaviors by exposure to interpersonal or media displays of them, particularly through peer modeling | Learning to do physical activity by exposure to interpersonal or media displays of them, particularly through peer modeling |
| Facilitation | Providing tools, resources, or environmental changes that make new behaviors easier to perform | Providing tools, resources, or environmental changes that make PA behaviors easier to perform |

| | | |
|---|---|---|
| Moral disengagement | Ways of thinking about harmful behaviors and the people who are harmed that make infliction of suffering acceptable by disengaging self-regulatory moral standards | Considering the adverse effects of physical inactivity |

According to the SCT, human behaviors are controlled by forethought through two main cognitive processes: self-efficacy and outcome expectations.[214,217] Self-efficacy refers to the confidence or belief in one's ability to perform a specific behavior, while outcome expectation refers to beliefs about the likelihood and value of the results and consequences of a behavioral choice.[128,213,220] As an interpersonal level theory, the SCT emphasizes reciprocal determinism which refers to the dynamic interaction between personal factors, behavior, and external environments.[213,217] The environment influences both individuals and groups, but people and groups can regulate their own behavior as well as influence the environment.[213,220]

It is essential that physical activity interventions are based on a strong theoretical framework.[130] Social Cognitive Theory has been widely used by researchers in designing and evaluating interventions targeted to improve physical activity, especially in Western and Asian cultures.[123,221,222] A random-effects meta-analysis of 44 eligible studies of different populations revealed that these SCT models accounted for 31% of the variance in physical activity behavior.[221] The results of a prospective study indicated good fit (accounting for 55% of the variance) of a SCT-based model to the data of the physical activity in a sample of 277 university students in Virginia.[223] It was found that self-efficacy was the strongest determinant of physical activity, followed by self-regulation and social support. Research involving 396 university students indicated that psychosocial factors were significant predictors of physical activity, including self-efficacy, outcome expectations, and social support.[124] Results from a study of 350 college students revealed that SCT constructs (role identity, self-regulation, outcome expectance,

social support, self-efficacy, and positive experience) accounted for 27% of the variance of VPA days.[224] In a study involving 787 undergraduate students in Thailand, SCT constructs (self-efficacy, self-regulation and outcome expectations) were found to be significant predictors of physical activity, accounting for 29% of the variance.[225] Choi and colleagues surveyed 688 Korean college students and found that SCT constructs were significant predictors of physical activity for both males (goal setting and self-efficacy) and females (goal setting and outcome expectations).[226] Similarly, in a study of 937 undergraduate students, self-efficacy was found to be significant predictor for both genders[227] In addition, the findings from 449 college students reported that self-efficacy and self-regulation were significant predictors of physical activity for both Black and White groups.[130]

SCT and its constructs have also been used as a foundation for telehealth interventions. A qualitative study of 56 college students suggested the importance of self-efficacy for developing effective text message interventions to promote physical activity. In 2019, Wang and colleagues found that the use of mobile fitness apps had a significantly effect on physical activity levels through social support ($\beta$=0.126; P<0.001) and self-efficacy ($\beta$ =0.294; P<0.001) among 384 Chinese college students.[228] A focus groups study of 56 college students reported that SCT and its constructs provide a valuable framework for understanding how text messages can influence physical activity.[128]

### 2.5 Summary of the Literature Review

A substantial body of literature highlights the association between physical activity and a wide range of physiological and psychological benefits. Being physically active can lower mortality risk, help manage weight, reduce the risk of disease and cancer, strengthen muscles, and improve mental well-being. [3-6,13,14,70,71] It is recommended that adults should perform at least

150 minutes of moderate-intensity or 75 minutes of vigorous-intensity physical activity per week, as well as muscle-strengthening activities on two or more days per week.[62] However, physical activity levels remain low in the U.S. In 2019, only 23.0% of U.S. adults achieved the recommend physical activity, compared to 17.0% in Alabama.[15] Furthermore, physical inactivity among university students is a significant public health concern: 30%-35% of university students have overweight or obesity, and 40%-50% of university students are physically inactive. [18-24]

Given the low prevalence rate, research on the effectiveness of different physical activity interventions is of significant importance for public health, particularly for university students.[25] Competition-based interventions have been recognized to motivate individuals to better perform in various health behaviors, including physical activity.[32,33] Evidence supports the effectiveness of text message interventions in addressing physical activity.[36,170,179-181] Campus-based programs also play critical roles in promoting physical activity among university students.[21,26,28,43,44,129] Factors that motivate exercise among university students include perceived enjoyment, physical and mental health benefits (e.g., strength gains, improved athletic performance, improved body composition, improved cognition, improved affect/mood), and social factors (e.g., peers, family, friends, and environment), while internal barriers, [44,125,198,205] unsatisfactory environment, time management, and negative experience are common reasons why university students do not start in the first place or stop exercising.[126,134,145,203,204]

Proposed by Bandura, SCT is one of the most widely used and robust behavioral theories for promoting physical activity interventions.[128,138,213,222] SCT describes the dynamic interplay of personal, behavioral, and environmental influences.[219] The main constructs of SCT are self-efficacy, self-regulation, incentive motivation, social support, outcome expectations, collective

efficacy, observational learning, facilitation, and moral disengagement.[213,220] Research has shown self-efficacy, self-regulation, and social support serve as strong influencers of PA.

Physical activity promotion studies that specifically target university students are limited. To provide evidence-based solutions for this group, well-designed interventions are highly recommended. Hence, we conducted a systematic review and meta-analysis to synthesize evidence of the effectiveness of text message interventions targeting physical activity from published literature. We conducted a three-group quasi-experiment study to assess and compare the effectiveness of text message interventions and a competition-based intervention in improving physical activity among university students, as well as evaluate participants' acceptability and experiences.

# Chapter 3. Methods

The overall goal of this project was to assess and compare how text message interventions and a competition-based intervention impact university students' physical activity levels, mental well-being, and Social Cognitive Theory constructs. It was hypothesized that both the text message intervention and the competition-based intervention would positively influence university students' Physical Activity, Self-Efficacy, Self-Regulation, Social Support, Incentive Motivation, And Mental Well-being. The study design and methods used to examine these anticipated relationships are described in this chapter.

The first research question is, "What is the relevant evidence related to text message interventions targeting physical activity among university students?" This question was addressed by the systematic review and meta-analysis in Aim 1. Aim 1 inspired the development of text messages for Aim 2.1. The second research question is, "What are the effects of text message interventions and competition-based interventions on university students' physical activity levels, self-efficacy, self-regulation, social support, incentive motivation, and mental well-being?" This question was addressed by a quasi-experimental study in Aim 2.1. The third research question is, "What are participants' perceptions regarding their experience with and acceptability of text message interventions and competition-based interventions?" This question was addressed in Aim 2.2.

## 3.1 Specific Aim 1

To conduct a systematic review and meta-analysis of text message interventions targeting physical activity among university students from published literature.

Previous systematic reviews and meta-analyses have reported positive effects of text message interventions on improving physical activity levels in adults,[179,229,230] children,[231,232] adolescents,[27,169,170,231,232] older adults,[30,233-235] type 2 diabetes patients,[235,236] and the general population[38,237-239]. Therefore, we hypothesized that text message interventions are effective in improving physical activity among university students. However, there is no systematic review specifically focused on the effect of text messaging on physical activity among university students. A systematic review and meta-analysis to synthesize the findings qualitatively and quantitatively is foundational for the proposed project.

### 3.1.1 Eligibility Criteria

Inclusion criteria for studies in the systematic review were: 1) peer-reviewed articles; 2) written in English; 3) including university or college students; 4) using text messaging as an intervention to promote physical activity; 5) outcome variables are physical activity, fitness, or exercise; and 6) physical activity outcomes are measured at two or more time points (Table 3.1). Studies were excluded if they: 1) include people other than university students; 2) only include collegiate athletes; 3) do not report physical activity outcomes or are not aimed to improve physical activity; 4) do not include any intervention components about text messaging; or 5) are not published in English.

Table 3.1. Population, Intervention, Comparator, Outcome, and Study Design (PICOS) Criteria for the Systematic Reviews and Meta-Analysis

| | Criteria | Justification |
|---|---|---|
| **P**opulation | University or college students | Aim 1 and 2 focus on university or college students |
| **I**ntervention | Using text messaging as an intervention to increase physical activity or exercise | Sub Aim 1 is intended to determine the effectiveness of text messaging specifically |
| **C**omparator | Interventions with and without comparison or control group | Although lack of comparison or control group will increase bias, only including comparative studies could lead to fewer studies and more narrow review |

| | | |
|---|---|---|
| **O**utcome | Physical activity levels, including physical activity scores, MPA minutes, VPA minutes, MVPA minutes, walking minutes, weekly steps, and metabolic equivalents (METs) | Sub Aim 1 is intended to determine the effectiveness of text messaging on physical activity levels |
| | Physical activity outcomes are measured at two or more time points | Sub Aim 1 is intended to detect the difference before and after text message interventions, so both baseline and follow-up measures are needed |
| **S**tudy design | Observational and interventional study | Sub Aim 1 is a systematic review and meta-analysis of text message interventions. |

### 3.1.2 Data Source

A structured electronic search employing Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA)[240] reporting guidelines was performed on text message intervention studies carried out in tertiary-level educational institutions. We searched the APA PsycINFO, National Library of Medicine's bibliographic database/article index (MEDLINE), SPORTDiscuss, Cumulative Index to Nursing and Allied Health Literature (CINAHL) through the EBSCO interface, and keywords through the Web of Science interface and a high sensitivity search for published, peer-reviewed studies via Google Scholar. We used the following keywords: (exercise or physical activity or fitness) AND (college students or university students or undergraduates or graduate students or professional students) AND (texting or text messaging or text message or SMS or short message service). Hand-searched published studies were also included using a snowballing method from the citations of retained articles. All retrieved studies were downloaded to Endnote X9 citation management software (Thomson Reuters, Philadelphia, PA, USA). Articles written in English and published in peer-reviewed journals were considered for review.

### 3.1.3 Study Screening and Data Extraction

Articles underwent initial title and abstract screening, followed by full-text screening. Each screening was first performed by the primary investigator and then checked by a second

independent investigator. A standardized form based on article inclusion criteria was used to guide each screening (Table 3.2). Two investigators met before using this form to pre-test it with five purposefully selected articles from the initial search to discuss and fine-tune the inclusion and exclusion criteria and ensure consistency of application. If articles were included by both investigators, then they were included in the review. A consensus was reached over discrepancies in retained articles via discussion between the two reviewers, and mentors if needed.

To capture preferences from different types of university students, exclusions were not made based on university students' gender, age, majors, race, ethnicity, or other socioeconomic factors, and both undergraduate students and graduate students were included. During title and abstract screening, the following criteria were required to be met for inclusion: English, university students, text message interventions, and physical activity. All inclusion criteria were required to be met during the full-text screening for article inclusion in the review.

Table 3.2. Standardized Article Screening Form for Systematic Review

| Study | English | University students | Text message interventions | Physical activity | Outcomes | Extraction | Include | Exclude |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |
| | | | | | | | | |

Data extraction was performed by the primary investigator using a standardized form developed by Cochrane Reviews[241] and consisted of the following dimensions: target sample and size, study design, intervention description and duration, PA measurement, and key findings. For meta-analysis, the value of physical activity scores, MPA minutes, VPA minutes, MVPA minutes, walking minutes, and weekly steps (mean and standard deviation) were extracted from each intervention group.

### 3.1.4 Quality Assessment

The risk of bias within each study was assessed by the primary investigator using the Mixed Methods Appraisal Tool (MMAT), Version 2018, [46,47] and was performed simultaneously with data extraction. Results were reviewed by another investigator for accuracy and completeness. The MMAT was first published in 2009 and has five categories of study design: (1) qualitative, such as case studies and grounded theory; (2) randomized controlled trials; (3) nonrandomized trials, such as cohort studies and case-control studies; (4) quantitative descriptive studies, such as surveys and case series; and (5) mixed methods studies. Each category contains five methodological criteria with assessment questions. Possible responses to the questions include 'Yes,' 'No,' and 'Can't tell.' The 'Can't tell' response category means that the paper does not report appropriate information to answer, 'Yes' or 'No', or that it reports unclear information related to the criterion.

### 3.1.5 Meta-analysis

Due to the possible variations in physical activity measurement, the data were combined across studies using standardized mean difference (SMD)[242] if studies reported the same outcomes. Meta-analysis was performed using Review Manager Software 5.3 Copenhagen (The Nordic Cochrane Center, the Cochrane Collaboration, 2014) if at least three studies[49,50] reported the same physical activity effectiveness outcomes (MPA minutes, VPA minutes, MVPA minutes, weekly walking minutes, weekly steps, physical activity scores, or METs). The physical activity levels, including mean difference (MD), standard deviation (SD), or 95% CI were extracted from each intervention group if 1) both pre- and post-intervention values or both intervention groups' values and comparative groups' values were available; 2) the sample size was known; and 3) the measurements of outcomes were sufficiently similar and comparable.

Heterogeneity among studies was assessed using Higgins $I^2$ statistic.[26,39,243] If $I^2$ value was greater than 75%, a random-effects model was conducted, otherwise we chose a fixed-effects model.[26,39,243] Thus, we conducted subgroup meta-analysis of each outcome if there were at least three studies having reported the same outcome (MPA minutes, VPA minutes, MVPA minutes, weekly walking minutes, weekly steps, physical activity scores, and MET). For all analyses, the significance level was $p < 0.05$.

### 3.1.6 Publication Bias

A major challenge for conducting systematic reviews was that not all studies are published, and those that are published may differ from unpublished studies in the statistical significance of their results.[244,245] The probability of publishing research with statistically significant results is higher than that of work with null results or without significant results.[244,246,247] Publication bias was assessed using a funnel plot asymmetry test (Figure 3.1).[248,249] In funnel plots, the effect estimates (on the X-axis) from individual studies are plotted against the precision of each study on the Y-axis (usually measured by the standard error).[250] Studies with a smaller sample size are more likely to appear wide at the bottom, while studies with a larger sample size are more likely to appear narrow at the top.[48] If there is no bias and between-study heterogeneity, the scatter of included studies will result only from sampling variation, and the plot will seem like a symmetrical inverted funnel, as shown in Figure 3.1.[251] Note that the funnel plot asymmetry test is only used for meta-analyses containing more than ten studies.[252]

In the fixed-effect meta-analysis model, it is assumed that all studies share a common effect size (Figure 3.1).[251,253] Figure 3.1 shows that the triangle area is centered on the center line, which shows the estimated common effect of all studies in the meta-analysis. In the absence

of heterogeneity and biases (such as publication bias and data irregularities), the pseudo 95% CI (triangle area) shows the predicted distribution of studies. Conversely, in the random-effect meta-analysis model (Figure 3.2), it is assumed that the estimated effects in the different studies are not identical because of the real differences between studies and sampling variability.[253,254] Therefore, it is not necessary to add a pseudo 95% CI.

Figure 3.1. Example of Symmetrical Funnel Plot (Fixed-Effect Meta-Analysis Model)[48]

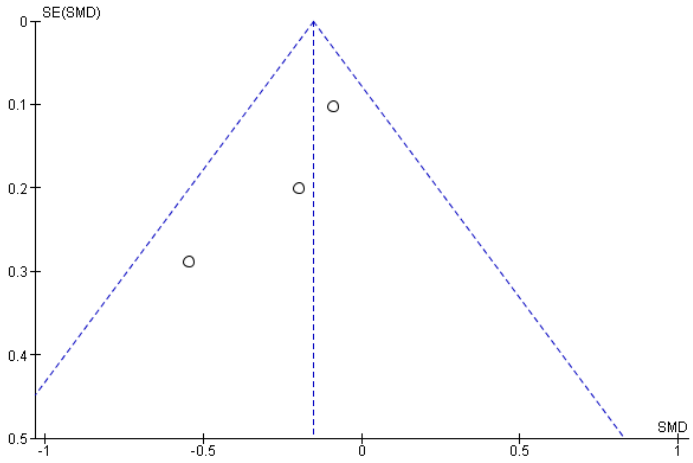
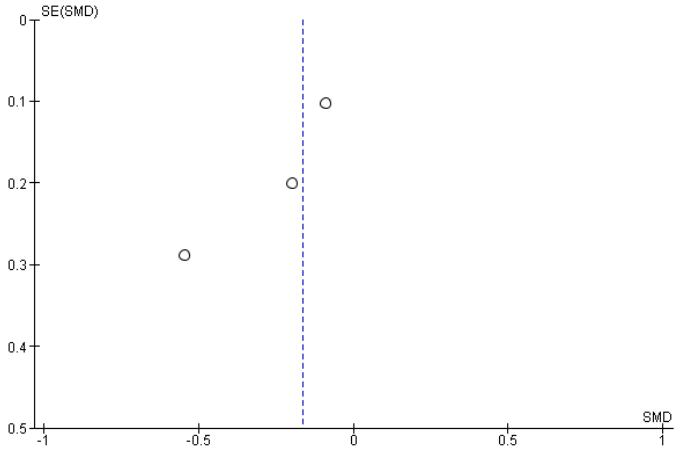



Figure 3.2. Example of Funnel Plot for the Random-Effects Meta-Analysis[255]




### 3.1.7 Potential Limitations and Alternative Strategies

First, to avoid insufficient search of electronic databases and failure to include all relevant studies, we worked with the Auburn University Health Sciences Librarian to create

appropriate research queries for each electronic database. Second, bias in selecting studies cannot be totally avoided in a systematic review or meta-analysis. Although assessments of the magnitude of the bias or how this source of bias can be reduced are not available,[256-259] we evaluated risk of bias for all included studies. In order to identify and possibly reduce such bias, we used a dual review process with transparent inclusion criteria, and referred to gray literature (e.g., U.S. FDA documents, trial registry reports) if needed.[256-258] Last, funnel plot asymmetry tests should not be used if there are less than 10 studies included in the meta-analysis.[241,260] Thus, the alternate strategy is to conduct a narrative synthesis of evidence instead of a quantitative analysis.

### 3.2 Specific Aim 2

**Specific Aim 2: To assess and compare the effectiveness of text message interventions and a competition-based intervention in improving physical activity among university students, and evaluate participants' acceptability and experiences of the text message interventions and the competition-based intervention**

**Specific Aim 2.1:** To conduct a quasi-experimental study to assess and compare the effectiveness of text message interventions and a competition-based intervention among university students

**Specific Aim 2.2:** To evaluate participants' acceptability and experiences of the text message interventions and the competition-based intervention

To encourage health professional students to be physically active, Auburn University (AU) holds the Deans' Fit Family Challenge each fall semester since 2019 among the Harrison College of Pharmacy (AUHCOP), College of Nursing (AUCON), and the Edward Via College

of Osteopathic Medicine (VCOM). However, the implementation and impact of the DFFC have not been systematically evaluated. Previous systematic reviews and meta-analysis indicate positive effectiveness of text message interventions in promoting physical activity and other behavioral outcomes in adults, youth, and the general population.[36,38,39,170,182,183,261] Evidence also shows that theory-based interventions on physical activity behavior are more effective than those that are not.[262-265] Hence, we hypothesized that:

1) Participants in both the text message and DFFC competition groups would report significant increases in physical activity.

2) There is a significant difference in post-test SCT variables and mental-welling scores between intervention groups and control groups.

3) The effects of physical activity interventions are mediated by SCT variables and mental well-being.

### 3.2.1 Research Design / Experimental Approach

A quasi-experimental study was utilized to accomplish Aim 2. Participants in the 2022 Deans' Fit Family Challenge competition were invited and randomly assigned to the competition intervention group (Group 1) or the competition plus text message intervention group (Group 2). Students in HCOP, AUCON, and VCOM who did not enroll in the 2022 DFFC were invited as the Control Group (Group 3). Participants in Group 3 did not participate in 2022 DFFC or receive text messages from study personnel. Recruitment plans are explained below.

#### 3.2.1.1 Sample Size Calculation

The effect size of text message interventions on improving physical activity varies in the literature. Fanning and colleagues reported that the overall weighted mean effect size of mobile device on increasing physical activity is 0.54.[183] Smith and colleagues also indicated that the

effect on increasing physical activity of one-arm text message studies is 0.54.[229] Head and colleagues found that SMS interventions were most successful on smoking cessation (d = 0.447; 95% CI = 0.367, 0.526; p < 0.001) and physical activity (d = 0.509; 95% CI = 0.236, 0.781; p < 0.001).[171] Armanasco and colleagues suggested that text message interventions targeting physical activity showed a small but significant pooled effect (d=0.35, 95% CI=0.17, 0.53, p<0.001).[266] However, there are few meta-analysis that have reported effect sizes for fitness competitions.

To achieve a power of 80% and a level of significance of 5% (two sided) for detecting an effect size of 0.3 using Repeated measures ANOVA, this study required a sample size of 22 per group (66 in total).[267] We targeted a larger sample size goal of 66 inflated to 100 to allow for attrition.

#### 3.2.1.2 Incentives

Participants were incentivized with a total of $15 Amazon gift cards to encourage enrollment and prevent attrition. Specifically, $5 was provided at baseline after completing the week-0 survey, and a $10 Amazon gift card was provided upon completion of the study. At the conclusion of DFFC, there was a drawing for participants from all three groups who completed both surveys, one for $20, one for $30, and one for $50.

### 3.2.2 Participants and Settings

#### 3.2.2.1 Inclusion and Exclusion Criteria

Our recruitment pool for the DFFC Group and DFFC + Text Group included all students who were enrolled in the 2022 DFFC in the HCOP, AUCON, and VCOM, while the recruitment pool for the Control Group included all HCOP, AUCON, and VCOM students who did not enroll in the 2022 DFFC. We recruited university students (≥ 18 years of age) who could read and write English, possessed a smartphone and a fitness tracker or smartwatch, and a expressed a

willingness to receive a weekly email including motivational information, instructions, and reminders for physical activity. Participants were expected to automatically submit their weekly MVPA minutes using their fitness trackers or smartwatches (if using one of the following apps, which could synchronize activity minutes to the ChallengeRunner app: Apple Health, Fitbit, Garmin, Google Fit, Omron, Oura, Polar, Samsung Health, Strava, Suunto, Under Armour MapMyFitness, Withings). Participants could also choose to manually enter data on the ChallengeRunner website (https://www.challengerunner.com). Participants were also required to be able to perform physical activities. Pregnant women, and individuals with disabilities or chronic diseases that prevent them from being physically active were excluded.

ChallengeRunner is an online platform for establishing, tracking, and managing fitness and wellness challenges among employees.[268] With ChallengeRunner, administrators are able to easily set up and run many types of fitness challenges. Also, the leaderboard in the ChallengeRunner app and website, presented as a bar chart displaying each team's updated minutes, enables participants to stay informed about their rankings. It is also simple for users to enter, monitor, and edit activity data from the ChallengeRunner website, mobile apps, fitness activity trackers, or via text message.[268] Everyone who participates in the 2022 Challenge submitted their data via ChallengeRunner, independent of their participation in the study described here.

#### 3.2.2.2 Recruitment

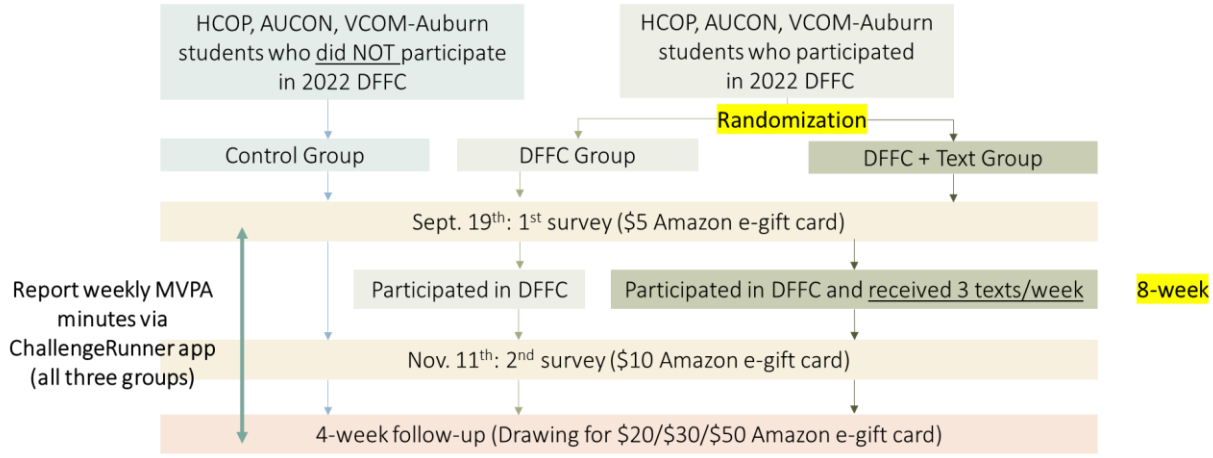
All research participants were recruited from HCOP, AUCON, or VCOM students. Information about the study was included in the first email sent about the DFFC (Appendix 1). The "2nd DFFC email" (Appendix 2) contained a link for non-DFFC students to sign up for the study (Appendix 3). The "3rd DFFC email" (Appendix 4) was only sent to those who signed up

for the DFFC, containing a link to sign up for the study (Appendix 5). Students desiring to participate in this project provided the informed consent approved by the Institutional Review Board (IRB) of Auburn University or VCOM by selecting "Yes" to the question, "Do you agree to participate in this project?" Participants answered three screening questions to indicate they were at least 18 years of age, not pregnant or with disabilities or chronic diseases, and would submit their minutes to ChallengeRunner automatically through their fitness tracker or smartphone apps. Participants' Auburn or VCOM email addresses were collected in the recruitment survey. This study also received IRB approval from VCOM prior to recruiting VCOM students.

### 3.2.3 Interventions

There were two intervention groups and one control group (Figure 3.3). Participants in the DFFC Group and DFFC + Text Group participated in the 8-week DFFC competition among HCOP, AUCON, and VCOM from September 19 to November 11. Participants in DFFC + Text Group received three text messages about physical activity per week, on Mondays, Wednesdays, and Friday. The literature suggests that interventions involving daily[136,137,269] or 2-4 text messages per week[131,140,270-272] are feasible and acceptable among university students. Participants in the Control Group were students in HCOP, AUCON, and VCOM who did not enroll in the 2022 DFFC. They did not participate in 2022 DFFC, nor receive any text messages. After the DFFC, physical activity data were collected for an additional four weeks follow-up for all three groups.

Figure 3.3. Timeline of Interventions




### 3.2.3.1 The Deans' Fit Family Challenge

The Deans' Fit Family Challenge began on September 19, 2022, and concluded on November 11, 2022, lasting eight weeks. Table 3.3 depicts the relationships between components of DFFC and SCT constructs, which are discussed in the following section. Considering the nature of both interventions, these domains were selected because of their ability to influence physical activity in this population. Self-Regulation: Self-regulation refers to controlling oneself to perform sufficient physical activity through self-monitoring, goal setting, feedback, self-reward, self-instruction, and enlistment of social support. The ChallengeRunner app allowed participants to automatically submit activity minutes, after initially connecting the app to their fitness trackers. Participants received a weekly email reminder to track their physical activity minutes. They could also edit their minutes manually on the ChallengeRunner app or website, if desired. Self-Efficacy: Self-efficacy refers to a person's confidence that they can perform sufficient physical activity to meet the recommended guidelines. DFFC also focused on developing self-efficacy through weekly motivational emails that include general information, instructions, and reminders to promote physical activity and mental well-being behavior. During the competition period, fact sheets, flyers, and infographics from the CDC website containing the

knowledge, information, guidance, recommendation, and initiative were shared via email to promote exercise.[273] Evidence indicates that advertisements can improve self-efficacy and motivation of physical activity.[274,275] Social support: Social support refers to discussing physical activity, invitations to perform physical activity, and celebrating the enjoyment of doing physical activity with peers, friends, family, and other people. Participants competed in teams of two throughout the competition. Additionally, group fitness activities provided opportunities to participate in physical activity classes with peers. The group fitness activities in 2022 included a yoga class, F45 class, True 40 class, HIIT class, and an Orange Theory Fitness class. Incentive motivation: Incentive motivation refers to the use and misuse of rewards and punishments to modify physical activity behavior. Weekly winners were announced based on activity minutes for the previous week. Additionally, the winning college was awarded the Deans' Fit Family Challenge Trophy at the conclusion of the competition.

Table 3.3. The SCT Components of the Deans' Fit Family Challenge

| Theoretical construct | DFFC components | Examples |
|---|---|---|
| **Self-Efficacy** | Weekly motivational email | • Receive weekly emails about information, instructions, and reminders to promote physical activity and mental health behaviors |
| **Self-Regulation** | Weekly activity minute logging | • Participants receive a weekly email reminder to track their minutes<br>• The ChallengeRunner app allows participants to enter their minutes manually, or automatically submit activity minutes after initially connecting the app to their fitness tracker |
| | Weight reporting | • Participants provide self-reported weight prior to and at the conclusion of the DFFC |
| **Social Support** | Working with teammate | • Participants compete in teams of two throughout the DFFC |
| | Group fitness classes | • Orange Theory Fitness, Yoga, F45, True 40 HIIT at student recreation center |
| **Incentive Motivation** | Prizes and awards throughout the Challenge | • The winning college is awarded the DFFC Trophy by the university's Provost<br>• Weekly winners are announced based on physical activity minutes for the previous week<br>• Individual winners are determined based on minutes of physical activity and weight loss |

### 3.2.3.2 Text message interventions

Text message frequency was informed by the literature which suggests that college students prefer not to see repeat text messages, or receive text messages too early in the morning,

late at night or during weekends, while they prefer to receive messages between 10am and 7pm.[132,270,276] Participants recruited from 2022 DFFC were randomly assigned to the DFFC Group or the DFFC + text group. Participants in DFFC + text group received three text messages per week, on Mondays, Wednesdays, and Friday.

Text messages were sent through a third-party text platform, EZ Texting.[277,278] Table 3.4 contains the detailed texts schedule and components for the DFFC + Text Group. Appendix 6 shows 20 texts that were sent to the DFFC + Text Group. Reviews of physical activity messaging indicate that text messages to adults should be framed positively instead of negatively.[180,181] Accordingly, we designed gain-framed messages rather than loss-framed messages to address participants' Self-Efficacy, Social Support, Self-Regulation, and Incentive motivation. Self-Efficacy: We developed messages focusing on self-efficacy to make participants feel encouraged and increase awareness of their own activity.[180,184,279] Social Support: In text messages focusing on social support, participants received guidance or suggestions to practice physical activity with friends.[280,281] Incentive motivation: Research indicates that gentle and suggestive motivational messages are acceptable by providing practical tips and suggestions to promote exercise.[177] Self-Regulation: Messages targeting self-regulation were sent every Friday to remind participants that their minutes were collected and to check if they achieved the recommended 150 minutes for the week.[177,282] We drafted the textual content, drawing inspiration from published literature. Two committee members reviewed and refined the drafted texts. We also asked 3-5 Doctor of Pharmacy students and graduate students to test all text messages, and we revised the messages based on students' feedback.

Table 3.4. Text Message Schedule and Examples Based on SCT Components

| | Theoretical construct | Texting components | Examples |
|---|---|---|---|
| **Monday** | Self-efficacy | To encourage participants and increase awareness of their own activity | • The first step is the hardest. Focus on getting out there and getting started. You've got this! |
| **Wednesday** | Social support | Guidance or suggestions to practice physical activity with friends/peers/teammates | • If you're having trouble finding a way to stop sitting, grab a friend and exercise! |
| **Friday** | Self-regulation | To remind participants that their PA minutes will be collected and to check if they achieved the recommended 150 minutes for the week. | • Happy Friday! Your exercise minutes will be collected today. Set a regular time to exercise daily, so you'll be healthy! |
| | Incentive motivation | Motivational messages providing practical tips and suggestions to promote exercise | • Even if you're glued to your phone, you don't have to be glued to your seat! Make it a habit this week to talk and walk whenever possible! |

### 3.2.4 Measures and Data Collection

The primary outcome of this project is physical activity levels, measured by weekly moderate-to-vigorous activity (MVPA) minutes. Secondary outcomes were collected via self-report survey including Self-Efficacy, Self-regulation, Social Support, Incentive motivation, Mental Well-being, and participants' experiences and acceptability with the DFFC and text messages. Self-Efficacy, Self-regulation, Social Support, Incentive motivation, and Mental Well-being were assessed by validated scales during both the week-0 and week-8 surveys. Participants' experiences and acceptability were assessed by multiple choice, 5-point Likert scale, and open-ended questions during the week-8 survey. Week-0 survey and Week-8 survey for the competition group can be found in Appendices 7-10. After completing week-0 and week-8 surveys, participants were redirected to a separate survey (Appendix 11-12) to enter their email address for a $5 or $10 Amazon gift card. The information collected in the contact information survey was maintained in a separate database and not linked in any way to participants' responses to their main surveys. The outcomes, measurement methods, and data collection methods are presented in Table 3.5 below.

Table 3.5. Outcomes, Measurement, and Data Collection

| Outcomes | | Measurement | Data collection methods | Time Point |
|---|---|---|---|---|
| Demographic Variables | | Race, ethnicity, gender, and age | Self-reported survey | Week-0 |
| Primary Outcome | Physical activity levels | Weekly moderate and vigorous activity (MVPA) minutes | Self-reported Survey (One multiple choice question) | Week-0 |
| | | | Collected via the ChallengeRunner app | Weeks 1-12 |
| Secondary Outcomes | Self-Efficacy | 9-item Exercise Self Efficacy Scale[283] | Self-reported survey | Week-0 and week-8 |
| | Self-Regulation | 10-item Self-Regulation Scale[223] | | |
| | Social Support | 5-item Friend Support for Exercise Habits Scale[223] | | |
| | Incentive motivation | 23-item Physical Activity Motivation Scale[284,285] | | |
| | Mental Well-being | The World Health Organization Five Well-being Index (WHO-5) [286,287] | | |
| | Participants' experiences | Two multiple choice and two open-ended questions | | Week-8 |
| | Acceptability | Two 5-point Likert scale questions | | |

### 3.2.4.1 Demographic Information

During the week-0 survey, participants' demographic information was collected via Qualtrics, including gender, age, ethnicity, and race. Students were asked if they participated in other organized fitness programs during the study period. Additionally, participants' health literacy was assessed by Brief Health Literacy Screening Tool – BRIEF.[288] The BRIEF scores range from 2 to 20, where scores of 2 to 12 indicate *limited* health literacy ("Not able to read most low literacy health materials; will need repeated oral instructions; materials should be composed of illustrations or video tapes. Will need low literacy materials; may not be able to read a prescription label."), scores of 13 to 16 indicate *marginal* health literacy ("May need assistance; may struggle with patient education materials."), and scores of 17 to 20 indicate *adequate* health

literacy ("Will be able to read and comprehend most patient education materials"). Research indicates that BRIEF had a strong internal consistency in adults (Cronbach's α = 0.77).[288]

### 3.2.4.2 Physical Activity

The primary outcome of this aim was physical activity, measured by weekly MVPA minutes. Weekly MVPA minutes were collected via fitness trackers or smartwatches and synchronized to the ChallengeRunner app or manual data entry (Figure 3.4 & Table 3.6). During the week-0 survey, participants were encouraged to look at data collected the previous week by their existing activity tracker and report their weekly MVPA minutes. Additionally, participants were asked if they participate in any other organizational program to increase their physical activity during the study period. Weekly MVPA minutes were analyzed to determine the effectiveness of interventions. Participants were asked to track and report their weekly MVPA minutes for 12 weeks, from September 19, 2022, to December 11, 2022.

Figure 3.4. Process of Collecting MVPA Minutes Via the ChallengeRunner App

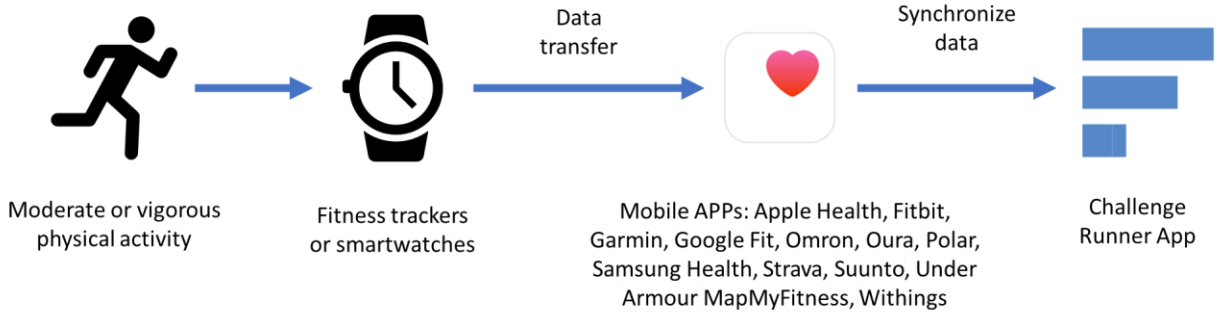



Table 3.6. ChallengeRunner Trackers and Activities

| | Steps Walked | Distance Traveled | Active Minutes | Calories Burned | Sleep Hours | Walking, Running, Swimming, or Cycling Distance | Walking, Running, Swimming, or Cycling Minutes |
|---|---|---|---|---|---|---|---|
| Apple Health | X | X | X | X | X | X | X |
| Fitbit | X | X | X | X | X | X | X |
| Garmin | X | X | X | X | X | X | X |
| Google Fit Online | X | X | X | | | | X |
| Google Fit Mobile | X | X | X | X | X | X | X |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Misfit | X | X | | X | X | | |
| Omron | X | X | X | X | | | |
| Oura | X | X | X | X | X | | |
| Polar | X | X | X | X | X | X | X |
| Samsung Health | X | X | X | X | X | X | X |
| Strava | X | X | X | | | X | X |
| Suunto | X | X | X | X | | X | X |
| Under Armour MapMyFitness | X | X | X | X | X | X | X |
| Withings | X | X | X | X | X | | |

*All apps support tracking steps, 13/14 apps support collecting active minutes, 12/14 apps support collecting burned calories.

In the week-0 and week-8 survey, the Physical Activity Vital Sign (PAVS)[289] was used to screen PA and muscle strengthening exercises for participants. PAVS is a widely used PA assessment tool incorporating three self-reported questions: 1) On average, how many days per week do you engage in moderate to vigorous physical activity (like a brisk walk)?, 2) On average, how many minutes do you engage in physical activity at this level?, and 3) How many days a week do you perform muscle strengthening exercises, such as bodyweight exercises or resistance training?

#### 3.2.4.3 Mental Well-being

The World Health Organization Five Well-being Index (WHO-5) was used to assess subjective psychological well-being.[287] The WHO-5 score is the sum of responses to five items: (1) ‘I have felt cheerful and in good spirits'; (2) ‘I have felt calm and relaxed'; (3) ‘I have felt active and vigorous'; (4) ‘I woke up feeling fresh and rested'; and (5) ‘My daily life has been filled with things that interest me'. These items are scored on a five-point Likert type scale from 0 (at no time) to 5 (all the time), summed, and the summed score is multiplied by a factor of four. Clinical validity of the WHO-5 has been evaluated as high since it can be used across many

different settings, regardless of the underlying illness.[286,287] Usually, a score of ≤50 is recommended for clinical depression screening.[286,287] As shown in previous research, WHO-5 has demonstrated high internal consistency in university students (Cronbach's α = 0.85, 0.81, and 0.89).[290,291] A referral list (Appendix 13) of mental health providers, including on campus services, off campus services, and emergency services, was provided for participants at the end of survey.

#### 3.2.4.4 Self-Efficacy

A 9-item Self-Efficacy for Exercise Scale was used to measure self-efficacy by assessing participants' belief that they are able to meet the physical activity guidance for adults when encountering different barriers. [283] In each situation, participants provide their current confidence level ratings on a scale from 1 (not confident) to 5 (very confident). The overall score is calculated as the average of the 9-item ratings, with higher scores indicating higher self-efficacy. This scale has been used widely in studies applying SCT to understanding physical activity[283,292-294] and has demonstrated high internal consistency among older adults (Cronbach's α = 0.92[283] and 0.75[293]) nursing and medical students (Cronbach's α = 0.88),[292] and adults (Cronbach's α = 0.90-0.94).[294]

#### 3.2.4.5 Incentive motivation

Incentive motivation was measured using the 23-item Motivation for Physical Activities Measure.[284] Participants rate 23 statements on a 5-point scale ranging from 1 (strongly disagree) to 5 (strongly agree) with higher scores indicating higher Incentive Motivation. This scale has been used in studies applying SCT to understanding physical activity[285] and has demonstrated high internal consistency among adults (Cronbach's α = 0.92[285] and Cronbach's α = 0.82[295]).

#### 3.2.4.6 Social Support

Social support from friends, family, and teammates was measured by five items from the Social Support for Exercise Habits Scale.[296] This scale consists of 15 items from three subscales: Family Participation, Family Punishment, and Friends Participation. The score of each item is from 1 (never) to 5 (very often) with higher scores indicating higher Social Support. The Friends scale has been used widely in studies applying SCT to understanding physical activity,[124,138,223,297-300] and has demonstrated high internal consistency among Hispanic populations (RMSEA=0.106, CFI=0.919, TLI=0.839, and SRMR=0.045),[301] urban African American adults (Cronbach's $\alpha = 0.967$),[297] young university students (Cronbach's $\alpha = 0.91$),[223] and African American female college students (Cronbach's $\alpha = 0.95$).[138]

#### 3.2.4.7 Self-Regulation

Self-regulation was measured using the 10-item Exercise Planning and Scheduling Scale (EPS) instruments.[223] Participants rate EPS items on a 5-point scale ranging from 1 (does not describe) to 5 (describes completely) with higher scores indicating higher Self-regulation. This EPS scale has been used widely in studies applying SCT to understanding physical activity[223,298-300,302,303] and has demonstrated high internal consistency among Chinese adolescents (Cronbach's $\alpha = 0.91$),[299] young university students (Cronbach's $\alpha = 0.87$),[223] and female undergraduate students ($\alpha = 0.72 - 0.89$).[304]

#### 3.2.4.8 Participants' Experiences

Participants were asked to identify an enabler and barrier to physical activity during the study through two multiple choice questions (one for enablers, and one for barriers) on the week-8 survey. The survey also included two open-ended questions asking participants to describe an

aspect of the intervention (i.e., the DFFC or text messages) they enjoyed the most and what they dislike about the intervention.

#### 3.2.4.9 Acceptability

Acceptability was assessed via two 5-point Likert scale questions: (1) ‘Overall, how satisfied were you with the DFFC/text message intervention’, the score of each item is from 1 (very dissatisfied) to 5 (very satisfied); and (2) ‘How likely will you choose to participate in next year’s Challenge if you are still eligible/How likely are you to choose to receive text messages about physical activity in the future, the score of each item was from 1 (extremely unlikely) to 5 (extremely likely).

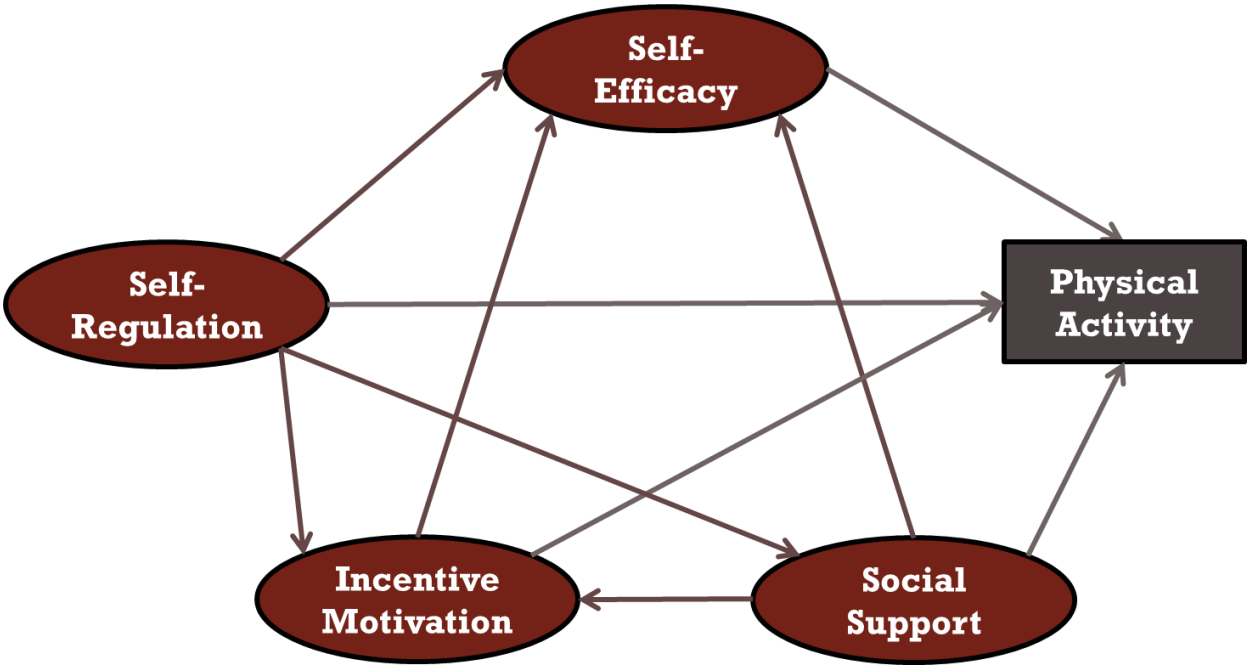
### 3.2.5 Statistical Analysis

#### 3.2.5.1 Quantitative Analysis

Descriptive analyses were conducted to analyze demographic variables and SCT variables prior to the study. Two sample t-test (for continuous variables) and chi-square test or fisher exact test (for categorical variables) were used to compare the baseline characteristics between the Control Group and other participants who enrolled in the DFFC (including DFFC Group and DFFC + Text Group).

Path analysis was performed to assess hypothesized relationships between mental well-being, self-efficacy, self-regulation, incentive motivation, social support, and physical activity using the pre-test survey data (Figure 3.5). Arrows present a direct effect of each variable on an endogenous variable.

Figure 3.5 Path Analysis of the Effect of Interventions on Weekly MVPA Minutes, Mental Well-being, Self-Efficacy, Self-Regulation, Incentive Motivation, and Social Support




Before interpreting the causal relationship of the structural model, measurements of model fit were assessed.[305] Fit refers to the capability of a model to generalize data; a good model fit refers to the capability of a model to accurately predict unknown data.[305,306] There could be an error in the proposed structure model and/or data if the model does not fit the data. As a result, the predicted parameter values could be questionable.[307] The Chi square and Root Mean Square Error of Approximation (RMSEA) were calculated to measure the accuracy of the model. Non-significant Chi-square value indicates a good model fit.[276,308] A RMSEA value between 0.08 and 0.1 is considered borderline fit, a value between 0.05 and 0.08 is considered acceptable fit, and a value less than 0.05 indicates an excellent model fit.[276,309]

Since we had repeated measurements of weekly MVPA minutes for all three groups for 8 weeks, the Repeated Measures ANOVA was used to test the effect of the DFFC and text

messaging during the DFFC, as well as the four weeks after the DFFC concluded. One-way ANOVA was then used if weekly MVPA minutes were statistically significant different between the groups, and the paired t-test was used for within group comparations. A p-value of less than 0.05 was considered statistically significant. Data were analyzed using SPSS version 22.0 (IBM Armonk, New York, USA).

One-way ANOVA was performed to determine if Mental Well-being, Incentive Motivation, Social Support, Self-Efficacy, and Self-Regulation were significant different between the three groups after the interventions. Five mediation models were developed to determine if the effect of the interventions on Physical Activity was mediated by SCT variables. For each model, the independent variable is the interventions, the dependent variable is physical activity, and the mediator variables are Mental Well-being, Incentive Motivation, Self-Efficacy, Social Support, and Self-Regulation, respectively.

#### 3.2.5.2 Qualitative Analyses

Responses to the open-ended questions were analyzed using open coding and thematic analysis with NVivo 12 (QSR International, Melbourne, Australia) software. The coding team comprised two researchers. Prior to analyzing data, an initial guide of deductive coding based on the constructs of enablers, barriers, experience, and acceptability was developed by the primary investigator.[310,311] Two coders were both responsible for coding the entire dataset. Similar codes or patterns were grouped into larger themes, and emerged themes were assessed for internal homogeneity (e.g., internal cohesiveness) and exclusivity between categories.[312-314] Representative quotes were selected to further illustrate each theme. To maintain methodological rigor and trustworthiness of data analysis, kept a detailed audit trail and reflection journal of our initial definitions of categories, sub-categories and schema, and our discussions during these

meetings.[315-317] Disagreements were solved through discourse and consensus. To support the trustworthiness of interpretations and analyses, we kept an audit trail to track who, when, and how to collect and analyze data.[318]

Table 3.7 below provides a concise summary of the data analysis plan for the studies.

Table 3.7. Summary of Data Analyses Plan

| Aim | Outcomes | Variables | Instrument | Time Point | Analysis |
|---|---|---|---|---|---|
| 1 | Synthesis and effectiveness of text message interventions in university students | - | | - | Systematic review and meta-analysis |
| 2.1 | Change in MVPA minutes in three groups | IV: Interventions<br>DV: MVPA | MVPA minutes, PAVS | Weeks 1 – 12 | Repeated Measures ANOVA, Paired t-test, and One-way ANOVA |
| | Change in Self-Efficacy in three groups | IV: Interventions<br>DV: Self-Efficacy | Exercise Self Efficacy Scale | Week-0 and week-8 | One-way ANOVA |
| | Change in Self-Regulation in three groups | IV: Interventions<br>DV: Self-Regulation | Self-Regulation Scale | | |
| | Change in Social Support in three groups | IV: Interventions<br>DV: Social Support | Support for Exercise Habits Scale | | |
| | Change in Incentive Motivation in three groups | IV: Interventions<br>DV: Incentive Motivation | Physical Activity Motivation Scale | | |
| | Change in Mental Well-being in three groups | IV: Interventions<br>DV: Mental Well-being | WHO-5 | | |
| | Relationship between Physical Activity, Self-Efficacy, Self-regulation, Social Support, and Incentive Motivation (pre-test) | Exogenous: Self-Regulation<br>Endogenous: Self-Efficacy, Social Support, and Incentive Motivation | PAVS, Exercise Self Efficacy Scale, Self-Regulation Scale, Support for Exercise Habits Scale, Physical Activity Motivation Scale, | Week-0 | Path-analysis |
| | Relationship between interventions, Physical Activity, Mental Well-being, Self-Efficacy, Self-regulation, Social Support, and Incentive Motivation (post-test) | IV: Interventions<br>Mediators: Mental -Well-being, Self-Efficacy, Self-Regulation, Social Support, and Incentive Motivation<br>DV: Physical Activity, | PAVS, Exercise Self Efficacy Scale, Self-Regulation Scale, Support for Exercise Habits Scale, | Week-8 | Mediation models |

| | | | | | |
|---|---|---|---|---|---|
| | | | Physical Activity Motivation Scale, WHO-5 | | |
| 2.2 | Participants' experiences | | Multiple choices and open-ended questions | Week-8 | Descriptive Analyses and thematic analysis |
| | Participants 'acceptability | | Likert scale questions | | |

### 3.2.6 Expected Findings

We expected to find the effects of text messaging and fitness competition on university students' Physical Activity, Mental Well-being, Self-Efficacy, Incentive Motivation, Self-Regulation, and Social Support. Participants expected to identify their enablers and barriers to practice physical activity, and general satisfaction with both interventions.

### 3.2.7 Potential Limitations and Alternative Strategies

First, due to the non-randomized and quasi-experimental nature of the study, potential for bias arising from differences in baseline risks and sampling bias between three groups could not be completely ruled out. The DFFC was open to everyone, but one member of each two-person team was required to be an employee or student of one of the three colleges. Hence, participants could not be randomly assigned to the competition-based intervention groups. Second, although we aimed to reduce the error inherent in PA measurement by using fitness trackers, there are potential self-report bias, especially for SCT constructs. Therefore, we used validated and clear instruments when framing questionnaires. Third, losses to follow-up could lead to incomplete study results and introduce bias if there were differences in likelihood of loss to follow-up related to exposure status and outcome. Therefore, participants received weekly reminders and incentives after completing all follow-up surveys. Fourth, we did not know if the participants actually read all, some, or none of text messages. However, EZ Texting provides delivery reports indicating whether the text message is delivered successfully.

Ethical Approval: Prior to conducting the study, an approval was received from Auburn University' and VCOM Institutional Review Board. All participants provided informed consent to participate in the study.

# Chapter 4. Results

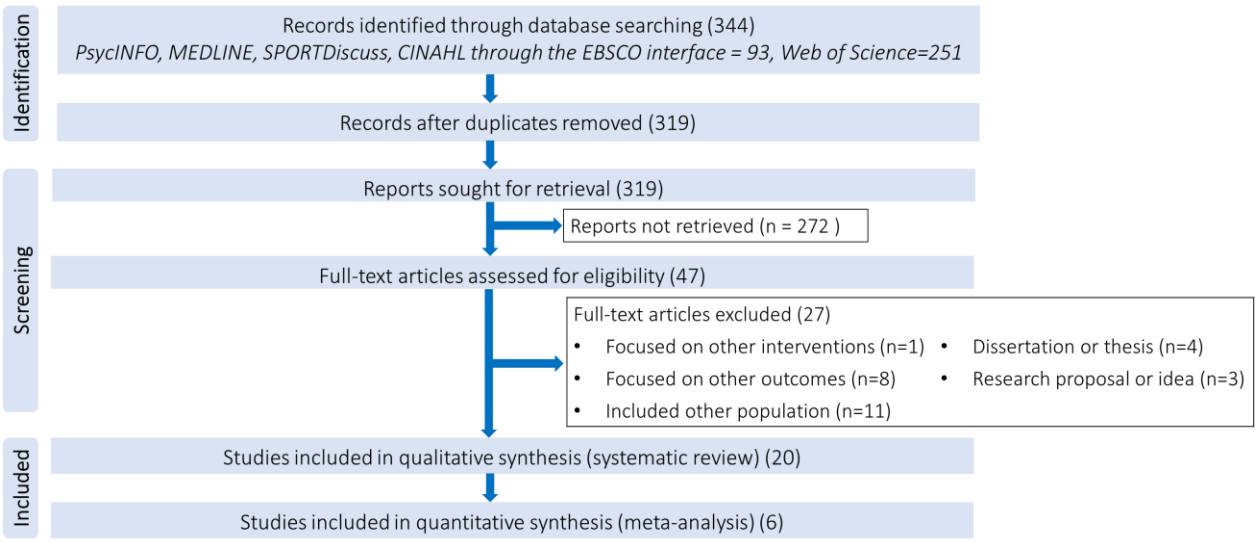
This chapter first presents the results of the systematic review and meta-analysis from Aim 1. Results for Aim 2 follow and include the effect of competition-based and text message interventions, as well as relationships between interventions, Mental Well-being, Incentive Motivation, Social Support, Self-Efficacy, Self-Regulation and Physical Activity. This is followed by results describing participants' experience and acceptability of the DFFC.

## 4.1 Aim 1: Systematic Review and Meta-Analysis

### 4.1.1 Systematic Review

The PRISMA diagram in Figure 4.1 depicts the study selection process. The initial literature searches retrieved a total of 344 records after removing duplicates and 47 full-text articles were screened for eligibility. Out of these, 20 articles were selected for the systematic review and six were selected for meta-analysis.

Figure 4.1. Study Identification and Selection following the PRISMA Guidelines



The details of the 20 included studies are described in Table 4.1. More than half (11, 50%) of included were published in the last five years (2018-2022). There were 15 (75%) RCTs, one focus group study, and four quasi-experimental studies (one study with a nonequivalent control group and three studies with one-group pretest–posttest design). The total number of participants in the RCTs and non-randomized controlled trials was 2,798, accounting for 93.57% of the total number of participants in the 20 included studies. Over half (12, 60%) of the studies lasted for 4-8 weeks, and two lasted over twelve months, while the longest duration was 24 months[319] and the shortest duration was 6 days.[133]

Table 4.1. Characteristics of Included Studies

| Author Year | Participants | N | Comparisons | Study design | Intervention | Results |
|---|---|---|---|---|---|---|
| Castro 2021 | University students | 9 | N/A | pre-post one group | One-on-one session with automated text-messages based on COM-B components (4 texts per day for 6 days) | Significant reduction in sedentary time (−1.65 h/d, p = .005) and significant increase in standing (+1.1 h/d, p = .019) and stepping time (+0.55 h/d, p = .003) during weekend days. |
| Cotten 2016 | University students | 82 | Daily text messages unrelated to sedentary behavior | RCT | Sedentary behavior related text messages twice daily for 6 weeks | Significant increase in LPA (+74.34 m/d, p = .07) for intervention group. |
| Dillon 2021 | University students | 114 | N/A | RCT | One-on-one behavioral counseling session and tailored text messages twice daily | Significant group by time interaction effects favoring the intervention group for sitting time (p=0.004, $\eta_p^2$ = 0.10), walking time (p=0.021, $\eta_p^2$ = 0.06) and stretching time (p=0.023, $\eta_p^2$= 0.08). |
| Figueroa 2022 | University students | 93 | Daily feedback messages | RCT | Daily motivational messages for 6 weeks | Sending text message initially resulted in an increase in daily steps (729 steps, p = .012). |
| Godino 2016 | College students (18-35 yrs) have overweight or obesity | 404 | General information about health and wellness | RCT | Facebook, mobile apps, a website with blogs, e-mail, SMS (at least 1 text per week, customize frequency), and | Adjusted weight was significantly less in intervention group compared to control group at 6 months (−1.33 kg, p |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | | occasional 'lifeline' contact with a health coach (24 months) | = .011) and 12 months (−1.33 kg, p = .008). |
| Hardan-Khalil 2021 | University students | 201 | No intervention | Nonequivalent control group design | Daily motivational messages for 8 weeks | No significant interactions on PA outcomes. |
| Hayes 2021 | University students (18-25 yrs) | 95 | Assignment of dietary weighing goal | RCT | Asked to form implementation intentions and 4 texts per week for 4 weeks | Decrease in weight (d = 0.35, p = .002), BMI (d = 0.33, p = .003), and caloric intake (d = 1.14, p < .001) across groups. |
| Keahey 2021 | Undergraduate students (17–25 yrs) | 158 | N/A | pre-post one group | 4 texts per week for 4 weeks and 2-week follow-up | Significant decrease in weekly PA after intervention (p < .001) and follow-up (p < .001). |
| Lua 2013 | University students (18-24 yrs) | 417 | No intervention | RCT | Conventional lecture, brochures, and texts (1 text per five days) for 10 weeks | Significant increase in MET spending on walking (d = .48), MPA (d = .38), VPA (d = .34), and total PA (d = .75), and decrease in MET for sitting (d = .35). |
| Mbada 2018 | Female undergraduates (BMI>25) | 64 | Pedometer and text messages were sent as reminders | RCT | Pedometer and structured SMS thrice weekly for 8 weeks | Significant difference in weight (−0.92 ± 2.15 kg vs. 1.52 ± 2.10 kg P = 0.001) and BMI (−0.35 ± 0.84 $kg/m^2$ vs. 0.58 ± 0.81 $kg/m^2$) at week four between the experimental and control group. |
| Muñoz 2014 | University students enrolled | 114 | Pedometer | RCT | Text 2-3 times per week for 16 weeks with pedometer | No significant difference in daily steps (p = .467). |

| | | | | | | |
|---|---|---|---|---|---|---|
| | in a wellness course | | | | | |
| Nam 2020 | Female university students | 64 | No intervention | RCT | Social-media-based support through Fitbit Flex, Fitbit's smartphone application, text messages (2 texts per week), and e-mail for 28 days | Significant increase in total weekly MET ($p = .006$) for intervention group with significant difference ($p = .010$) compared with control group. |
| Napolitano 2013 | University students (18-29 yrs and BMI between 25 and 50 kg/m$^2$) | 52 | 1) Facebook group; and 2) control group (no intervention) | RCT | Facebook group, daily text, and weekly tailored feedback reports for 8 weeks | Facebook Plus group had significantly greater weight loss ($-2.4 \pm 2.5$ kg) than the Facebook ($-0.63 \pm 2.4$ kg) and control ($-0.24 \pm 2.6$ kg) (both Ps $< 0.05$) |
| Napolitano 2021 | University students (18-35 yrs and BMI between 25 and 45 kg/m$^2$) | 460 | General healthy body content | RCT | Facebook group, text message (personalized or generic, 2 texts per week), and weekly report for 18 months | Highly engaged member in TAILORED (personalized) group lost more weight compared to control group ($-2.32$ kg, $p = .004$) at 6 months. |
| Olofintuyi 2018 | African American university students (18-25 yrs) | 11 | Participants did not respond | pre-post one group (with post-hoc grouping) | Text message (week 1, daily message; weeks 2–3, 5 text per day) | No statistically significant differences in PA variable between groups. |
| Prestwich 2009 | University students | 155 | Motivational message or no intervention | RCT | Implementation intentions and SMS (customized frequency) for 4 weeks | Combined intervention increased exercise frequency significantly more than the other groups. |
| Reese 2017 | African American women university students (19-30 yrs, BMI>25) | 14 | N/A | Focus group | 1-2 texts per day for 2 weeks and 5 texts per week for 1 week | Participants preferred brief, specific, and time sensitive text messages. |

| | | | | | | |
|---|---|---|---|---|---|---|
| Sandrick 2017 | Full-time students aged 18-30 | 60 | No intervention | RCT | Face-to-face meeting with a health coach and SMS (< 3 text/week) for 8 weeks | Significant difference in MET (2047 m/w for control group, 3114 m/w for intervention group, p = .04) |
| St Quinton 2021 | First-year undergraduate student (18-25y) | 289 | Generic PA information 4 weeks | RCT | Attitude messages, goal priority messages, or a combination of these (6 texts in 2 weeks and 4-week follow-up) | Participants that received attitude messages had significantly more positive attitudes (p = .04), intentions (p = .001), and rates of PA (p = .001). |
| Stark 2016 | Health professional students | 134 | Pedometer | RCT | Daily affective text messages for 2 weeks with a pedometer | No significant difference in daily steps |

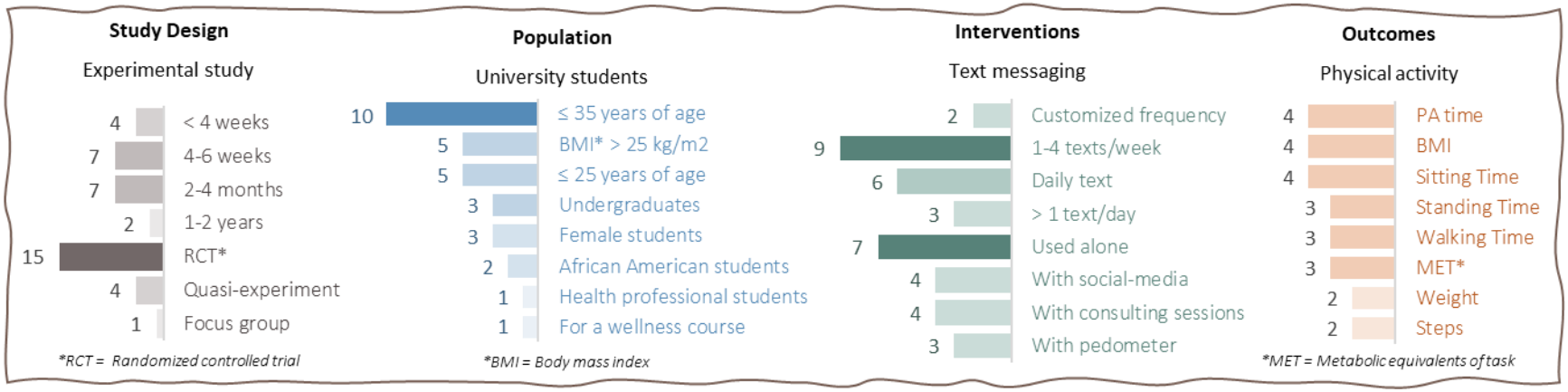
Note: LPA = light-intensity PA; RCT = randomized controlled trial; SMS = short messages service;

There was a restriction on the age of the participants in ten of the studies. Among them, five studies recruited university students younger than 24 or 25 years old[131,270,320-322], and five studies recruited students younger than 30 or 35 years old[140,319,323-325]. There were five studies targeting students who had overweight or obese[319,323-326], two studies targeting African American students[131,325], and three studies focusing on female students.[271,325,326] Although the studies were open to all enrolled university students, three of the studies focused on undergraduates[270,322,326], while one was designed for students enrolled in a wellness course[327], and one was for health professional students.[328] Only one of 20 included studies was based on a health behavior theory (COM-B Model).[133]

Text message interventions varied across studies in higher education settings. Text messages were used alone in seven studies[131,137,269,270,322,325,329], while some studies used text messages as part of other interventions, such as monitoring steps with a pedometer[326-328], consulting sessions or lectures[133,140,321,330], forming implementation intentions[320,331] (e.g., If there are stairs, then I will take them instead of the elevator), and social-media-based programs.[271,319,323,324] In three studies, texts were sent more than once per day[133,269,330], but no more than four messages per day.[133] Texts were sent on a daily basis in six studies[131,137,323,325,328,329] and were sent 1-4 times per week in nine studies.[140,270,271,320-322,324,326,327] Participants in two studies were allowed to customize the frequency of receiving messages.[319,331]

Figure 4.2 summarizes the overall characteristics of 20 articles in systematic review. Most of them are RCTs, and the population of ten studies are university students younger than 35 years old. Interventions and outcome measurement vary across studies.

Figure 4.2. Overall Characteristics of 20 Articles in Systematic Review




The included studies used various measures to assess the effectiveness of text message, including MET, activity minutes, sitting time, walking time, standing time, steps, weight, BMI, and other clinical outcomes (Table 4.2).

Table 4.2. Categories of Outcomes for 20 Included Studies

| **Randomized Controlled Trials** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | MET | Sitting Time | Walking Time | BMI | Standing Time | Steps | PA time | Weight |
| Cotten 2016 | | | | | Minutes (self-reported using SLIPA questionnaire) | | LPA and MPA minutes (self-reported using 7-day PAR questionnaire) | |
| Dillon 2021 | | Minutes (self-reported using OSPAQ questionnaire) | Minutes (self-reported using OSPAQ questionnaire) | | Minutes (self-reported using OSPAQ questionnaire) | | | |
| Figueroa 2022 | | | | | | Steps (mHealth app): Final GEE models presented but no numerical data provided | | |
| Hayes 2021 | | | | BMI (objective measurement): Final ACOVA and paired t-test statistics presented but no numerical data provided | | | | |
| Lua 2013 | MET (self-reported using IPAQ) | | | BMI (measured objectively) | | | | Weight (measured objectively) |
| Mbada 2018 | | | | BMI (measured objectively) | | Steps (measured objectively using pedometer) | | |
| Muñoz 2014 | | | | | | Steps but SD unknown (measured objectively using pedometer) | | |
| Nam 2020 | MET (self-reported using IPAQ) | | | | | | | |
| Napolitano 2013 | | | | | | | PA (self-reported using Godin-Shephard leisure-time physical activity questionnaire): Bonferroni correction | Height and weight differences (objective measurement) |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | statistics presented but no numerical data provided | |
| Napolitano 2021 | | | | | | | | Adjusted weight differences (measured objectively) |
| Godino 2016 | | | | BMI (measured objectively) | | | | |
| Prestwich 2009 | | | | | | | Differences in exercise behavior (self-reported items) | |
| Sandrick 2017 | MET (self-reported using IPAQ) | | | | | | | |
| St Quinton 2021 | | | | | | | PA scores (self-reported items) | |
| Stark 2016 | | | | | | Steps (measured objectively using pedometer): Final t-test statistics presented but no numerical data provided | | |
| **Quasi-experimental studies** | | | | | | | | |
| Hardan-Khalil 2021 | | Minutes (self-reported using IPAQ) | | BMI (self-reported) | | | LPA and MPA minutes (self-reported IPAQ) | |
| **One group pre post study** | | | | | | | | |
| Castro 2021 | | Minutes (self-reported using NWU questionnaire and measured objectively using accelerometer) | Minutes (self-reported using NWU questionnaire and measured objectively using accelerometer) | | Minutes (self-reported using NWU questionnaire and measured objectively using accelerometer) | | | |
| Keahey 2021 | | Hours (self-reported using PASB-Q questionnaire) | | | | | MVPA minutes (self-reported using PASB-Q questionnaire) | |
| Olofintuyi 2018 | MET (self-reported using IPAQ) | | | BMI (measured objectively) | | | | |
| **Qualitative study** | | | | | | | | |
| Reese 2017 | Participants expressed a preference for text messages that were concise, targeted, and time-sensitive | | | | | | | |

Note: IPAQ = International Physical Activity Questionnaire; NWU = Nightly-Week-U; OSPAQ = Occupational Sitting and Physical Activity Questionnaire; PAR = Physical Activity Recall; PASB-Q = Physical Activity and Sedentary Behavior Questionnaire; SLIPA = sedentary and light intensity physical activity

The MET was measured by the self-reported International Physical Activity Questionnaire (IPAQ) and was calculated using the following formulas:

Total MET (min/week) = Walking MET + Moderate MET + Vigorous MET

Walking MET = 3.3 * Walking minutes * Walking days

Moderate MET = 4.0 * MPA minutes * MPA days

Vigorous MET = 8.0 * VPA minutes * VPA days

Activity minutes, sitting time, walking time, standing time, and PA times were measured subjectively using self-reported surveys, except for in the study conducted by Castro et al., which reported both accelerometer-based and self-reported measurements for sitting time, walking time, and standing time.[133] Steps were measured using pedometers or mHealth apps in all studies where steps were included as an outcome. Objective measurements of BMI or weight were used in most studies, with the exception of two studies: one conducted by Stark et al. and another conducted by Hardan-Khalil et al., where self-reported BMI was used.[137,328]

Of the 15 RCTs, 13 reported significant improvements in PA in different aspects[140,269,271,319-324,326,329-331], and two studies[133,328] did not report significant differences between intervention and control groups. Muñoz et al. assessed the effectiveness of text message interventions for participants who were enrolled in a wellness course.[327] The intervention group received texts about healthy behaviors two to three times per week over 16 weeks of the semester[327]; while Stark's study was among health profession students, and participants received two texts per week for 2 weeks.[328] Both studies used a pedometer to measure daily steps and did not find a significant difference between the intervention group and the control group.[327,328]

Half of the four quasi-experimental studies found that the intervention led to a significant increase in PA. Castro et al. developed one educational session and 24 text messages based on COM-B components, and found significant post-test reduction in sedentary time (−1.65 h/d, $p = .005$) and significant increases in standing (+1.1 h/d, $p = .019$) and stepping time (+0.55 h/d, $p = .003$) during weekend days.[133] In Keahey's study, texts were sent four times per week for 4 weeks. A significant decrease was found in weekly PA after intervention ($p < .001$) and follow-up ($p < .001$).[270] Regarding the one qualitative study by Reese et al., a focus group was conducted among African American female university students under 30 years old with BMI>25, and found that brief, specific, and time sensitive text messages were preferred.[325] Overall, commonalities across the included studies that contributed to positive findings included: (1) personalized or tailored messages, (2) customized frequency, (3) relevant and engaging content that was comprehensible, and (5) integration into other programs.

The results of quality assessment using MMAT are shown in Table 4.3. Ratings from the MMAT indicate that all included 15 RCTs performed randomization appropriately and provided complete outcome data, and all but one of the RCT studies assessed baseline characteristics across groups. Among five of the RCTs, research personnel were unaware of intervention allocation, and four RCTs reported more than a 30% drop-out rate. For three quantitative, nonrandomized trials, only one met all five quality criteria, while two did not account for the confounders in the design and analysis. All quality criteria were met in one qualitative study and one mixed methods study.

Table 4.3. Article Quality Assessment

| **Quantitative randomized controlled trials** | | | | | |
|---|---|---|---|---|---|
| Author Year | Is randomization appropriately performed? | Are the groups comparable at baseline? | Are there complete outcome data? | Are outcome assessors blinded to the intervention provided? | Did the participants adhere to the assigned intervention? |
| Cotten 2016 | Yes | Yes | Yes | No | No 31% drop out |
| Dillon 2021 | Yes | Yes | Yes | Yes | Yes |
| Figueroa 2022 | Yes | No | Yes | No | Yes |
| Hayes 2021 | Yes | Yes | Yes | Yes | Yes |
| Lua 2013 | Yes | Yes | Yes | Can't tell | Yes |
| Mbada 2018 | Yes | Yes | Yes | Can't tell | Yes |
| Muñoz 2014 | Yes | Yes | Yes | Yes | No about 45% drop out |
| Nam 2020 | Yes | Yes | Yes | Can't tell | Yes |
| Napolitano 2013 | Yes | Yes | Yes | Can't tell | Yes |
| Napolitan 2021 | Yes | Yes | Yes | Yes | No 38% drop out |
| Godino 2016 | Yes | Yes | Yes | Yes | Yes |
| Prestwich 2009 | Yes | Yes | Yes | Can't tell | Yes |
| Sandrick 2017 | Yes | Yes | Yes | No | Yes |
| St Quinton 2021 | Yes | Yes | Yes | Can't tell | No 40% drop out |
| Stark 2016 | Yes | Yes | Yes | Can't tell | Yes |
| **Quantitative nonrandomized studies** | | | | | |
| | Are the participants representative of the target population? | Are measurements appropriate regarding both the outcome and intervention (or exposure)? | Are there complete outcome data? | Are the confounders accounted for in the design and analysis? | During the study period, is the intervention administered (or exposure occurred) as intended? |
| Hardan-Khalil 2021 | Yes | Yes | Yes | No | Yes |
| Keahey 2021 | Yes | Yes | Yes | Yes | Yes |

| | | | | | |
|---|---|---|---|---|---|
| Olofintuyi 2018 | Yes | Yes | Yes | No | Yes |
| **Qualitative study** | | | | | |
| | Is the qualitative approach appropriate to answer the research question? | Are the qualitative data collection methods adequate to address the research question? | Are the findings adequately derived from the data? | Is the interpretation of results sufficiently substantiated by data? | Is there coherence between qualitative data sources, collection, analysis and interpretation? |
| Reese 2017 | Yes | Yes | Yes | Yes | Yes |
| **Mixed methods** | | | | | |
| | Is there an adequate rationale for using a mixed methods design to address the research question? | Are the different components of the study effectively integrated to answer the research question? | Are the outputs of the integration of qualitative and quantitative components adequately interpreted? | Are divergences and inconsistencies between quantitative and qualitative results adequately addressed? | Do the different components of the study adhere to the quality criteria of each tradition of the methods involved? |
| Castro 2021 | Yes | Yes | Yes | Yes | Yes |

### 4.1.2 Meta-analysis

Meta-analysis was conducted of each outcome if there were at least three studies reporting the same outcome using the same study design. Therefore, two PA outcomes in six RCTs were included for the meta-analysis: total MET (n=3) and BMI (n=3). The Higgins $I^2$ statistics for both meta-analyses were lower than 75%, indicating no statistical heterogeneity between the studies and suggesting the use of fixed effects models.

There were three RCTs included in the analysis of intervention effect on total MET. When compared with control groups that did not receive PA text messages, text message interventions led to a greater total MET (standardized mean difference [SMD] = 0.67, 95% CI = 0.49, 0.85, $p < 0.01$; Figure 4.3) in the intervention groups. MET was measured subjectively by IPAQ in these three RCTs. However, for the analysis of intervention effects on BMI, statistically significant differences were not observed in three RCTs (SMD = -0.15, 95% CI = -0.32, 0.02, $p = 0.08$; Figure 4.4). BMI was measured objectively in these three RCTs.

Figure 4.3. Impact of Text Message Interventions on weekly total MET (RCTs, n=3)

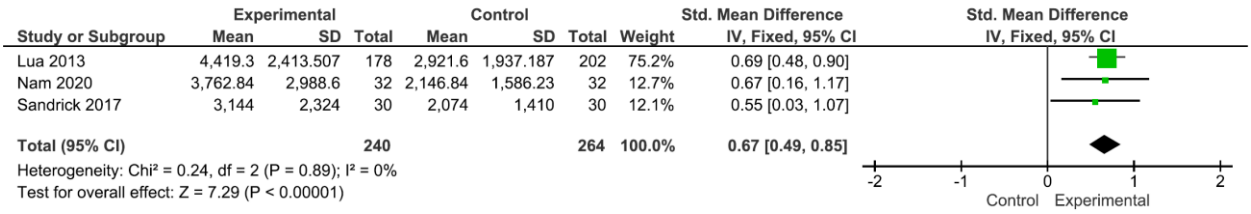
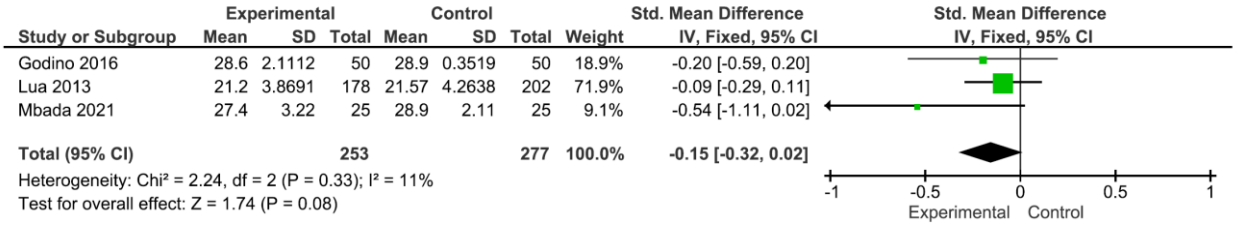


Figure 4.4. Impact of Text Message Interventions on BMI (RCTs, n=3)




## 4.2 Aim 2.1

### 4.2.1 Study Enrollment

As described in Chapter 3, the study invitation, which included the 2022 DFFC kickoff emails, was sent to all HCOP, AUCON, and VCOM-Auburn students, approximately 1,349 students total. A total of 260 participants in the DFFC were then recruited for this study, and 58 enrolled (Table 4.4). Interested students registered for the study via a sign-up survey in Qualtrics, distributed by the investigator's major professor. Among 58 participants, 48 (82.76%) students contributed to the initial baseline survey, and 52 (89.66%) students completed the second survey. More than 70% in the DFFC Group and DFFC + Text Group submitted weekly MVPA data during the follow-up weeks, in contrast to a loss of over 70% in the Control Group. In DFFC + Text Group, one person dropped out after enrolling, so physical activity data are not reported for this individual. In the Control Group, four participants did not sign up for their ChallengeRunner account, so their physical activity data were not included in the final analysis.

Table 4.4. Response Rate for Two Surveys

| | Enrolled in study | Completed 1st survey | Registered for a ChallengeRunner account | Completed 2nd survey | Follow-up |
|---|---|---|---|---|---|
| Group 1: Control | 19 | 15 (78.95) | 16 (84.21%) | 16 (84.21%) | 5 (26.32%) |

| | | | | | |
|---|---|---|---|---|---|
| Group 2: DFFC | 19 | 16 (84.21%) | 19 (100%) | 16 (84.21%) | 14 (73.68%) |
| Group 3: DFFC+ Text | 20 | 17 (85%) | 19 (95%) | 20 (100%) | 14 (70.00%) |
| Total | 58 | 48 (82.76%) | 53 (91.38%) | 52 (89.66%) | 33 (56.90%) |

### 4.2.2 Descriptive Results

Baseline characteristics of participants are presented in Table 4.5. Most participants were female (77.08%), non-Hispanic (95.83%), enrolled in HCOP (79.17%), and had adequate health literacy (89.58%). The Control group consisted of students who did not enroll in DFFC, while DFFC participants who enrolled in the study were randomized to the DFFC Group or the DFFC + Text Group. Therefore, we conducted two sample t-test (Mean Age, Mental Well-being, Incentive Motivation, Social Support, Self-Efficacy, and Self-Regulation) and Fisher's Exact test (categorical variables) to compare the baseline characteristics between the non-enrolled and non-randomized participants (Control Group) and those who enrolled and were randomized (DFFC Group and DFFC + Text Group). The mean age of all students was 24.87 (range: 20-40, SD 4.21), while the average age of participants in the Control Group was significantly higher than groups two and three combined ($p = 0.0013$). Among all participants, 70.83% of them identified themselves as white, but the proportion of Asian students was significantly higher in Control Group than groups two and three combined ($p = 0.0003$). At baseline, there was no statistically significant difference between the three groups in Mental Well-being, Incentive Motivation, Social Support, Self-Efficacy, or Self-Regulation.

Table 4.5. Participants' Baseline Characteristics

| **Characteristics** | **Full cohort (n=48)** | **Control Group (n=15)** | **DFFC Group (n=16)** | **DFFC + Text Group (n=17)** | **P-value** (Control Group vs. two intervention groups) |
|---|---|---|---|---|---|
| **Mean Age** (years), range, SD | 24.87, 20-40, 4.21 | 27.79, 22-38, 4.26 | 24.62, 20-40, 4.56 | 23.24, 21-30, 2.41 | 0.0013 |
| **Sex** (n, %) | | | | | |
| Female | 37 (77.08%) | 10 (66.67) | 13 (81.25) | 14 (82.35) | 0.2831 |
| **Race** (n, %) | | | | | 0.0003 |
| Asian | 11 (22.92) | 8 (55.33) | 0 | 3 (17.65) | |
| Black, African American | 3 (6.25) | 2 (13.33) | 0 | 1 (5.8) | |
| White, Caucasian | 34 (70.83) | 5 (33.33) | 16 (100) | 13 (76.47) | |
| **Ethnicity** (n, %) | | | | | 1.0000 |
| Other Hispanic, Latino(a), or Spanish origin | 2 (4.17) | 0 | 2 (12.5) | 0 | |
| Not of Hispanic origin | 46 (95.83) | 15 (100) | 14 (87.5) | 17 (100) | |
| **Health Literacy** (n, %) | | | | | 0.3070 |
| Adequate | 43 (89.58) | 12 (80) | 15 (93.75) | 16 (94.12) | |
| Marginal | 5 (10.42) | 3 (20) | 1 (6.25) | 1 (5.88) | |
| **Enrolled Program** (n, %) | | | | | 0.2770 |
| HCOP | 38 (79.17) | 12 (80) | 12 (75) | 14 (82.35) | |
| AUCON | 4 (8.33) | 0 | 2 (12.5) | 2 (11.76) | |
| VCOM | 6 (12.5) | 3 (20) | 2 (12.5) | 1 (5.88) | |
| **Enrolled in any other organized PA program** (n, %) | | | | | 0.5421 |
| Yes | 7 (14.58) | 0 | 0 | 3 (17.65) | |
| No | 41 (85.42) | 15 (100) | 16 (100) | 14 (82.35) | |
| **Mental Well-being** (mean, SD) | | 53.4 (19.0) | 63.2 (14.22) | 58.6 (12.48) | 0.1188 |
| **Incentive Motivation** (mean, SD) | | 3.41 (0.95) | 3.99 (0.39) | 3.77 (0.65) | 0.0925 |
| **Social Support** (mean, SD) | | 2.4 (1.07) | 2.36 (0.6) | 2.22 (0.74) | 0.7086 |
| **Self-Efficacy** (mean, SD) | | 2.31 (0.89) | 2.55 (0.62) | 2.37 (0.57) | 0.5012 |
| **Self-Regulation** (mean, SD) | | 2.33 (0.82) | 2.18 (0.6) | 2.16 (0.76) | 0.4636 |

### 4.2.3 Path Analysis for Pretest Survey Data

A path analysis model was developed to understand the relationship between Self-Regulation, Incentive Motivation, Self-Efficacy, Social Support, and Physical Activity using the baseline survey data (Figure 4.5). In this model, the arrows indicate the direct effect of Social Support, Self-Regulation, Incentive Motivation, and Self-Efficacy on the endogenous variables

(Self-Regulation, Incentive Motivation, Self-Efficacy, and Physical Activity). As shown in Table 4.6, this model has a mediocre but acceptable fit.

Figure 4.5. Path Analysis of the Effect of Framing on Self-Regulation, Incentive Motivation, Self-Efficacy, Social Support, and Physical Activity (Pre-test Model)

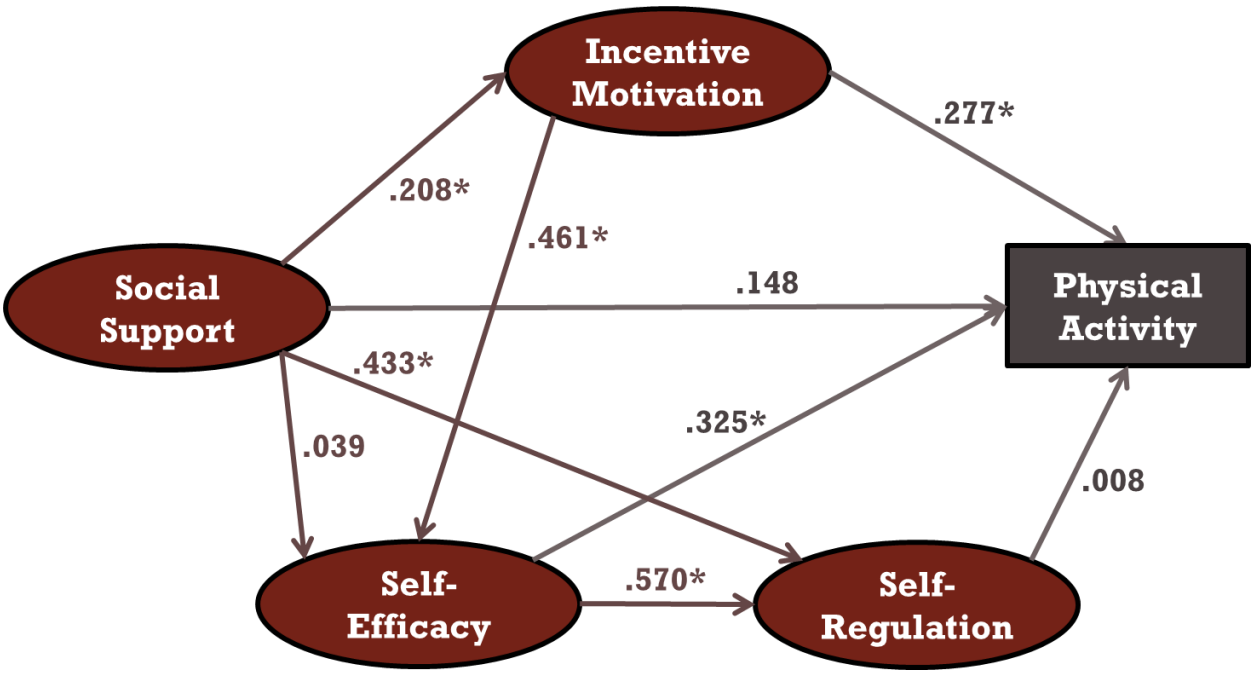



Table 4.6. Pre-test Model Fit Information

| | | |
|---|---|---|
| Chi-Square Test of Model Fit | | |
| | Value | 1.264 |
| | Degrees of Freedom | 1 |
| | P-Value | 0.2609 |
| RMSEA (Root Mean Square Error Of Approximation) | | |
| | Estimate | 0.074 |
| | 90 Percent C.I. | 0.000<br>0.400 |
| | Probability RMSEA <= .05 | 0.289 |
| CFI/TLI | | |
| | CFI | 0.996 |

| | | |
|---|---|---|
| | TLI | 0.960 |
| Chi-Square Test of Model Fit for the Baseline Model | | |
| | Value | 75.771 |
| | Degrees of Freedom | 10 |
| | P-Value | 0.0000 |
| SRMR (Standardized Root Mean Square Residual) | | |
| | Value | 0.022 |
| R-Square | Observed Variable | Estimate |
| | PA | 0.325* |
| | SE | 0.222* |
| | IM | 0.043 |
| | SR | 0.578* |

Table 4.7 shows the standardized total, direct, and indirect effects between variables. Self-Efficacy and Incentive Motivation have a medium direct and significant total effect on Physical Activity, while Social Support and Self-Regulation have a small and non-significant direct and total effect on Physical Activity. Self-Efficacy and Social Support have a large and significant effect on Self-Regulation, and Incentive Motivation has a medium and significant effect on Self-Efficacy.

Table 4.7. Standardized Total and Direct Effects of Pre-Test Model

| | Physical Activity | Self-Regulation | Self-Efficacy | Incentive Motivation |
|---|---|---|---|---|
| Standardized Total Effects | | | | |
| Self-Efficacy | 0.330* | 0.570* | - | - |
| Incentive Motivation | 0.429* | - | 0.461* | - |
| Social Support | 0.254 | 0.509* | 0.135 | 0.208 |
| Self-Regulation | 0.008 | - | - | - |
| Standardized Direct Effects | | | | |
| Self-Efficacy | 0.325* | 0.570* | - | - |
| Incentive Motivation | 0.277* | - | 0.461* | - |
| Social Support | 0.148 | 0.433* | 0.039 | 0.208 |
| Self-Regulation | 0.008 | - | - | - |

Table 4.8 shows the indirect effects between variables. Incentive Motivation has a small but significant indirect effect on Physical Activity through two paths: IM->SE->PA and IM->SE->SR->PA. In addition, Social Support has a small and non-significant indirect effect on Physical Activity and Self-Efficacy.

Table 4.8. Standardized Indirect Effects of Pre-Test Model

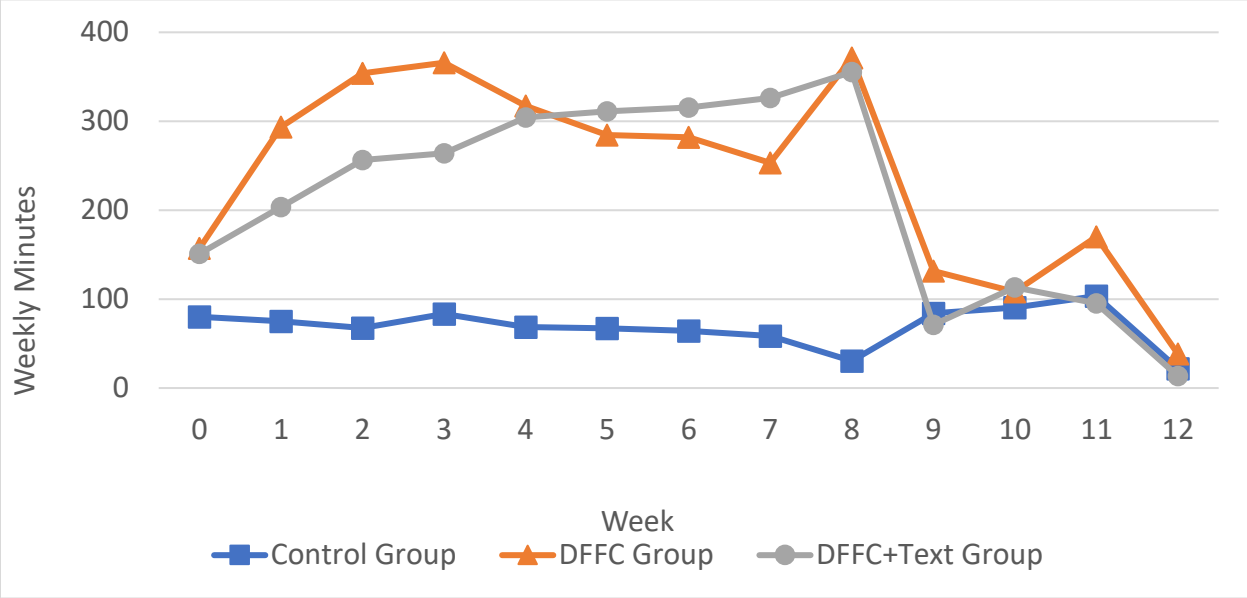
| Standardized Indirect Effects | | | | | | | |
|---|---|---|---|---|---|---|---|
| | Physical Activity | | Self-Regulation | | Self-Efficacy | | Incentive Motivation |
| Self-Efficacy | SE-SR-PA | 0.005 | 0.000 | | - | | - |
| Incentive Motivation | IM-SE-PA | 0.150 | - | | 0.000 | | - |
| | IM-SE-SR-PA | 0.002 | | | | | |
| | Total | 0.152* | | | | | |
| Social Support | SS-SE-PA | 0.013 | SS-SE-SR | 0.022 | SS-IM-SE | 0.096 | 0.000 |
| | SS-IM-PA | 0.058 | | | | | |
| | SS-SR-PA | 0.004 | | | | | |
| | SS-IM-SE-PA | 0.031 | SS-IM-SE-SR | 0.055 | | | |
| | SS-SE-SR-PA | 0.000 | | | | | |
| | SS-IM-SE-SR-PA | 0.0000 | | | | | |
| | Total | 0.106 | Total | 0.077 | | | |

### 4.2.4 Effects of the DFFC and Text Message Interventions on PA

Figure 4.6 presents the weekly MVPA for all three groups from the 0 to 12 weeks of the DFFC. The week-0 data were self-reported as there were from the first survey, which was sent at the beginning of the DFFC, while the week 1–12 data were gathered via the ChallengeRunner app. From the start of the DFFC until the follow-up weeks (weeks 9-12), the Control Group's MVPA remained stable at around 100 minutes per week. However, with the commencement of the DFFC, both the DFFC Group and DFFC + Text Group experienced an increase in their

weekly MVPA. The DFFC + Text Group's MVPA increased until the 8th week, whereas the DFFC Group's MVPA decreased in the third week and again during week 8 of the DFFC.

Figure 4.6. Weekly MVPA Minutes Weeks 0-12




Repeated Measures ANOVA was conducted to test the equality of means between and within subjects. During the 8-week competition (Table 4.9), the effect of the DFFC was significant in weekly MVPA ($p = 0.0006$), indicating there was a significant difference in MVPA between the control group (who did not enroll in the competition) and the participants who enrolled in the competition (DFFC Group and DFFC + Text Group). However, the effect within the subject (Table 4.10) was not significant ($p = 0.6917$), meaning that there was no significant change observed within each group across the competition (week 1-8).

When considering both the 8-week competition *and follow-up weeks* (Table 4.11), the effects of both the DFFC ($p = 0.1149$) and text message interventions ($p = 0.8439$) were not significant in weekly MVPA, suggesting that there was no significant difference in MVPA between the control group (who did not enroll in the competition) and the participants who

enrolled in the competition (DFFC Group and DFFC + Text Group), as well as between the DFFC + Text Group and participants who did not receive text messages (control group and DFFC group). However, the MVPA changed significantly within each group over the entire 12-week period (Table 4.12, p = 0.0009), encompassing both the competition and follow-up phases. This indicates that within each group, there was a significant change in MVPA levels over time (week 1-12).

Also, it is worth noting that the change in mean MVPA across time depended on texting (week 1-8: p = 0.0107; week 1-12: p = 0.0410). Specifically, there was a statistically significant interaction between time and text message intervention on mean MVPA, indicating that the texting intervention had a differential effect on MVPA over time.

Table 4.9. Repeated Measures ANOVA for Between Subjects Effects (DFFC and text, week 1-8)

| Source | DF | Type III SS | Mean Square | F Value | Pr > F |
|---|---|---|---|---|---|
| Text | 1 | 3820.17 | 3820.17 | 0.01 | 0.9058 |
| DFFC | 1 | 3673605.41 | 3673605.41 | 13.64 | 0.0006 |
| Error | 42 | 11313484.12 | 269368.67 | | |

Table 4.10. Repeated Measures ANOVA for Within Subject Effects (Time, week 1-8)

| Source | DF | Type III SS | Mean Square | F Value | Pr > F | Adj Pr > F | |
|---|---|---|---|---|---|---|---|
| | | | | | | **G - G** | **H-F-L** |
| time | 7 | 83293.756 | 11899.108 | 0.68 | 0.6917 | 0.5938 | 0.6082 |
| time*Text | 7 | 329136.122 | 47019.446 | 2.67 | 0.0107 | 0.0395 | 0.0340 |
| time*DFFC | 7 | 118220.610 | 16888.659 | 0.96 | 0.4602 | 0.4246 | 0.4304 |
| Error(time) | 294 | 5168497.139 | 17579.922 | | | | |

Table 4.11. Repeated Measures ANOVA for Between Subjects Effects (DFFC and text, week 1-12)

| Source | DF | Type III SS | Mean Square | F Value | Pr > F |
|---|---|---|---|---|---|
| Text | 1 | 7209.707 | 7209.707 | 0.04 | 0.8439 |
| DFFC | 1 | 485228.340 | 485228.340 | 2.66 | 0.1149 |
| Error | 26 | 4740043.860 | 182309.379 | | |

Table 4.12. Repeated Measures ANOVA for Within Subject Effects (Time, week 1-12)

| Source | DF | Type III SS | Mean Square | F Value | Pr > F | Adj Pr > F | |
|---|---|---|---|---|---|---|---|
| | | | | | | **G - G** | **H-F-L** |
| time | 11 | 638502.424 | 58045.675 | 2.99 | 0.0009 | 0.0185 | 0.0115 |
| time*Text | 11 | 402797.512 | 36617.956 | 1.89 | 0.0410 | 0.1115 | 0.0953 |
| time*DFFC | 11 | 277952.035 | 25268.367 | 1.30 | 0.2232 | 0.2720 | 0.2646 |
| Error(time) | 286 | 5555641.483 | 19425.320 | | | | |

One-way ANOVA was conducted for each week to test the mean of weekly MVPA between the three groups (Table 4.13). From 0-week to 8-week, the mean weekly MVPA was significantly different between the Control and DFFC Group, as well as between the Control and DFFC + Text Group. However, there was no statistically significant difference observed between the two intervention groups. During the follow-up weeks, there was no significant difference found among all three groups.

A paired t-test was performed to compare the weekly MVPA within each week to the first week of the competition ("Within Group" in Table 4.12). There was no statistically significant difference compared to the 1st week for the Control Group. In the DFFC Group, there was no significant difference observed until the 10th week, when weekly MVPA was significantly lower than week 1. In the DFFC + Text Group, the weekly MVPA was significantly

higher than that of the 1st week from week-4 to week-8, but it significantly decreased beginning in week-9.

Table 4.13. Weekly MVPA Minutes Weeks 0-12

| | | | | | | | **Between Group** | | | **Within Group** | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Comparisons significant at the 0.05 level are indicated by *** | | | | | |
| **Week** | Control | SD | DFFC | SD | DFFC + Text | SD | Control -DFFC | Control -DFFC + Text | DFFC-DFFC + Text | Control | DFFC | DFFC + Text |
| **0** | 80.00 | 124.27 | 157.188 | 81.5673 | 150.88 | 90.87 | *** | *** | | | | |
| **1** | 75.07 | 103.47 | 293.32 | 215.69 | 203.38 | 125.92 | *** | *** | | | | |
| **2** | 67.50 | 112.45 | 354.01 | 298.18 | 256.35 | 186.00 | *** | *** | | 0.6205 | 0.3575 | 0.1615 |
| **3** | 83.43 | 107.06 | 365.72 | 294.40 | 264.15 | 194.04 | *** | *** | | 0.2636 | 0.4262 | 0.192 |
| **4** | 68.46 | 122.42 | 317.22 | 279.37 | 304.42 | 215.15 | *** | *** | | 0.795 | 0.9012 | 0.0451 |
| **5** | 67.29 | 120.38 | 284.47 | 311.02 | 311.19 | 241.94 | *** | *** | | 0.5131 | 0.9014 | 0.049 |
| **6** | 64.43 | 104.16 | 282.06 | 210.92 | 315.31 | 241.65 | *** | *** | | 0.5259 | 0.8023 | 0.0443 |
| **7** | 58.71 | 86.25 | 253.28 | 285.41 | 326.26 | 219.05 | *** | *** | | 0.3319 | 0.5373 | 0.0337 |
| **8** | 30.57 | 117.56 | 371.06 | 358.43 | 355.38 | 251.81 | *** | *** | | 0.0797 | 0.5208 | 0.0232 |
| **9** | 84.20 | 126.82 | 131.71 | 136.37 | 71.30 | 64.87 | | | | 0.673 | 0.0534 | 0.0001 |
| **10** | 90.60 | 182.89 | 108.21 | 109.02 | 113.27 | 124.32 | | | | 0.4518 | 0.0194 | 0.0041 |
| **11** | 103.40 | 25.04 | 170.21 | 165.01 | 95.16 | 93.40 | | | | 0.4447 | 0.0329 | 0.0004 |
| **12** | 21.80 | 124.27 | 38.36 | 44.67 | 13.43 | 16.32 | | | | 0.227 | 0.0005 | <.0001 |

### 4.2.5 Effects of the DFFC and Text Message Interventions on Mental Well-being, Incentive Motivation, Social Support, Self-Efficacy, and Self-Regulation.

One-way ANOVA and mediation models were performed to determine if Mental Well-being, Incentive Motivation, Social Support, Self-Efficacy, and Self-Regulation were significantly different between three groups using data from the second survey. Table 4.14 presents the posttest scores and the difference between posttest and pretest scores for the three groups. Only the Incentive Motivation score was significantly different between the three groups.

Table 4.14. Scores for Mental Well-being and Social Cognitive Outcomes After Intervention

| **Mental Well-being** | | | | |
|---|---|---|---|---|
| | Control Group | DFFC Group | DFFC + Text Group | P-value |
| **Posttest score** | 58.6 (22.83) | 66.6 (18.83) | 66.2 (13.84) | 0.373 |
| **Post test score minus pretest** | 5.2 | 3.4 | 7.6 | |
| **Incentive Motivation** | | | | |
| **Posttest score** | 3.24 (1.13) | 4.17 (0.57) | 3.82 (0.59) | 0.006 |
| **Post test score minus pretest** | -0.17 | 0.18 | 0.05 | |
| **Social Support** | | | | |
| **Posttest score** | 2.37 (0.84) | 2.82 (1.01) | 2.50 (1.03) | 0.647 |
| **Post test score minus pretest** | -0.03 | 0.46 | 0.28 | |
| **Self-Efficacy** | | | | |
| **Posttest score** | 2.05 (0.79) | 2.78 (0.98) | 2.65 (0.90) | 0.058 |
| **Post test score minus pretest** | -0.26 | 0.23 | 0.23 | |
| **Self-Regulation** | | | | |
| **Posttest score** | 2.18 (1.33) | 2.58 (1.19) | 2.40 (0.83) | 0.559 |
| **Post test score minus pretest** | -0.15 | 0.40 | 0.24 | |

Table 4.15 shows the results of one-way ANOVA, indicating a significant difference for Incentive Motivation between Control Group and DFFC Group (95% CI, 0.2561-1.6048), but not between DFFC Group and DFFC + Text Group (95% CI, -0.2984-0.9812) or between Control Group and DFFC + Text Group (95% CI, -0.0507-1.2288).

Table 4.15. One-way ANOVA with Multiple Comparisons for Mental Well-being and Social Cognitive Outcomes

| **Mental Well-being** | | | |
|---|---|---|---|
| **Group Comparison** | Difference Between Means | 95% CI | |
| **DFFC - DFFC + Text** | 0.0150 | -0.7307 | 0.7607 |
| **DFFC - Control** | 0.4000 | -0.3860 | 1.1860 |
| **DFFC + Text - Control** | -0.0150 | -0.7607 | 0.7307 |
| **Incentive Motivation** | | | |
| **DFFC - DFFC + Text** | 0.3414 | -0.2984 | 0.9812 |
| **DFFC - Control** | 0.9305 | **0.2561** | **1.6048** |
| **DFFC + Text - Control** | 0.5891 | -0.0507 | 1.2288 |
| **Social Support** | | | |
| **DFFC - DFFC + Text** | 0.3127 | -0.4986 | 1.1240 |
| **DFFC - Control** | 0.2060 | -0.6492 | 1.0611 |
| **DFFC + Text - Control** | -0.1067 | -0.9180 | 0.7046 |
| **Self-Efficacy** | | | |
| **DFFC - DFFC + Text** | 0.1295 | -0.5956 | 0.8546 |
| **DFFC - Control** | 0.7300 | -0.0343 | 1.4943 |
| **DFFC + Text - Control** | 0.6005 | -0.1246 | 1.3256 |
| **Self-Regulation** | | | |
| **DFFC - DFFC + Text** | 0.1851 | -0.6714 | 1.0416 |
| **DFFC - Control** | 0.4048 | -0.4981 | 1.3077 |
| **DFFC + Text - Control** | 0.2197 | -0.6369 | 1.0762 |

Figures 4.7-4.101present the mediation models for Mental Well-being, Incentive Motivation, Social Support, Self-Efficacy, and Self-Regulation. For each model, the independent variable is Group, the dependent variable is Physical Activity, and the mediator variables are Mental Well-being, Incentive Motivation, Self-Efficacy, Social Support, and Self-Regulation, respectively. Group impacts Physical Activity in all five models, as evidenced by the significant relationship between Group and PA in all models. The effect of Group is mediated by Self-Efficacy (Figure 4.8) and Incentive Motivation (Figure 4.9), but there is no evidence that this effect is mediated by Mental Well-being, Social Support, or Self-Regulation.

Figure 4.7. Mediation Model for Mental Well-being

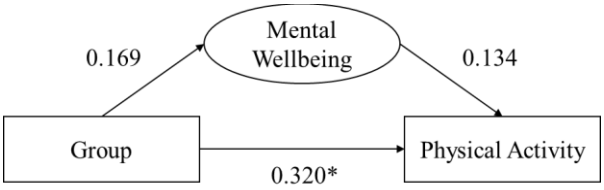



Figure 4.8. Mediation Model for Self-Efficacy

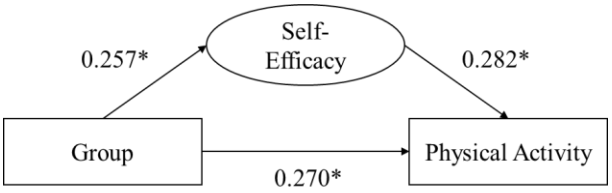



Figure 4.9. Mediation Model for Incentive Motivation

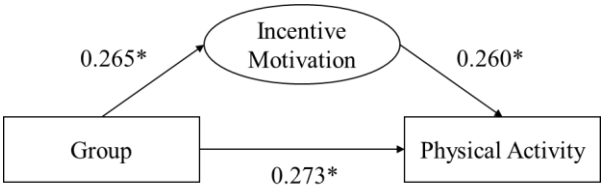



Figure 4.10. Mediation Model for Self-Regulation

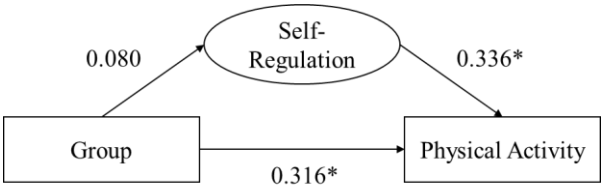
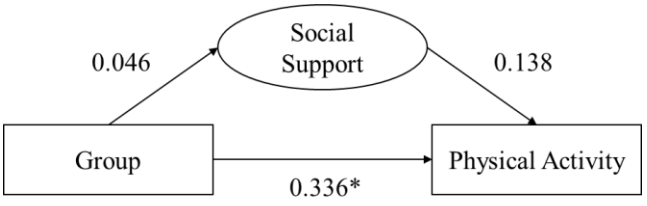



Figure 4.11. Mediation Model for Social Support

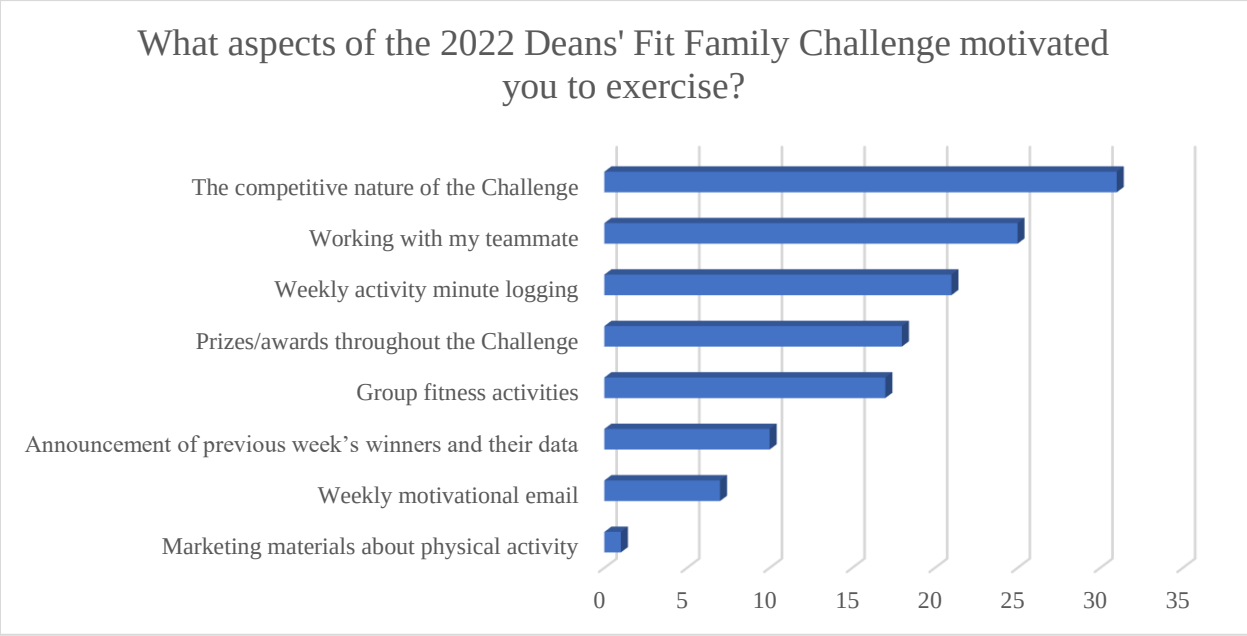


### 4.3 Aim 2.2

#### 4.3.1. Feedback and Satisfaction in DFFC

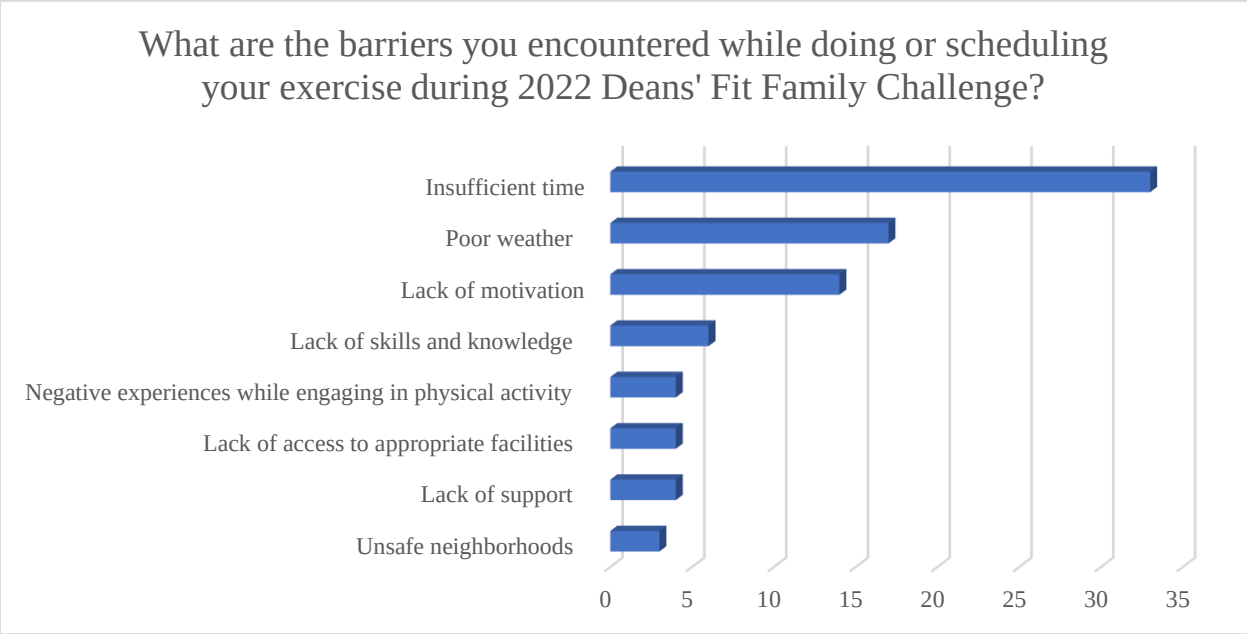
DFFC participants identified several positive and negative factors influencing their adherence and commitment to regular exercise (Figure 4.12). They were allowed to pick multiple or all factors that influenced their participation from the given list. A majority of participants (86.11%) in the DFFC Group and the DFFC + Text Group indicated that their exercise was motivated by the competitive nature of DFFC. Working with teammates (69.44%) and weekly activity logging (58.33%) were also reported by students to motivate their exercise, as well as prizes throughout the DFFC (50%), group fitness activities (47.22%), and announcement of previous week's winners and their data (27.78%). In addition, the weekly motivational email (19.44%) and marketing materials (2.78%) were mentioned by some students.

Figure 4.12. Motivators of Exercise Among DFFC Participants



As shown in Figure 4.13, the primary barriers to exercise identified by participants included insufficient time for exercising (91.67%), poor weather (47.22%), and decreased motivation (38.89%). Other barriers that made doing or scheduling exercise difficult during DFFC included lack of skills and knowledge (16.67%), lack of support (11.11%), lack of access to appropriate facilities (11.11%), negative PA experiences (11.11%), and unsafe neighborhoods (8.3%).

Figure 4.13. Barriers of Exercise Among DFFC Participants




Responses to two open-ended questions provided insight into aspects of the 2022 DFFC participants enjoyed the most and which aspects they would like to change (Table 4.16). Many students described how they enjoyed the group fitness activities and working together with teammates, peers, and friends, which kept them motivated and engaged. For some students, participating in the fitness competition improved their awareness of their fitness and wellness. The ChallengeRunner leaderboard feature was also popular, as they were excited to see their

minutes and rankings compared to the other participants. However, some students were discouraged when they were unable to keep up with other teams' accomplishments, and some students doubted the methods of ensuring the authenticity and trustworthiness of the minutes data. Other suggestions included incorporating more activities (such as workout videos, strength exercises, and time management skills) into the DFFC and optimizing the timeframe of the DFFC to make it more manageable.

Table 4.16. Excerpts from Open-Ended Questions

| | Aspect of 2022 DFFC | Excerpt from responses |
|---|---|---|
| Things they like | Group fitness activities | I enjoyed the fitness classes. It was nice to try things I have never done before. |
| | | I enjoyed the fact that I had a teammate that kept me motivated and doing group fitness activities! |
| | Working with teammates | It always motivates me when I have other people doing it with me. |
| | | I enjoyed the fact that I had a teammate that kept me motivated and doing group fitness activities! |
| | | I enjoyed communicating with my team-mate on the exercise we had been doing |
| | Competitive atmosphere | I enjoyed seeing the leaderboard and seeing where other teams were at for motivation |
| | | I enjoy tracking my minutes and seeing our team go up the rankings |
| | | Having a partner and seeing the leaderboard over time. |
| | Minutes logging | I was able to see how much I actually work out |
| | | (I like) logging minutes with my partner/ registering minutes completed each day |
| | | I enjoyed logging the minutes because it was rewarding/positive reinforcement! |
| | Awareness of fitness and health | I enjoy the fitness challenge because it keeps me aware of my movement, even if I'm unable to do a physical activity for that day, I can recognize when I haven't moved enough during the day |
| | | I enjoyed the competition. I thought that I was going to do much better. I am however grateful for the challenge because it prompted me to visit my doctor when I wasn't losing any weight and realized I have issues with my thyroid causing me to gain excessive weight, so now it's |

| | | |
|---|---|---|
| | | being treated appropriately. Even though I didn't lose weight I still enjoyed the fun of it! |
| Ways to improve | Competitive atmosphere | We got discouraged being able to see what the other teams were doing each day or week. When we felt we couldn't catch up, we lost motivation to try. |
| | | (I) was discouraging to see them put up such high numbers. |
| | Complaint about the ChallengeRunner app | Maybe include optional workout videos to follow |
| | | Easier way to ensure people are truthful about minutes tracked. |
| | | The app is very outdated |
| | | Some kind of accountability measure. I like being able to enter in my own minutes because I wasn't always able to wear my watch when I was doing physical activities. However, people were abusing this because I found it hard to believe that 2 people were averaging 2 1/2 hours of exercise per day consistently over multiple weeks when at least one of the members was in school. This just didn't seem very realistic to me |
| | More activities in DFFC | Offer time management skills on how to incorporate exercise in your daily routine |
| | | I think it would be nice to have a group fitness class on learning about the movements of strength exercises. Like how to do exercises and when to do them for optimal benefits |
| | | I think it would be interesting to somehow include the hours slept in the Dean's Challenge. |
| | Timeframe | I think making the DFFC challenge a longer period of time would be a great idea. It kept us motivated so the longer the better. |
| | | I would make it 6 weeks instead of 8 weeks. It is hard to keep up motivation and not get bored after that long! |

Among 36 DFFC participants in DFFC Group and the DFFC + Text Group, 33 (91.67%) students were very satisfied or somewhat satisfied with the 2022 DFFC (Figure 4.14), and 31 students stated that they were extremely likely to participate in the 2023 DFFC, if eligible (Figure 4.15).

Figure 4.14. Overall Satisfaction of DFFC

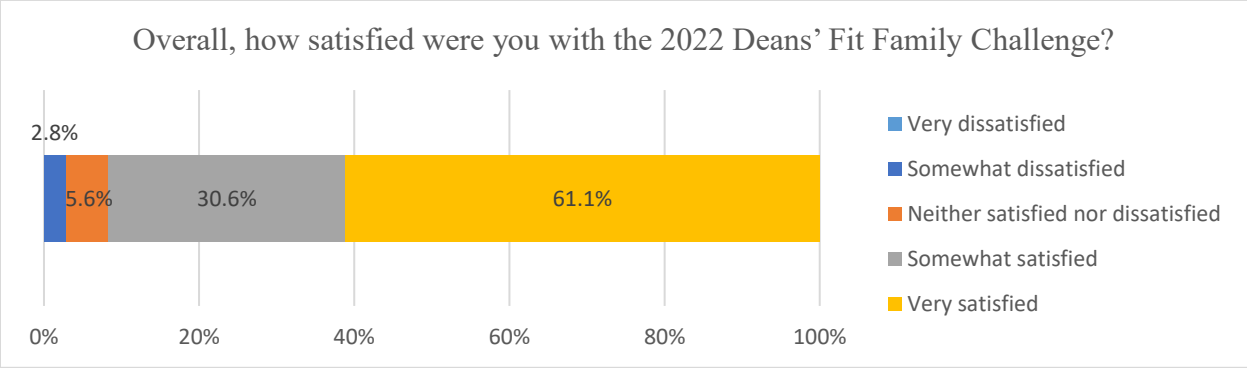
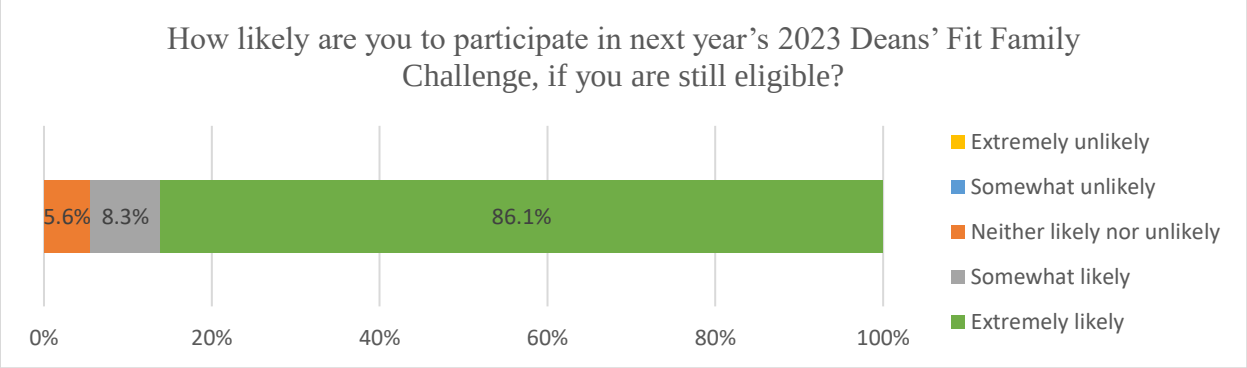



Figure 4.15. Intentions to Participant in 2023 DFFC




### 4.3.2 Feedback and Satisfaction of Text Message Interventions

Among the 20 participants in the DFFC + Text Group who received three text messages each week, 11 (55%) students reported that the messages were very helpful or helpful in *motivating them to start* exercising, but less than 40% of students reported that messages were very helpful or helpful in *motivating them to do more* exercise (35%) and helping them *achieve the recommended PA goal* (25%) (Figure 4.16).

Figure 4.16. Acceptability of Text Message Interventions

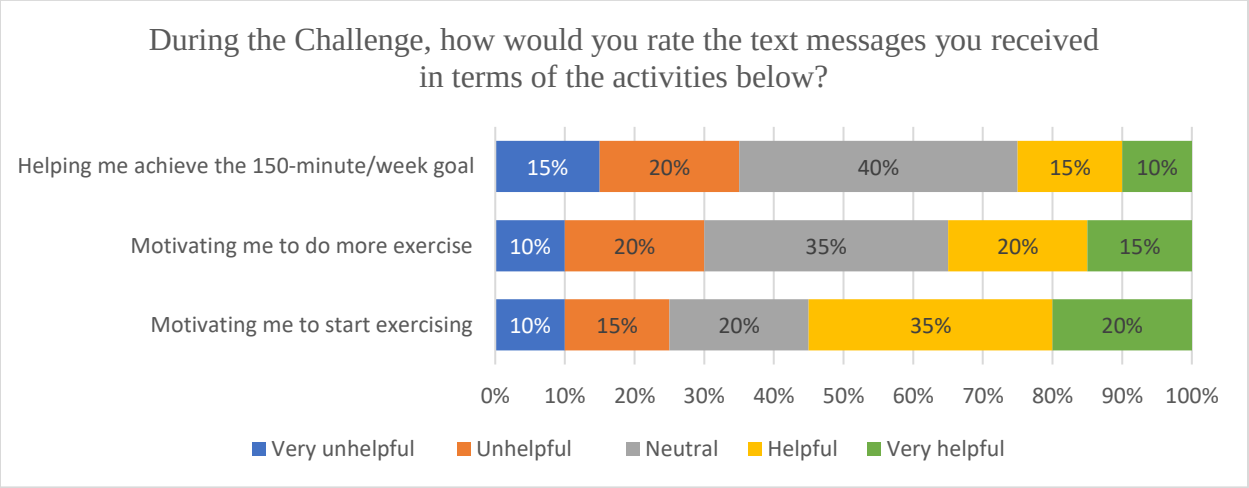
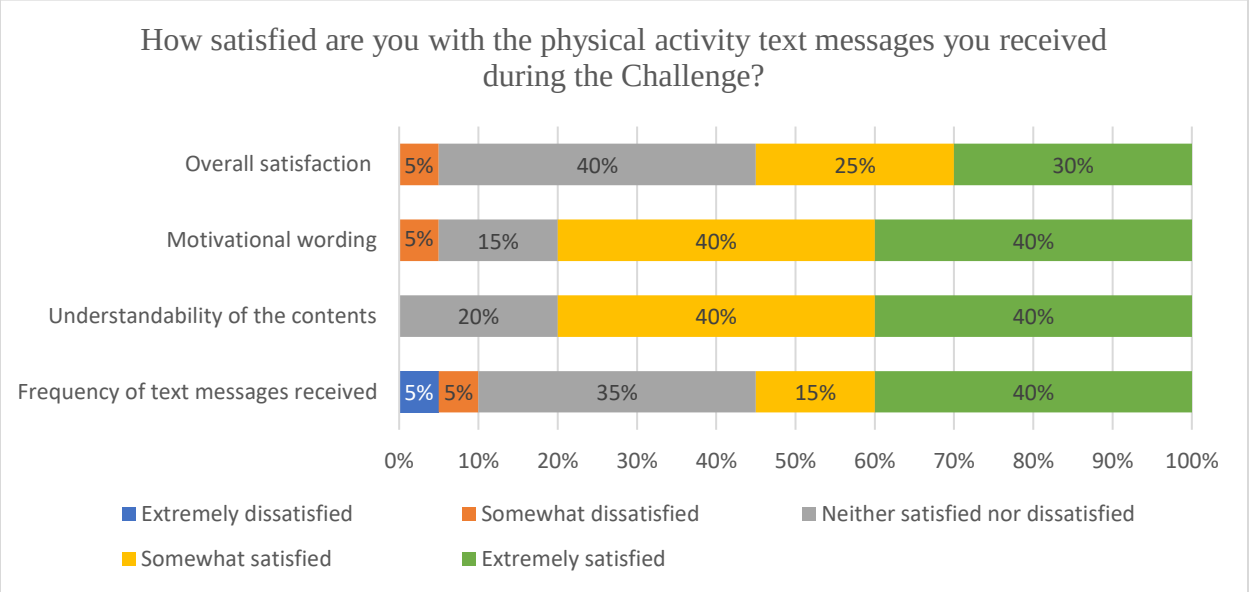



Figure 4.17 indicates that the overall satisfaction with text message interventions was 55% of 20 participants. There were 16 (80%) students who were extremely or somewhat satisfied, while two (10%) students were extremely or somewhat unsatisfied with the frequency of text messages, which was three messages per week.

Figure 4.17. Overall Satisfaction of Text Message Interventions



## 4.4 Summary

In summary, both competition-based and text message interventions were found to be effective and acceptable in promoting physical activity among university students. During the DFFC competition, the mean weekly MVPA was significantly different between the Control Group and two intervention groups. There was statistically significant difference in post-intervention Incentive Motivation among three groups, but not for Mental Well-being, Social Support, Self-Efficacy, and Self-Regulation. Self-Efficacy and Incentive Motivation have a medium direct and significant effect on Physical Activity. The effect of interventions was mediated by Self-Efficacy and Incentive Motivation.

# Chapter 5. Discussion

The objectives of this study were 1) to conduct a systematic review and meta-analysis of text message interventions targeting physical activity among university students from published literature, and 2) to assess and compare the effectiveness of text message interventions and a competition-based intervention in improving physical activity among university students, and evaluate participants' acceptability and experiences of the text message interventions and the competition-based intervention. The findings of the first objective were used to develop text messages used in the second aim. Objective two was accomplished through a quasi-experimental study among HCOP, AUCON, and VCOM-Auburn students. The interventions were eight weeks long with four weeks of follow-up, and the primary outcome (weekly MVPA) was measured repeatedly for 12 weeks. This chapter discusses the findings and implications of each aim.

## 5.1 Aim 1

This aim involved a systematic review and meta-analysis of literature focusing on text message interventions in promoting PA among university students. The results indicated that text message interventions have a significant, medium effect on MET (SMD = 0.67, 95% CI = 0.49, 0.85, $p < 0.01$) according to Cohen's criteria.[43] However, positive effects of text message among university students have not been observed on BMI (SMD = -0.15, 95% CI = -0.32, 0.02, $p = 0.08$).

### 5.1.1 Discussion of Systematic Review and Meta-Analysis Findings

The findings of the current study provide a valuable extension of recent systematic reviews and meta-analysis. Previous studies of text message interventions predominantly focused on the general population[179], or a broader group of interventions.[144,332] In 2013, Buchholz et al.

conducted a systematic review on PA text message interventions in adults. The median effect size for ten included studies was 0.5.[179] Maselli et al. synthesized the evidence from 27 controlled trials among university students in 2018, and 16 of included studies reported increased PA levels.[144] Peng et al. updated the search in 2022, focusing on e-health interventions on PA and sedentary behavior in college students.[332] There were 22 RCTs included, but only two of them included text message.[326,330] A small-to-medium but significant improvement was found in PA for the experimental group at post-intervention compared to the control group (SMD = 0.32, 95% CI: 0.19, 0.45, $p < 0.001$). Specifically, positive effects were observed on total PA (SMD = 0.34, 95% CI: 0.10, 0.58, $p = 0.005$), MVPA (SMD = 0.17, 95% CI: 0.01, 0.32, $p = 0.036$), and steps (SMD = 0.75, 95% CI: 0.23, 1.28, $p < 0.001$). In addition, literature also suggested that text messaging also resulted in improvements in other health outcomes in university students, including decreased alcohol consumption[333], mental problems[334,335], and nutritional behaviors.[336] Compared with previous evidence, the current systematic review and meta-analysis focused specifically on text messaging and university students, narrowing the scope of interventions and the target population. While significant differences were not observed in some outcomes, the potential PA benefits of text message interventions should continue to be studied, such as potential reduction in BMI.

Because of the flexibility of text message interventions[229], they can be implemented in a variety of PA program structures, including those designed for university students. The data suggested that university students possess a high level of electronic device ownership and enthusiasm for new technologies, making them a suitable population for the widespread implementation of text message interventions on campus.[229] However, the results of previous reviews also identified several gaps in the existing evidence, such as limited information about

desired content of text messages, limited long-term evidence, and risk of bias of the studies.[144,332,335] There are eleven studies[133,137,140,269,270,321-323,327,328] in this systematic review that provided the content of texts used in their interventions, but the majority of them did not offer detailed information on how these text messages were developed. Informed by the COM-B model, Castro and colleagues developed a set of 24 text messages that encompassed four key domains: nudge messages, health-related messages, psychological well-being messages, and productivity messages.[133] Reese and colleagues developed the text messages through an iterative process involving participant input, ranking, group discussion, editing, and refinement based on feedback obtained from the nominal group technique sessions and subsequent focus groups.[325] Out of the twenty studies included in this review, only two had a duration of over twelve months (one lasting eighteen months[324] and one lasting 24 months[319]). Most studies lasted no more than eight weeks, which made it difficult to assess the engagement and retention of the interventions. Research demonstrates that the duration of the program may affect the program engagement and retention, as shorter interventions and higher level of completion were associated with better outcomes.[337,338]

### 5.1.2 Quality and Bias Assessment

The quality of included studies was assessed, indicating potential sources of bias, including lack of blinding and adherence in RCTs, and confounding factors in quantitative nonrandomized studies. These limitations in study design were also reported in previous reviews, highlighting the need for future research with well-controlled designs to address and improve the research quality.[144,229]

Additionally, the method of measuring PA was not consistent across the included studies, limiting the comparability of some outcomes and the number of studies in meta-analysis. For

some outcomes, such as sitting time, walking time, standing time, and BMI, the measurements were standardized using the same units (minutes or hours per day; $kg/m^2$). However, it is more complex to measure other variables, such as physical activity time. For example, the International Physical Activity Questionnaire (IPAQ)[100] were used in some RCTs to calculate the total MET, including LPA, MPA, and VPA. In contrast, Cotton et al.'s study measured LPA using a sedentary and light-intensity physical activity questionnaire[269,339], and MPA was measured using the seven-day physical activity recall questionnaire.[340] IPAQ was also used in one quasi-experimental study, but the authors reported the time of LPA, MPA, and VPA instead of calculating the total MET. Keahey and colleagues used the Physical Activity and Sedentary Behavior Questionnaire[341] to measure the MVPA, which cannot be compared with MPA or VPA directly.[270] Furthermore, some RCTs examined the effect of text message interventions using statistical models, without providing the numerical data on actual PA levels. For example, Figueroa and colleagues used the generalized estimating equations (GEE) models to evaluate the effect of several covariates (e.g., feedback and motivational messages) on steps.[329] They estimated that a motivational message increased 717 steps after controlling interactions ($p = .083$, $\delta = .144$).[329] IPAQ was also used in this study but neither the PA minutes nor MET were reported.

Different methods of measurement, particularly for outcomes which were measured subjectively, may introduce bias. For instance, while the IPAQ demonstrated acceptable validity assessing PA in older adolescents[342] and healthy adults[343], it may not be an accurate measure for PA or sedentary behavior in other populations. For example, Cleland and colleagues found that additional clarification is needed to ensure a more accurate and nuanced assessment of physical activity levels among older adults.[344] Similarly, the modified version of the IPAQ and the IPAQ

Short Form were found to be inadequate for measuring total physical activity in young teens.[342,345] Related, the 9-item IPAQ - Short Form (IPAQ-SF) was found to "overestimate" PA by an average of 84% compared to objective criteria.[346]

### 5.1.3 Implications and Future Directions

Text message interventions showed promising results in increasing PA among university students, and the success of these interventions is dependent on the contents and timing of text messages which should be tailored to the needs and preferences of participants. To address current limitations and challenges of text message interventions among university students, future studies should investigate the effects of longer-duration text message interventions with larger sample sizes and well-controlled designs. Also, characteristics of effective text messages among university students should be examined, including the interactional content, frequency, timing, and duration. Furthermore, studies could consider the potential benefits of combining text message interventions with other strategies, such as wearable fitness trackers, one-on-one consulting sessions, and group-based interventions. Table 5.1 below summarizes effective strategies for text messaging university students for physical activity purposes.

Table 5.1. Effective Strategies for Text Messaging University Students for PA Purposes

| | |
|---|---|
| Personalization | Tailor and personalize messages to individual students, addressing their specific needs, preferences, and goals.<br>Customize frequency and time to receive texts. |
| Goal Setting | Help students set realistic and achievable PA goals, providing guidance and support in developing exercise plans. |
| Reminders | Timely reminders about scheduled PA and tracking progress |
| Motivation | Share fitness tips and ideas to keep students engaged and prevent boredom.<br>Introduce new PA opportunities or challenges |
| Two-Way Communication | Provide positive feedback and words of encouragement to boost students' confidence<br>Students can reply to messages, ask questions, seek guidance, or share their experiences |

### 5.1.4 Strengths

This review is the first systematic review and meta-analysis to assess the effectiveness of text message interventions among university students in promoting physical activity, including both quantitative, qualitative, and mixed-method studies. It provides valuable insights and updated evidence on text message interventions for PA among university students, supporting the potential of text message as a tool for promoting PA. Considering the prevalence of physical inactivity in this population, the findings of the study strengthen the understanding of how text message programs can be implemented and utilized in academic settings. The review also informs the development of evidence-based interventions to improve PA in university students. Additionally, the study highlights the importance of standardized and objective measurements for PA to control the study bias. Overall, the study contributes to the growing body of evidence supporting the use of text message interventions as a feasible and effective strategy for promoting physical activity among university students.

### 5.1.5 Limitations

This review also has several limitations to consider. First, similar to all systematic reviews, our search might have missed relevant studies in other languages, published after our data extraction date, or not indexed in the search engines or databases. Second, despite narrowing the search to target PA interventions with text messages for university students, the heterogeneity of study designs, qualities, outcome measurements, and intervention length among the included articles may have impacted the synthesis of findings. Third, the number of studies that were eligible for meta-analysis was limited, making it difficult to estimate between-study heterogeneity and potentially leading to biased estimates and narrow confidence intervals.[347,348]

Meanwhile, publication bias cannot be assessed for non-randomized studies or in meta-analyses of less than ten included studies because of confounders and the lack of power.[349]

## 5.2 Aim 2

The purpose of this quasi-experimental study was to assess and compare the effectiveness of a competition-based intervention and text message interventions among university students and evaluate participants' acceptability and experiences. Our findings suggest that both competition-based and text message interventions were effective and acceptable in increasing physical activity among university students, and Self-Efficacy and Incentive Motivation were important factors in promoting engagement in physical activity.

### 5.2.1 Effects, Experience, and Satisfaction with the DFFC

During weeks 0-8 of the DFFC, there were statistically significantly higher weekly MVPA minutes in the DFFC Group and DFFC + Text Group compared to the Control Group. These findings suggest an association between participation in the DFFC – either alone or in combination with text messages – and increased MVPA during the early and middle stages of the study. However, among the DFFC Group, no significant differences were observed in MVPA for weeks 1-8 compared to the first week. The DFFC Group and DFFC + Text Group showed increases in scores on the post-DFFC survey for Mental Well-being, Incentive Motivation, Social Support, Self-Efficacy, and Self-Regulation compared to the baseline. However, only the differences in Incentive Motivation scores between the Control Group and DFFC Group, as well as between the Control Group and DFFC + Text Group, were statistically significant.

The overall trend of MVPA minutes during this year's DFFC is comparable to the previous three years (2019-2021). The initial increases in MVPA in the DFFC Group and DFFC + Text Group during the first three weeks of DFFC likely reflect participants' motivation and

enthusiasm for the competition. According to participant feedback, the key strategies employed by the DFFC to motivate participants to exercise centered on the competitive nature of the fitness competition, followed by teamwork and tracking physical activity. These findings are consistent with existing literature, which suggests that competitive environments could encourage individuals to set goals and promote PA among competitive people.[33,34,153,155,156]

However, the MVPA in the DFFC Group decreased beginning in week-4. Potential explanations for the observed decrease could relate to discouragement and self-doubt. Specifically, falling behind other teams in the first few weeks of DFFC may have a negative impact on participants' motivation to engage in the competition. Other potential explanations include concerns about data authenticity submitted by other participants, technical difficulties with the ChallengeRunner app, and competing demands for participants' time as the academic semester neared its conclusion. Previous studies found that competition could discourage individuals who did not meet their goals, feel overwhelmed, or are unable to win.[159,161-163]

The maximum reported MVPA was in week-8 in both the DFFC Group and DFFC + Text Group, followed by a sharp drop. During the follow-up weeks (weeks 9-12), there was no statistically significant difference between all three groups in weekly MVPA. Compared to the week-1, both the DFFC Group and DFFC + Text Group experienced a statistically significant decrease in weekly MVPA in weeks 9-12. This could possibly be attributed to the assessment week for Doctor of Pharmacy students (week 9), Thanksgiving break (week 10), and final weeks for graduate students (week 11-12). According to the Fogg Behavior Model, three main components that explain human behavior: Motivation, Ability, and a Prompt. Motivation refers to an individual's willingness to perform a behavior; ability represents the individual's capability to behave; and a prompt is a cue that reminds a person to engage in a particular behavior.[350]

During weeks 9-12, participants' physical activity levels decreased compared to weeks 1-8. In the context of the Fogg Behavior Model, participants' motivation may have decreased because the competition concluded, leading to their reduced engagement in physical activity. Second, participants may not have been able to exercise due to semester exams, travel, and holiday breaks. Also, the lack of a prompt (email and text) after the intervention may have deprived them of a cue or reminder to engage in physical activity. Our apparent challenge of participant retention during the last few weeks of the semester was consistent with findings in previous research. A literature review on website-delivered physical activity interventions revealed that sample attrition rates varied from 7% to 69% across 15 studies, with an average attrition rate of 27%.[351] A 12-week study among 117 first-year students tested monetary incentives to boost fitness-center use and found that weekly incentives increased goal achievement.[352] However, attendance declined noticeably during weeks 10 to 12 in the presence of incentivs.[352] Compliance remained high in a 50-day online social networking physical activity intervention involving 51 adults, but engagement steadily declined throughout the duration.[353] It is noteworthy that some participants in DFFC Group and DFFC + Text Group recommended extending the duration of the competition, while others suggested shortening it to maintain motivation. Additionally, it is important to consider the potential bias introduced by missing data due to sample attrition, given that the follow-up rate was about 70% in the DFFC Group and DFFC + Text Group and less than 30% in the Control Group.

Overall, satisfaction with the DFFC was high, and most participants indicated they were extremely likely or somewhat likely to participate in the 2023 DFFC. The popularity of the DFFC demonstrates the fitness tracking and competition programs in motivating participants and helping them maintain an active and healthy lifestyle. Likewise, Chung's study on tracking tools

in workplace wellness programs revealed that 66% of participants found these programs useful in supporting their health goals, and 78% of participants expressed their willingness to recommend health tracking programs to their colleagues.[354]

### 5.2.2 Effects, Experience, and Satisfaction with Text Message

Starting from week 4 of the DFFC, participants in the DFFC + Text Group demonstrated a statistically significant increase in weekly MVPA minutes compared to week 1. During the competition and follow-up weeks, there was a significant interaction between time and text message intervention on mean MVPA, indicating the impact of the text message interventions on MVPA varied across different time points. However, the one-way ANOVA analysis did not reveal a statistically significant difference in MVPA minutes between the DFFC Group and DFFC + Text Group during the competition and follow-up period. Additionally, there was no statistically significant difference in Mental Well-being, Incentive Motivation, Social Support, Self-Efficacy, and Self-Regulation between the DFFC Group and DFFC + Text Group in mean scores on the post-DFFC survey.

The MVPA minutes in DFFC + Text Group decreased in week 9 when text messages were no longer sent to participants. As shown in previous research, text message interventions could be an effective alternative in dealing with current challenges and barriers faced by university students when seeking assistance with their physical activity.[36,170,171,179-183] Nevertheless, we also found that the text message interventions did not lead to significant increase MVPA or sustained maintenance in PA during the intervention and follow-up weeks. In addition to previously mentioned explanations such as holidays, end of semester deadlines, and exams, it could result from the relatively short duration of our text message interventions (7 weeks) and the potential inherent limitations of this approach. A systematic review of PA text

message interventions indicated that adults may benefit from the "newness" of using text messages to affect PA.[179] Compared to using texts alone, text message interventions featuring multiple components, such as educational sessions, phone/video calls, email messages, and self-monitoring equipment, resulted in larger but non-significant effect sizes.[229] The effectiveness of text messages also varies across different outcome measures. In the Aim 1 meta-analysis, we found evidence for a positive effect of text message interventions in MET, but not for other outcomes. However, our quasi-experimental study did not find evidence supporting the effectiveness of the text message intervention significantly increasing MVPA. One potential reason could be our limited sample size and short duration, which may not have been large enough or long enough to detect a significant effect. Also, the present study included a competition + text group instead of the text-only group. It is possible that the impact of the text message intervention could have been overshadowed by the influence of the fitness competition. Furthermore, in Aim 1, text messages were sent alongside other fitness programs in some studies, making it uncertain whether the observed effects were solely attributable to the text messages or influenced by other concurrent interventions. Additionally, our quasi-experimental study only recruited health professional students, whereas the systematic review included all university students, which limits the generalizability of our findings to the broader university student population. A recent meta-analysis also reported that text message interventions resulted in a significant increase in daily steps (d=0.38, n=10 studies) but a non-significant increase in MVPA (d=0.31, n=5 studies).[229]

In DFFC + Text Group, 80% of participants reported that they were satisfied with the understandability and motivational wording of the messages they received, and more than half found the texts helped motivate them to *start exercising*. While developing these messages, we

followed established guidelines from prior investigations, such as using positive framing,[180,181] incorporating humor and emoticons, and avoiding delivery during early morning or late night hours.[132,270,276,325] However, it is noteworthy that less than 40% of participants in the DFFC + Text Group found the messages helpful in motivating them to *engage in more PA* or *achieve PA goals*. One possible explanation for this negative experience could be a lack of personalization and contextualization in text message content.[329] For example, Figueroa et al. interviewed participants in a PA intervention using a mobile application and found that some texts, such as "you can do better!", were annoying and unhelpful without any introduction to "do better." In our study, we also noted some similar contexts, like "You've got this!", which may not be very useful for university students to promote PA.[329] Also, in our developed messages, we prioritized and emphasized the concept of "starting to exercise" over engaging in more exercise or achieving PA goals. However, it is important to acknowledge that participants in the DFFC may possess a high level of self-motivation for PA and seek guidance on how to exercise more and attain their PA goals. In addition, some messages we sent included more than two sentences, which was not recommended in the previous research. Overall, the satisfaction of text messages was acceptable.[325]

### 5.2.3 Roles of Incentive Motivation and Self-Efficacy

The results of this study revealed that both Self-Efficacy and Inventive Motivation exerted a moderate but significant impact on PA among university students, and these two factors mediated the effects of interventions on PA. In the context of physical activity, Self-Efficacy is the belief that one can successfully engage in adequate exercise and maintain an active lifestyle, and individuals with high PA Self-Efficacy are more likely to establish PA goals and exhibit perseverance in the face of obstacles.[221,228,355] Research demonstrates that Self-

Efficacy is a strong predictor of PA in university students.[124,223,228,356] A literature review published in Lancet in 2012 highlighted that both health status and self-efficacy show the strongest associations with physical activity among adults.[206] In the mediation analysis of Aim 2, we found that the effect of interventions was mediated by Self-Efficacy, which is consistent with previous studies.[355,357-359] Additionally, Self-Efficacy and Social Support were found to have a large and significant effect on Self-Regulation in the path analysis of Aim 2. This is consistent with previous research indicating that the impact of Self-Efficacy on physical activity was mediated by Self-Regulation. [223]

Incentive Motivation, which was operationalized as the use of rewards to modify PA behavior, had a medium and significant effect on Self-Efficacy and PA in this study. This finding is consistent with previous studies that demonstrated the effectiveness of incentives in improving PA behavior.[352,360-363] A systematic review and meta-analysis found that incentives could also improve the attendance at PA interventions.[361] According to research by RAND Europe, participants in the Vitality Active Rewards program with Apple Watch reported an additional 4.8 activity days per month compared to non-participants.[364] Similarly, the results of the ACHIEVE project demonstrated that an incentives-based program was a feasible method to improve participant retention leading to a significant increase on PA ($p < 0.001$).[365] In 2015, Barte and Wendel-Vos conducted a systematic review of twelve PA interventions with financial incentives and found that compared to unconditional incentives (e.g., public facilities), conditional incentives (e.g., rewards based on achieving specific goals) had favorable impacts on PA.[362]

Previous research found that offering incentives - such as financial rewards or social recognition - can provide students with a tangible and immediate reward for their efforts.[361,366] The nature of this type of incentive helps offset the short-term costs of exercise, such as time and

effort. In the present study, we found that Incentive Motivation significantly affected Self-Efficacy, suggesting a stronger sense of Self-Efficacy when students experience positive outcomes and rewards from their exercise efforts. However, in this study, we did not find adequate evidence that supported the long-term effects of incentives.

### 5.2.4 Implications and Future Directions

Previous research underscored the significance of prioritizing the well-being of healthcare professionals, emphasizing the need to implement interventions that promote healthy habits among healthcare workers, including health professional students.[367-369] However, it is essential to recognize that the effectiveness of wellness interventions is not uniform across populations or settings, and the implementation of wellness interventions should go beyond a "one-size-fits-all approach".[229] Further research is needed to investigate the generalizability of the findings and explore the long-term effects of these interventions with more robust study designs. For future studies, we suggest exploring multimodal interventions grounded in behavior theories to target different aspects of behavior change. Moreover, there is a need to develop evidence-based guidelines for promoting the wellness of health professional students as well as other university students.

### 5.2.5 Strengths

This study is the first experimental study to quantitatively evaluate the DFFC competition and PA-related text messages among students in three health professional programs, providing evidence for the feasibility and effectiveness of competition-based interventions, text message interventions, and combined interventions of these two approaches among university students. Additionally, we collected quantitative and qualitative perceptions of participants and proposed future directions for the improvement of both interventions. Moreover, this study included a

follow-up period to assess the maintenance of behavior change and monitor participants' PA after the interventions. Furthermore, our findings revealed the relationships between Self-regulation, Incentive Motivation, Self-efficacy, Social Support, and Physical Activity, which is of great importance given that the mediation effect of Incentive Motivation on PA has never been investigated.

Overall, this quasi-experimental study provided first-hand evidence to support the implementation of fitness competition and text message interventions as feasible, acceptable, and effective strategies for promoting healthy lifestyles among university students, especially for health professional students.

### 5.2.6 Limitations

The primary limitation of this study was the sample population. First, due to limited sample size, we were unable to develop some hypothesized models, such as path analysis including both interventions, as well as a complicated mediation model including all dependent variables. Second, our samples were enrolled in health professional programs and may not generalize to all university students. Given the demands and high-pressure of their work, health professional students are known to experience higher levels of stress and anxiety compared to university students in other fields, which may introduce external confounders in assessing bias.[370-372] For example, we cannot consistently control their academic pressure and workload throughout the interventions and follow-up. Third, while participants were randomized to receive text messages or not, they were not randomized to participate in the DFFC or to a control group with no intervention, resulting in unbalanced baseline characteristics such as age and race. Due to self-selection for participation, students in the DFFC and DFFC + Text Group may exhibit a higher enthusiasm for exercise than students in the Control Group. One possible indicator

supporting this is the lower follow-up rate in the Control Group compared to the two intervention groups (30% vs. 70%).

Another important limitation is measurement bias. For the primary outcome, the accuracy of MVPA minutes could not be guaranteed. While PA minutes were collected through fitness trackers and the ChallengeRunner app, participants had the ability to manually enter data. The veracity of unusually high MVPA data of several teams was questioned. While these teams were not enrolled in this study, we were unable to validate any PA data for DFFC participants. Several participants reported technical issues connecting their trackers/phones with the ChallengeRunner app and had to report data manually, which could impact the intervention retention and the objectivity of the measurement. For the secondary outcomes, self-report measures were used for Self-regulation, Incentive Motivation, Self-efficacy, Social Support, and Mental Well-being, which is subject to recall bias and social desirability bias.[373] Also, a limitation of our survey instruments is the lack of attention-tracking questions which help gauge respondents' attentiveness and ensure data accuracy.

Additionally, due to the setting of the DFFC competition, the Control Group in this study was not fully "controlled". During the competition, all students, faculty, and staff members in these three programs received the weekly email, including participants in the Control Group. Additionally, the group fitness classes were open to the Auburn community, meaning that students in the Control Group also had opportunities to participate. Because all participants in this study used the ChallengeRunner app to report their data, participants in the Control Group were using some competitive functions of this platform, such as the leader board. Also, the group activities during the competition were open to HCOP students and employees, meaning that participants from AUCON and VCOM-Auburn did not have organized group fitness classes.

Lastly, for participants in the DFFC + Text Group, although we had delivery reports for text message delivery, we were not able to confirm messages were read or any actions taken after reading the messages. In this study, the incorporation of text message interventions into a competition setting makes it challenging to isolate the specific effects of text message interventions. To accurately assess the effectiveness of text message interventions, it is crucial to introduce an additional intervention group, the Text Group, which would solely receive the text messages without the competition aspect, and compare outcomes of the Text Group to DFFC Group as well as the Control Group,

### 5.3 Implications and Conclusions

A comprehensive study was conducted to understand various components in promoting physical activity among university students, including a systematic review, meta-analyses, a fitness competition (DFFC) group, a combination of DFFC and text message interventions (DFFC + Text), and qualitative data analysis. Overall, both fitness competitions and text message interventions have been identified as valuable strategies for promoting engagement in physical activity among university students.

Updated evidence from the literature supports the positive effect of text message interventions on metabolic equivalents of tasks (MET) among university students but not for other outcomes. Effective text messages should be tailored to the specific needs and preferences of the target audience.

In the quasi-experimental study, both competition-based and text message interventions were found to be feasible and acceptable in promoting physical activity among university students. The fitness competition highlights the role of competitive environments and teamwork in motivating students to participate in physical activity. The quantitative analyses reveal that

Self-Efficacy and Incentive Motivation are significant factors in influencing Physical Activity and mediating the effects of Physical Activity interventions. Future work needs to develop multimodal interventions based on behavior theories and explore long-term effects and generalizability with robust study designs. It is essential to evaluate the need of target populations for personalized interventions, and incorporate social support through teamwork, peer support, and group activities to enhance interpersonal interaction and increase physical activity engagement. Also, more resources are needed to enhance self-efficacy for physical activity, such as education sessions, one-on-one consulting, workouts, and more training opportunities. Moreover, to retain participation and maintain motivation throughout and after the competition, introducing new incentives, events, or challenges regularly could help provide ongoing support for participants and prevent plateauing in engagement. For example, implementing multiple reward tiers could increase physical activity motivation for both high achievers and beginners, providing everyone with a chance to win some award for their efforts.

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## Appendix 1. 1st DFFC Email for Students

### 1st DFFC Email - HCOP

We kick off our fifth annual **Deans' Fit Family Challenge** next week!

**What is the Deans' Fit Family Challenge?** The Deans' Fit Family Challenge is a health and wellness competition between HCOP vs. AUCON vs. VCOM-Auburn. Participants representing each college compete in teams of two. The competition is based on two metrics: cumulative minutes of exercise logged and number of total pounds lost from baseline to endpoint.

**What does it cost to participate?** Nothing!

**What about prizes?** Weekly prizes will be awarded to the team with the most exercise minutes logged that week and to a randomly selected participant from HCOP, AUCON, and VCOM-Auburn (i.e., 3 winners per college per week). The overall winning college gets the coveted Deans' Cup. Let's get to moving, HCOP, and win that cup this year! We have not won since Nursing and VCOM-Auburn joined the Challenge.

**Why should I participate?** We all work hard to do our best each day. But, do we devote enough time to being physically active? The goal of the Challenge is to encourage you to get out there and get active. What better way to relieve today's stress than being physically active?!

**How do I get started?** Find a partner and think of a fun team name! One member of each team must be a current HCOP employee or student.

**What do I need to do next week?** Watch for an email with the link to sign up, submit your team name, and complete your weigh-in. Everyone wanting to participate must be signed up by September x, including weighing in. Weigh-ins begin September X and conclude September X. The weigh-in process will consist of you weighing yourself and submitting an image of the scale to a Qualtrics survey. Weigh-outs will be the same process.

**Is my weight going to be posted for everyone to see?** No way! Weights will be submitted through a Qualtrics link that is only accessible by Dr. B. Fox. He will use weight data to determine the winner and to submit the overall weight loss by the HCOP.

**When do I submit exercise data?** Exercise/activity logging will begin September x, which is the official kick-off for the challenge. Minutes are due every Sunday by 11:59pm. The Challenge concludes November x.

**How do I submit my exercise data?** We will use Challenge Runner to automatically record activity using activity trackers. This means that participants with compatible devices do not have to manually submit their data! Challenge Runner is compatible with Android, Apple Health, Samsung Health, Fitbit, Garmin, Google Fit, Misfit, Withings (Nokia), Oura, Suunto, and MapMyFitness. Data can also be submitted manually for those who do not have a compatible device. Stay tuned for more details on the app.

**What activities are included in the Challenge?** Any intentional, moderate or vigorous physical activity (i.e., that increases your heart rate) counts!

**Do I have to lose weight to win?** NO! Number of exercise minutes logged is also a huge component of this competition. You could win the individual prize for total minutes logged!

**What about the group fitness Village competition?** The popular Village competition returns this year. We will have several group fitness activities throughout the Challenge. The Village with the highest participation rate during group fitness activities wins a prize, including points toward the Hargreaves' Day competition.

**Students are also invited to participate in a research study** to assess and compare the effectiveness of text message interventions on improving physical activity among university students and evaluate participants' acceptability and experiences. The study is being conducted by Chenyu Zou, MS, as her doctorate dissertation project under the direction of Brent I. Fox, PharmD, PhD, in the Department of Health Outcomes Research and Policy. Each participant will be compensated with a total of $15 Amazon gift card for two surveys, and there are chances to win a $20, a $30, or $50 Amazon gift card! This research project is open to all students from HCOP, AUCON, and VCOM-Auburn, regardless of whether you sign up for the DFFC 2022. Additional details will be provided in a future email.

We are so excited for the Challenge this year and we encourage you to participate!

If you have any questions, don't hesitate to email Madi Brown (meb0219@auburn.edu) or Bekcy Woodruff (rlw0067@auburn.edu).

## 1st DFFC Email - VCOM-Auburn

We kick off our fifth annual **Deans' Fit Family Challenge** next week!

**What is the Deans' Fit Family Challenge?** The Deans' Fit Family Challenge is an 8-week health and wellness competition between VCOM-Auburn vs. HCOP vs. AUCON. Participants representing each college compete in teams of two. The competition is based on two metrics: cumulative minutes of exercise logged and number of total pounds lost from baseline to endpoint.

**What does it cost to participate?** Nothing!

**What about prizes?** Weekly prizes will be awarded to the team with the most exercise minutes logged that week and to a randomly selected participant from VCOM-Auburn, HCOP, and AUCON (i.e., 3 winners per college per week). The overall winning college gets the coveted Deans' Cup. Let's get to moving, VCOM-Auburn, and win that cup this year - again!

**Why should I participate?** We all work hard to do our best each day. But, do we devote enough time to being physically active? The goal of the Challenge is to encourage you to get out there and get active. What better way to relieve today's stress than being physically active?!

**How do I get started?** Find a partner and think of a fun team name! One member of each team must be a current VCOM-Auburn employee or student.

**What do I need to do this week?** Watch for an email with the link to sign up tomorrow (9/15), submit your team name, and complete your weigh-in. Everyone wanting to participate must be signed up by September 17, including weighing in. The weigh-in process will consist of you weighing yourself and submitting an image of the scale to a Qualtrics survey. Weigh-outs will be the same process.

**Is my weight going to be posted for everyone to see?** No way! Weights will be submitted through a Qualtrics link that is only accessible by Dr. Hollingsworth. He will use weight data to determine the winner and to submit the overall weight loss by VCOM-Auburn.

**When do I submit exercise data?** Exercise/activity logging will begin September 19, which is the official kick-off for the challenge. Minutes are due every Sunday by 11:59pm. The Challenge concludes November 13.

**How do I submit my exercise data?** We will use Challenge Runner to automatically record activity using activity trackers. This means that participants with compatible devices do not have to manually submit their data! Challenge Runner is compatible with Apple Health, Fitbit, Garmin, Google Fit Online and Mobile, Misfit, Omron, Oura, Polar, Samsung Health, Strava, Suunto, Under Armour MapMyFitness, and Withings. Data can also be submitted manually for those who do not have a compatible device. Stay tuned for more details on the app.

**What activities are included in the Challenge?** Any intentional, moderate or vigorous physical activity (i.e., that increases your heart rate) counts!

**Do I have to lose weight to win?** NO! Number of exercise minutes logged is also a huge component of this competition. You could win the individual prize for total minutes logged!

**Students are also invited to participate in a research study** to assess and compare the effectiveness of text message interventions on improving physical activity among university students and evaluate participants' acceptability and experiences. The study is being conducted by Chenyu Zou, MS, as her doctorate dissertation project under the direction of Brent I. Fox, PharmD, PhD, in the Department of Health Outcomes Research and Policy. Each participant will be compensated with a total of $15 Amazon gift card for two surveys, and there are chances to win a $20, a $30, or $50 Amazon gift card! This research project is open to all students from HCOP, AUCON, and VCOM-Auburn, regardless of whether you sign up for the DFFC 2022. Additional details will be provided in a future email.

We are so excited for the Challenge this year and we encourage you to participate!

If you have any questions, don't hesitate to
email Dr. Hollingsworth (jhollingsworth@auburn.vcom.edu).

Let's go, VCOM-Auburn!

**1st DFFC Email -AUCON**

We kick off our fifth annual **Deans' Fit Family Challenge** next week!

**What is the Deans' Fit Family Challenge?** The Deans' Fit Family Challenge is a health and wellness competition between AUCON vs. VCOM-Auburn vs. HCOP. Participants representing each college compete in teams of two. The competition is based on two metrics: cumulative minutes of exercise logged and number of total pounds lost from baseline to endpoint.

**What does it cost to participate?** Nothing!

**What about prizes?** Weekly prizes will be awarded to the team with the most exercise minutes logged that week and to a randomly selected participant from AUCON, VCOM-Auburn, and HCOP (i.e., 3 winners per college per week). The overall winning college gets the coveted Deans' Cup. Let's get to moving, AUCON, and win that cup this year - again!

**Why should I participate?** We all work hard to do our best each day. But, do we devote enough time to being physically active? The goal of the Challenge is to encourage you to get out there and get active. What better way to relieve today's stress than being physically active?!

**How do I get started?** Find a partner and think of a fun team name! One member of each team must be a current AUCON employee or student.

**What do I need to do next week?** Watch for an email with the link to sign up, submit your team name, and complete your weigh-in. Everyone wanting to participate must be signed up by September x, including weighing in. Weigh-ins begin September X and conclude September X. The weigh-in process will consist of you weighing yourself and submitting an image of the scale to a Qualtrics survey. Weigh-outs will be the same process.

**Is my weight going to be posted for everyone to see?** No way! Weights will be submitted through a Qualtrics link that is only accessible by Dr. Robin Gosdin Farrell. She will use weight data to determine the winner and to submit the overall weight loss by AUCON.

**When do I submit exercise data?** Exercise/activity logging will begin September x, which is the official kick-off for the challenge. Minutes are due every Sunday by 11:59pm. The Challenge concludes November x.

**How do I submit my exercise data?** We will use Challenge Runner to automatically record activity using activity trackers. This means that participants with compatible devices do not have to manually submit their data! Challenge Runner is compatible with Android, Apple Health, Samsung Health, Fitbit, Garmin, Google Fit, Misfit, Withings (Nokia), Oura, Suunto, and MapMyFitness. Data can also be submitted manually for those who do not have a compatible device. Stay tuned for more details on the app.

**What activities are included in the Challenge?** Any intentional, moderate or vigorous physical activity (i.e., that increases your heart rate) counts!

**Do I have to lose weight to win?** NO! Number of exercise minutes logged is also a huge component of this competition. You could win the individual prize for total minutes logged!

**Students are also invited to participate in a research study** to assess and compare the effectiveness of text message interventions on improving physical activity among university students and evaluate participants' acceptability and experiences. The study is being conducted by Chenyu Zou, MS, as her doctorate dissertation project under the direction of Brent I. Fox, PharmD, PhD, in the Department of Health Outcomes Research and Policy. Each participant will be compensated with a total of $15 Amazon gift card for two surveys, and there are chances to win a $20, a $30, or $50 Amazon gift card! This research project is open to all students from HCOP, AUCON, and VCOM-Auburn, regardless of whether you sign up for the DFFC 2022. Additional details will be provided in a future email.

We are so excited for the Challenge this year and we encourage you to participate!

If you have any questions, don't hesitate to email Dr. Farrell (rgf0001@auburn.edu).

## Appendix 2. 2nd DFFC Email for Students

### 2nd DFFC Email – HCOP and AUCON

It's time!!!

Sign-up for the Deans' Fit Family Challenge **is open and closes September 17th at 10pm**. The link is below.

This is a free 8-week weight loss and exercise-minutes challenge between HCOP vs. AUCON vs. VCOM-Auburn with weekly prizes. Click here for more information: https://drive.google.com/file/d/1fl0psRGV07GaTW08L58i7vmCGoEmpUOn/view?usp=sharing

**To sign up, you will need:**

- A teammate. Your teammate does not have to be affiliated with the HCOP.
- A team name. Be creative but professional.
- Your weight, captured in a photo with your feet standing on the scale. This will be submitted using the link below.
    - Use the scale of your choice. Must use same scale when weighing out.

Weigh-in information is submitted individually, so **teammates register/weigh-in separately.**

It's easiest to register for the Challenge on your phone (to submit the weight photo).

**Go here to weigh-in and register for the Challenge:** https://auburn.qualtrics.com/jfe/form/SV_9WBG3dKnmmkRMaO

Once registration closes, an email will be sent with instructions to submit physical activity minutes via Challenge Runner.

- This email will also contain the link to register for the optional research study mentioned in our first email, provided below.

  **Students are also invited to participate in a research study** to assess and compare the effectiveness of text message interventions on improving physical activity among university students and evaluate participants' acceptability and experiences. The study is being conducted by Chenyu Zou, MS, as her doctorate dissertation project under the direction of Brent I. Fox, PharmD, PhD, in the Department of Health Outcomes Research

and Policy. Each participant will be compensated with a total of $15 Amazon gift card for two surveys, and there are chances to win a $20, a $30, or $50 Amazon gift card! This research project is open to all students from HCOP, AUCON, and VCOM-Auburn, regardless of whether you sign up for the DFFC 2022.

If you are **NOT** participating in the Challenge but would like to participate in the research study, click https://auburn.qualtrics.com/jfe/form/SV_0PTxF2SPgFXP0rQ.

If you ARE participating in the Deans' Fit Family Challenge and would like to also participate in the research study, we will send another email with the study link after you register for the Challenge. Stay tuned!

## 2nd DFFC Email – VCOM-Auburn

Sign-up for the Deans' Fit Family Challenge **is open and closes at 11:59 PM on Saturday September 17th**. The sign-up link is below.

This is a **free** 8-week weight loss and exercise-minutes challenge between HCOP vs. AUCON vs. VCOM-Auburn with **weekly prizes**. **Click here for more info**.

**To sign up, you will need:**

- A teammate. Your teammate does not have to be affiliated with VCOM.
- A team name. Be creative but professional.
- Your weight, captured in a photo with your feet standing on the scale. This will be submitted using the link below.
    - Use the scale of your choice. You must use same scale when weighing out in 8 weeks.

Weigh-in information is submitted individually, so **teammates register and weigh-in separately.**

It's easiest to **register for the Challenge on your phone** (to submit the weight photo).

**Go here to weigh-in and register for the Challenge:**

**https://auburn.qualtrics.com/jfe/form/SV_9WBG3dKnmmkRMaO**

**Once registration closes,** an email will be sent to participants with instructions to submit physical activity minutes via ChallengeRunner. This email will also contain the link to register for the optional research study mentioned in our first email and described below.

**Students are also invited to participate in a research study** to assess and compare the effectiveness of text message interventions on improving physical activity among university students and evaluate participants' acceptability and experiences. The study is being conducted by Chenyu Zou, MS, as her doctorate dissertation project under the direction of Brent I. Fox, PharmD, PhD, in the Department of Health Outcomes Research and Policy. Compensation will be pro-rated, with $5 for completion and submission of the first survey and $10 after completion and submission of the second survey. Individuals who have completed both surveys will be entered into a drawing for one of three prizes - a $20, a $30, or a $50 Amazon gift card. The chances of winning one of these prizes is 1/500. This research project is open to all students from HCOP, AUCON, and VCOM-Auburn, regardless of whether you sign up for the Challenge.

If you are **NOT** participating in the Deans' Fit Family Challenge **but would like to participate in the research study**, click here: **https://auburn.qualtrics.com/jfe/form/SV_0PTxF2SPgFXP0rQ**

If you **ARE** participating in the Deans' Fit Family Challenge **and would like to also participate in the research study**, we will send another email with the study link after you register for the Challenge. Stay tuned!

If you have any questions, please contact Dr. Hollingsworth by replying to this email.

Let’s go VCOM, Let’s go! 🙌

## Appendix 3. Sign-up Surveys for Control Group

Q7 Select your academic affiliation. If you are not affiliated with these programs, please indicate your teammate's affiliation.

- ○ HCOP (1)
- ○ AUCON (2)
- ○ VCOM-Auburn (3)

---

*Display This Question:*

*If Select your academic affiliation. If you are not affiliated with these programs, please indicate... = HCOP*

*Or Select your academic affiliation. If you are not affiliated with these programs, please indicate... = AUCON*

Q9

**(NOTE: DO NOT SIGN THIS DOCUMENT UNLESS AN IRB APPROVAL STAMP WITH CURRENT DATES HAS BEEN APPLIED TO THIS DOCUMENT.)**

INFORMATION LETTER
for a Research Study entitled

"The effect of text message and competition-based interventions on university students' physical activity levels, self-efficacy, self-regulation, social support, incentive motivation, and mental wellbeing"

**SUMMARY: The purpose of this study is to assess and compare the effectiveness of competition-based and text message interventions in improving physical activity among university students and evaluate participants' acceptability and experiences. Participants need to download the "Challenge Runner" app to automatically submit their weekly physical activity data. Participants will be asked to answer two anonymous online surveys about their physical activity levels, self-efficacy, self-regulation, social support, incentive motivation, and mental wellbeing. Each participant will be compensated with one $5 Amazon gift card after completing the first survey, and another $10 Amazon gift card after completing the second survey. Participants will be entered into a drawing for a chance to win a $20, a $30, or $50 Amazon gift card after completing both surveys. Participants' emails will be discarded once we complete data collection and incentive delivery. No identifiable information will be linked to survey responses.**

**You are invited to participate in a research study** to assess and compare the effectiveness of competition-based and text message interventions on physical activity among university students and to evaluate participants' acceptability and experiences. The study is being conducted by Chenyu Zou, MS, as her doctorate dissertation project under the direction of Brent I. Fox, PharmD, PhD, in the Auburn University Department of Health Outcomes Research and Policy. You are invited to participate because you are an Auburn University student and are not participating in the Deans' Fit Family Challenge.

**What will be involved if you participate?** Your participation is completely voluntary. To be eligible to

participate, you should be age 18 or older, and you will need a smartphone and a fitness tracker or smartwatch. If you decide to participate in this research study, you will be asked to download the "Challenge Runner" app on your smartphone and connect this app to your fitness tracker or smartwatch to automatically submit your weekly physical activity minutes (or you can submit weekly activity minutes on the Challenge Runner website). You will also be asked to answer two online surveys (will be sent in September and November). Both surveys will take approximately 20 minutes to complete. Your total time commitment for surveys will be approximately 45 minutes.

**Are there any risks or discomforts?** Breach of confidential information is possible. To minimize these risks, we will store your weekly activity minutes recordings and survey responses in a secured server; furthermore, your contact information will be kept on a password-protected computer, separate from questionnaire data. Participants' emails will be discarded once data collection is complete and incentives have been delivered. For the purposes of this research project, no identifiable information will be linked to survey responses or physical activity data. You may skip any items you choose not to answer because of potential discomfort answering questions of a personal nature.

**Are there any benefits to yourself or others?** There are no direct benefits associated with participating in this project. The study findings will inform future studies regarding physical activity interventions. We cannot promise you that will receive any or all of the benefits described.

**Will you receive compensation for participating?** To thank you for your time you will be offered one $5 Amazon gift card after completing the first survey, and another $10 Amazon gift card after completing the second survey. You will be entered into a drawing for a chance to win a $20, $30, or $50 Amazon gift card at the conclusion of the DFFC.

**Are there any costs?** There will be no cost to participate in this study. The Challenge Runner app is free to download. You will be responsible for your own expenses if you experience any injury during the study period.

**If you change your mind about participating,** you can withdraw at any time during the study. Your participation is completely voluntary. You can withdraw at any time by emailing Chenyu Zou (czz0065@auburn.edu) or Dr. Brent I. Fox (foxbren@auburn.edu). Once submitted, data cannot be withdrawn. Your decision about whether or not to participate or to stop participating will not jeopardize your future relations with Auburn University, the Department of Health Outcomes Research and Policy, or the study organizers.

**Your privacy will be protected.** Your identity will remain confidential. Information obtained through your participation may be used to fulfill an educational requirement, published in a professional journal, or presented at a professional meeting.

**If you have questions about this study,** please contact Chenyu Zou at czz0063@auburn.edu or 513-206-2455. This letter was approved by the VCOM and Auburn University Institutional Review Boards for use starting 9/12/22 as protocol 22-380 EX 2209.

**If you have questions about your rights as a research participant, and you are an AU student,** you may contact the Auburn University Office of Research Compliance or the Institutional Review Board by phone (334) 844-5966 or e-mail at IRBadmin@auburn.edu or IRBChair@auburn.edu. **If you are a**

**VCOM student**, please contact the VCOM IRB Chair, Dr. Gunnar Brolinson at pbrolinson@vcom.vt.edu or (540) 231-4981.

HAVING READ THE INFORMATION ABOVE, YOU MUST DECIDE IF YOU WANT TO PARTICIPATE IN THIS RESEARCH PROJECT. IF YOU DECIDE TO PARTICIPATE, PLEASE SELECT "YES" TO THE QUESTION BELOW. YOUR COMPLETION OF THIS ONLINE SURVEY INDICATES YOUR WILLINGNESS TO PARTICIPATE IN THIS PROJECT. YOU MAY PRINT A COPY OF THIS LETTER TO KEEP.

---

*Display This Question:*

*If Select your academic affiliation. If you are not affiliated with these programs, please indicate... = VCOM-Auburn*

Q8

**(NOTE: DO NOT SIGN THIS DOCUMENT UNLESS AN IRB APPROVAL STAMP WITH CURRENT DATES HAS BEEN APPLIED TO THIS DOCUMENT.)**

**INFORMATION LETTER**
**for a Research Study entitled**

**"Effect of text message and competition-based interventions on university students' physical activity levels, self-efficacy, self-regulation, social support, incentive motivation, and mental wellbeing"**

**SUMMARY: The purpose of this study is to assess and compare the effectiveness of competition-based and text message interventions in improving physical activity among university students and evaluate participants' acceptability and experiences. Participants need to download the "Challenge Runner" app to automatically submit their weekly physical activity data. Participants will be asked to answer two anonymous online surveys about their physical activity levels, self-efficacy, self-regulation, social support, incentive motivation, and mental wellbeing. All participants will be compensated with one $5 Amazon gift card after completing the first survey and another $10 Amazon gift card after completing the second survey. Participants will be entered into a drawing for a $20, a $30, or $50 Amazon gift card after completing both surveys, with a 1 in 500 chance of winning one of these prizes. Participants' emails will be discarded once we complete data collection and incentive delivery. No identifiable information will be linked to survey responses.**

**You are invited to participate in a research study** to assess and compare the effectiveness of competition-based and text message interventions on physical activity among university students and to evaluate participants' acceptability and experiences. The study is being conducted by Chenyu Zou, MS, as her doctorate dissertation project under the direction of Brent I. Fox, PharmD, PhD, in the Auburn University Department of Health Outcomes Research and Policy. You are invited to participate because you are an Auburn University student and are not participating in the Deans' Fit Family Challenge.

**What will be involved if you participate?** Your participation is completely voluntary. To be eligible to participate, you should be age 18 or older, and you will need a smartphone and a fitness tracker or smartwatch. If you decide to participate in this research study, you will be asked to download the "Challenge Runner" app on your smartphone and connect this app to your fitness tracker or smartwatch to automatically submit your weekly physical activity minutes (or you can submit weekly activity minutes on the Challenge Runner website). You will also be asked to answer two online surveys (will be sent in September and November). Both surveys will take approximately 20 minutes to complete. Your total time commitment for surveys will be approximately 45 minutes.

**Are there any risks or discomforts?** Breach of confidential information is possible. To minimize these risks, we will store your weekly activity minutes recordings and survey responses in a secured server; furthermore, your contact information will be kept on a password-protected computer, separate from questionnaire data. Participants' emails will be discarded once data collection is complete and incentives have been delivered. For the purposes of this research project, no identifiable information will be linked to survey responses or physical activity data. You may skip any items you choose not to answer because of potential discomfort answering questions of a personal nature.

**Are there any benefits to yourself or others?** There are no direct benefits associated with participating in this project. The study findings will inform future studies regarding physical activity interventions. We cannot promise you that will receive any or all of the benefits described.

**Will you receive compensation for participating?** To thank you for your time, you will be offered one $5 Amazon gift card after completing the first survey, and another $10 Amazon gift card after completing the second survey. After completing both surveys, you will be entered into a drawing for a $20, a $30, or $50 Amazon gift card, with a 1 in 500 chance of winning one of these prizes.

**Are there any costs?** There will be no cost to participate in this study. The Challenge Runner app is free to download. You will be responsible for your own expenses if you experience any injury during the study period.

**If you change your mind about participating,** you can withdraw at any time during the study. Your participation is completely voluntary. You can withdraw at any time by emailing Chenyu Zou (czz0065@auburn.edu) or Dr. Brent I. Fox (foxbren@auburn.edu). Once submitted, data cannot be withdrawn. Your decision about whether or not to participate or to stop participating will not jeopardize your future relations with Auburn University, the Department of Health Outcomes Research and Policy, or the study organizers.

**Your privacy will be protected.** Your identity will remain confidential. Information obtained through your participation may be used to fulfill an educational requirement, published in a professional journal, or presented at a professional meeting.

**If you have questions about this study**, please contact Chenyu Zou at czz0063@auburn.edu or 513-206-2455. This letter was approved by the VCOM Institutional Review Board for use starting 9/12/22 as protocol 2022-
061.

**If you have questions about your rights as a research participant,** please contact the VCOM IRB Chair, Dr. Gunnar Brolinson at pbrolinson@vcom.vt.edu or (540) 231-4981.

HAVING READ THE INFORMATION ABOVE, YOU MUST DECIDE IF YOU WANT TO PARTICIPATE IN THIS RESEARCH PROJECT.IF YOU DECIDE TO PARTICIPATE, PLEASE SELECT "YES" TO THE QUESTION BELOW. YOUR COMPLETION OF THIS ONLINE SURVEY INDICATES YOUR WILLINGNESS TO PARTICIPATE IN THIS PROJECT. YOU MAY PRINT A COPY OF THIS LETTER TO KEEP.

This research has been reviewed and approved by the VCOM Institutional Review board. (Record #2022-061)

---

Q2 Do you agree to participate in this project?

- ○ YES (1)
- ○ NO (2)

*Skip To: End of Survey If Do you agree to participate in this project? = NO*

**End of Block: Information Letter**

**Start of Block: Inclusion Criteria**

Q3 Are you at least 18 years of age ?

- ○ YES (1)
- ○ NO (2)

*Skip To: End of Survey If Are you at least 18 years of age ? = NO*

---

Q8 Do you have any health issues that prevent you from being physically active, including but not limited to pregnancy, disabilities, and chronic diseases?

- ○ YES (1)
- ○ NO (2)

*Skip To: End of Survey If Do you have any health issues that prevent you from being physically active, including but not li... = YES*

---

Q5 To be eligible to participate, you will need a smartphone and a fitness tracker or smartwatch. Please indicate which app you would like to use to synchronize activity minute to the Challenge Runner app.

- ○ Apple Health (1)
- ○ Fitbit (2)
- ○ Garmin (3)
- ○ Google Fit (online and mobile) (4)
- ○ Omron (5)
- ○ Oura (6)
- ○ Polar (7)
- ○ Samsung Health (8)
- ○ Strava (9)
- ○ Suunto (10)
- ○ Under Armour MapMyFitness (11)
- ○ Withings (12)
- ○ I don't have a fitness tracker or smartwatch, or my devices do not support any of these apps (13)

*Skip To: End of Survey If To be eligible to participate, you will need a smartphone and a fitness tracker or smartwatch. Pl... = I don't have a fitness tracker or smartwatch, or my devices do not support any of these apps*

Q6 Please provide your AU/VCOM email address. Please watch this email. We will send important information and links for your participation in this project. Thank you for your participation!

_____

**End of Block: Inclusion Criteria**

## Appendix 4. 3rd DFFC Email for Students

<Only those students who signed up for the Challenge will receive this email.>

Your registration for the Challenge is almost complete.

The next step is to create your Challenge Runner account, and to download the Challenge Runner app.

The Challenge Runner instructions are attached.

As previously mentioned, you can sign up for the optional research study, described below.

> **Students are also invited to participate in a research study** to assess and compare the effectiveness of text message interventions on improving physical activity among university students and evaluate participants' acceptability and experiences. The study is being conducted by Chenyu Zou, MS, as her doctorate dissertation project under the direction of Brent I. Fox, PharmD, PhD, in the Department of Health Outcomes Research and Policy. Each participant will be compensated with a total of $15 Amazon gift card for two surveys, and there are chances to win a $20, $30, or $50 Amazon gift card!

Click here to sign up for the research project.

## Appendix 5. Sign-up Surveys for DFFC and DFFC + Text Group

Q8 Select your academic affiliation. If you are not affiliated with these programs, please indicate your teammate's affiliation.

- ○ HCOP (1)
- ○ AUCON (2)
- ○ VCOM-Auburn (3)

---

*Display This Question:*

*If Select your academic affiliation. If you are not affiliated with these programs, please indicate... = HCOP*

*Or Select your academic affiliation. If you are not affiliated with these programs, please indicate... = AUCON*

Q13

**(NOTE: DO NOT SIGN THIS DOCUMENT UNLESS AN IRB APPROVAL STAMP WITH CURRENT DATES HAS BEEN APPLIED TO THIS DOCUMENT.)**

**INFORMATION LETTER**
**for a Research Study entitled**

**"The effect of text message and competition-based interventions on university students' physical activity levels, self-efficacy, self-regulation, social support, incentive motivation, and mental wellbeing"**

**SUMMARY: The purpose of this study is to assess and compare the effectiveness of competition-based and text messaging interventions in improving physical activity among health professional students and evaluate participants' acceptability and experiences. We will collect weekly physical activity data via the Challenge Runner app. Participants will be asked to answer two anonymous online surveys about their physical activity levels, self-efficacy, self-regulation, social support, incentive motivation, and mental wellbeing. Each participant will be compensated with one $5 Amazon gift card after completing the first survey, and another $10 Amazon gift card after completing the second survey. Participants will be entered into a drawing for a chance to win a $20, a $30, or $50 Amazon gift card after completing both surveys. Participants' emails will be discarded once we complete data collection and incentive delivery. No identifiable information will be linked to survey responses.**

**You are invited to participate in a research study** to assess and compare the effectiveness of competition-based and text messaging interventions on physical activity among health professional students and to evaluate participants' acceptability and experiences. The study is being conducted by Chenyu Zou, MS, as her doctorate dissertation project under the direction of Brent I. Fox, PharmD, PhD,

in the Auburn University Department of Health Outcomes Research and Policy. You are invited to participate because you are enrolled in HCOP, AUCON, or VCOM-Auburn.

**What will be involved if you participate?** Your participation is completely voluntary. To be eligible to participate, you should be age 18 or older and willing to receive text messages (at your expense, if it is not free). You will need a smartphone and a fitness tracker or smartwatch. If you decide to participate in this research study, your physical activity minutes collected for the 2022 Deans' Fit Family Challenge (DFFC) will be used in this research study. In addition, you may receive weekly text messages. You will be asked to answer two online surveys (will be sent in September and November). Both surveys will take approximately 20 minutes to complete. Your total time commitment for surveys will be approximately 45 minutes.

**Are there any risks or discomforts?** Breach of confidential information is possible. To minimize these risks, we will store weekly physical activity minutes recordings and survey responses in a secured server; furthermore, your contact information will be kept on a password-protected computer, separate from questionnaire data. Participants' phone numbers and emails will be discarded once data collection is complete and incentives have been delivered. For the purposes of this research project, no identifiable information will be linked to survey responses or physical activity data. You may skip any items you choose not to answer because of potential discomfort answering questions of a personal nature.

**Are there any benefits to yourself or others?** There are no direct benefits associated with participating in this project. The study findings will inform future studies regarding physical activity interventions. You may find it enjoyable to receive supportive messages and share your experience with us. We cannot promise that you will receive any or all of the benefits described.

**Will you receive compensation for participating?** To thank you for your time, you will be offered one $5 Amazon gift card after completing the first survey, and another $10 Amazon gift card after completing the second survey. You will be entered into a drawing for a chance to win a $20, $30, or $50 Amazon gift card at the conclusion of the DFFC.

**Are there any costs?** There will be no cost to participate in this study. The Challenge Runner app is free to download. Your decision regarding participation in this study will NOT affect your competition in 2022 Deans' Fit Family Challenge. You will be responsible for any carrier fees for text messages, if applicable. You will be responsible for your own expenses, if you experience any injury during the DFFC.

**If you change your mind about participating,** you can withdraw at any time during the study. Your participation is completely voluntary. To remain in the Deans' Fit Family Challenge but withdraw from the study, please email Chenyu Zou (czz0063@auburn.edu) or Dr. Brent I. Fox (foxbren@auburn.edu). Once submitted, data cannot be withdrawn. Your decision about whether or not to participate or to stop participating will not jeopardize your future relations with Auburn University, the Department of Health Outcomes Research and Policy, or the study
organizers.

**Your privacy will be protected.** Your identity will remain confidential. Information obtained through your participation may be used to fulfill an educational requirement, published in a professional journal, or presented at a professional meeting.

**If you have questions about this study**, please contact Chenyu Zou at czz0063@auburn.edu or 513-206-2455. This letter was approved by the VCOM and Auburn University Institutional Review Boards for use starting 9/18/22 as protocol 22-380 EX
2209.

**If you have questions about your rights as a research participant, and you are an AU student,** you may contact the Auburn University Office of Research Compliance or the Institutional Review Board by phone (334) 844-5966 or e-mail at IRBadmin@auburn.edu or IRBChair@auburn.edu. **If you are a VCOM student**, please contact the VCOM IRB Chair, Dr. Gunnar Brolinson at pbrolinson@vcom.vt.edu or (540) 231-
4981.

HAVING READ THE INFORMATION ABOVE, YOU MUST DECIDE IF YOU WANT TO PARTICIPATE IN THIS RESEARCH PROJECT. IF YOU DECIDE TO PARTICIPATE, PLEASE SELECT "YES" TO THE QUESTION BELOW. YOUR COMPLETION OF THIS ONLINE SURVEY INDICATES YOUR WILLINGNESS TO PARTICIPATE IN THIS PROJECT. YOU MAY PRINT A COPY OF THIS LETTER TO KEEP.

---

*Display This Question:*

*If Select your academic affiliation. If you are not affiliated with these programs, please indicate... = VCOM-Auburn*

Q9
**(NOTE: DO NOT SIGN THIS DOCUMENT UNLESS AN IRB APPROVAL STAMP WITH CURRENT DATES HAS BEEN APPLIED TO THIS DOCUMENT.)**

**INFORMATION LETTER**
**for a Research Study entitled**

**"Effect of text message and competition-based interventions on university students' physical activity levels, self-efficacy, self-regulation, social support, incentive motivation, and mental wellbeing"**

**SUMMARY: The purpose of this study is to assess and compare the effectiveness of competition-based and text messaging interventions in improving physical activity among health professional students and evaluate participants' acceptability and experiences. We will collect weekly physical activity data via the Challenge Runner app. Participants will be asked to answer two anonymous online surveys about their physical activity levels, self-efficacy, self-regulation, social support, incentive motivation, and mental wellbeing. All participants will be compensated with one $5 Amazon gift card after completing the first survey and another $10 Amazon gift card after completing the second survey. Participants will be entered into a drawing for a $20, a $30, or $50 Amazon gift card after completing both surveys, with a 1 in 500 chance of winning one of these prizes. Participants' emails will be discarded once we complete data collection and incentive**

**delivery. No identifiable information will be linked to survey responses.**

**Yo**

**u are invited to participate in a research study** to assess and compare the effectiveness of competition-based and text messaging interventions on physical activity among health professional students and to evaluate participants' acceptability and experiences. The study is being conducted by Chenyu Zou, MS, as her doctorate dissertation project under the direction of Brent I. Fox, PharmD, PhD, in the Auburn University Department of Health Outcomes Research and Policy. You are invited to participate because you are enrolled in HCOP, AUCON, or VCOM-Auburn.

**What will be involved if you participate?** Your participation is completely voluntary. To be eligible to participate, you should be age 18 or older and willing to receive text messages (at your expense, if it is not free). You will need a smartphone and a fitness tracker or smartwatch. If you decide to participate in this research study, your physical activity minutes collected for the 2022 Deans' Fit Family Challenge (DFFC) will be used in this research study. In addition, you may receive weekly text messages. You will be asked to answer two online surveys (will be sent in September and November). Both surveys will take approximately 20 minutes to complete. Your total time commitment for surveys will be approximately 45 minutes.

**Are there any risks or discomforts?** Breach of confidential information is possible. To minimize these risks, we will store weekly physical activity minutes recordings and survey responses in a secured server; furthermore, your contact information will be kept on a password-protected computer, separate from questionnaire data. Participants' phone numbers and emails will be discarded once data collection is complete and incentives have been delivered. For the purposes of this research project, no identifiable information will be linked to survey responses or physical activity data. You may skip any items you choose not to answer because of potential discomfort answering questions of a personal nature. There are inherent risks of physical injury or discomfort from moderate or vigorous exercise. However, the exercises/activities you will be performing are part of the Dean's Fit Family Challenge, and the research is not requiring you to do any additional exercise beyond what is included in that program. Neither the researchers nor their institutions have funds set aside should you require medical intervention following an injury, and you or your insurer would be responsible for any associated costs of that care.

**Are there any benefits to yourself or others?** There are no direct benefits associated with participating in this project. The study findings will inform future studies regarding physical activity interventions. You may find it enjoyable to receive supportive messages and share your experience with us. We cannot promise that you will receive any or all of the benefits described.

**Will you receive compensation for participating?** To thank you for your time, you will be offered one $5 Amazon gift card after completing the first survey, and another $10 Amazon gift card after completing the second survey. After completing both surveys, you will be entered into a drawing for a $20, a $30, or $50 Amazon gift card, with a 1 in 500 chance of winning one of these prizes.

**Are there any costs?** There will be no cost to participate in this study. The Challenge Runner app is free to download. Your decision regarding participation in this study will NOT affect your competition in 2022 Deans' Fit Family Challenge. You will be responsible for any carrier fees for text messages, if applicable. You will be responsible for your own expenses, if you experience any injury during the DFFC.

**If you change your mind about participating,** you can withdraw at any time during the study. Your participation is completely voluntary. To remain in the Deans' Fit Family Challenge but withdraw from the study, please email Chenyu Zou (czz0063@auburn.edu) or Dr. Brent I. Fox (foxbren@auburn.edu). Once submitted, data cannot be withdrawn. Your decision about whether or not to participate or to stop participating will not jeopardize your future relations with Auburn University, the Department of Health Outcomes Research and Policy, or the study organizers.

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**If you have questions about this study**, please contact Chenyu Zou at czz0063@auburn.edu or 513-206-2455. This letter was approved by the VCOM Institutional Review Board for use starting 9/12/22 as protocol 2022-061.

**If you have questions about your rights as a research participant,** please contact the VCOM IRB Chair, Dr. Gunnar Brolinson at pbrolinson@vcom.vt.edu or (540) 231-4981.

HAVING READ THE INFORMATION ABOVE, YOU MUST DECIDE IF YOU WANT TO PARTICIPATE IN THIS RESEARCH PROJECT. IF YOU DECIDE TO PARTICIPATE, PLEASE SELECT "YES" TO THE QUESTION BELOW. YOUR COMPLETION OF THIS ONLINE SURVEY INDICATES YOUR WILLINGNESS TO PARTICIPATE IN THIS PROJECT. YOU MAY PRINT A COPY OF THIS LETTER TO KEEP.

This research has been reviewed and approved by the VCOM Institutional Review board. (Record #2022-061)

---

Q2 Do you agree to participate in this project?

- ○ YES (1)
- ○ NO (2)

*Skip To: End of Survey If Do you agree to participate in this project? = NO*

**End of Block: Information Letter**

---

**Start of Block: Inclusion Criteria**

Q3 Are you at least 18 years of age ?

- ○ YES (1)
- ○ NO (2)

*Skip To: End of Survey If Are you at least 18 years of age ? = NO*

Q9 Do you have any health issues that prevent you from being physically active, including but not limited to pregnancy, disabilities, and chronic disease?

- ○ Yes (2)
- ○ No (9)

*Skip To: End of Survey If Do you have any health issues that prevent you from being physically active, including but not li... = Yes*

Q8 The physical activity minutes you submit for the DFFC will be used for this study. How do you plan to submit your physical activity minutes?

- ○ I do not possess a compatible fitness tracker, smartwatch, or smartphone. I will submit my minutes to ChallengeRunner.com manually. (1)
- ○ I will submit my minutes to ChallengeRunner automatically through my fitness tracker or smartphone app. (2)

*Skip To: End of Survey If The physical activity minutes you submit for the DFFC will be used for this study. How do you pla... = I do not possess a compatible fitness tracker, smartwatch, or smartphone. I will submit my minutes to ChallengeRunner.com manually.*

Q7 Please provide a cellphone number for you. We may use this number to send text messages about physical activity during this study.

_____

Q6 Please provide your AU or VCOM email address. Please watch this email. We will send important information and links for your participation in this project. Thank you for your participation!

_____

**End of Block: Inclusion Criteria**

## Appendix 6. 20 Texts for DFFC + Text Group

| | Monday | Wednesday | Friday |
|---|---|---|---|
| | Self-efficacy | Social support | Self-regulation and incentive motivation |
| WEEK-2 | | Thank you for agreeing to participate in this research project affiliated with the Deans' Challenge! 🤗 You'll receive a supportive text Mon, Wed, and Fri for the next 7 weeks. Now's the time to work on increasing your physical activity. You've got this! 💪 | Happy Friday! 🌞Exercise minutes will be collected this Sunday. Exercise at the same time and place every day to make it a habit. Cheers to health! 📣 |
| | | September 28, 2022, 12.40pm | September 30, 2022, 1.21pm |
| WEEK-3 | The first step is often the hardest. Focus on getting out there and getting started. Consistency is key. You've got this! 🤗 | If working out isn't working for you, try a fun activity with friends. Throw a frisbee, have a dance party, or go for bike ride or walk. 😴 It'll make you feel so much better to be active! 🍓 | Don't forget to track your minutes this week! 😉 And when reflecting on your performance, remember: Progress over perfection. You don't have to be perfect. Just keep moving in the right direction 🏆 |
| | October 3, 2022, 11.30am | October 5, 2022, 11.12 am | October 7, 2022, 9.15 am |
| WEEK-4 | Look for small ways to increase your physical activity. ⛳ Park in the back of the lot, take the stairs, pace when on the phone, and add short walks to your day. Small sustainable changes lead to big results! 😃 | Have a friend who is also working to increase their activity? Consider being partners in progress. 🥾Support and encourage each other. Be better together! 🤝 | If you miss an exercise, no worries. 🌞Don't beat yourself up. Instead of viewing it as a "fail," view it as FAIL: "First Attempts. I'm Learning." Take the lesson and focus forward. 💪 |
| | October 10, 2022, 11 am | October 12, 2022, 11am | October 14, 2022, 7pm |
| WEEK-5 | Spending a lot of time on the computer today? 💻Consider going for a short walk. Five minutes is better than none, and more is generally better. Focus small and do more when you're motivated and able! 👟 | Your friends can help keep you stay motivated to reach your goal!😆 Reach out to friends today and do some exercise or activity y'all enjoy! 🛴 | It's time to ask yourself: How'd I do this week? 🤔No matter how slow you go, you're still lapping everyone on the couch! 💪 Don't forget to track your minutes this week! |
| | October 17, 2022, 4.30pm | October 19, 2022, 11.20am | October 21, 2022, 1pm |
| WEEK-6 | If you hit any barriers to increasing your physical activity, don't give up! Ask yourself, "What's making this hard to do?" and then, "How can I | Got a break between classes? Go for a walk w friends around campus. 🥾Got a longer break? Explore a new park or hiking trail! 🏞 https://bit.ly/WalkAuburnAL | It's almost the weekend. 🥳 To celebrate, go for a nice, long, 40-minute walk tomorrow. Don't forget to track your minutes this week! 💪 |

| | | | |
|---|---|---|---|
| | make it easier?" You've got this! 🏅 | | |
| | October 24, 2022, 11am | October 26, 2022, 2pm | October 28, 2022, 2pm |
| WEEK-7 | Breaking up your sitting time can reduce your risk for certain types of cancer. You have more control over your health than you think! 👍 👍 👍 | Even if you're glued to your phone, 📱 you don't have to be glued to your seat! 🪑 Go and meet up with your friends. Working out with a group can be fun and motivating! | Here is another reason to sit less: taking a break from sitting to walk around or doing some light stretching can help strengthen your bones. 💪Reminder to track your minutes if you have not done so yet! 👟 |
| | 10-31-2022 11:29 AM | 11-02-2022 11:29 AM | November 4, 2022, 2.30pm |
| WEEK-8 | How's your exercise plan going? Make sure to get some walking in today and avoid sitting for too long. You got this! 🧨 | Let's replace an hour of sitting time with walking or exercising with your friends! Do something fun! 🚵 | Hopefully these goals have become habits by now, and if not, just keep practicing them! 🎽 Your health is worth the effort. Don't forget to track your minute this week! 🥰 |
| | 11-07-2022 11:30 AM | 11-09-2022 11:30 AM | 11-11-2022 02:00 PM |

## Appendix 7. Week-0 Survey for All Three Groups

Start of Block: Introduce

Q16 Thank you for participating in this research project. Please answer the following questions. The survey takes approximately 20 minutes to complete. Upon completion of this survey, you will be given the option to provide your contact information for a $5 Amazon gift card, to be delivered to your AU/VCOM email.

End of Block: Introduce

Start of Block: Physical activity levels

Q5 On average, how many days per week do you engage in moderate to vigorous physical activity (like a brisk walk)? You are encouraged to look at the data collected by your fitness tracker/smartphone.

| Moderate Intensity Activities | Vigorous Intensity Activities |
|---|---|
| • Walking briskly (2.5 miles per hour or faster)<br>• Recreational swimming<br>• Bicycling slower than 10 miles per hour on level terrain<br>• Tennis (doubles)<br>• Active forms of yoga (for example, Vinyasa or power yoga)<br>• Ballroom or line dancing<br>• General yard work and home repair work<br>• Exercise classes like water aerobics | • Jogging or running<br>• Swimming laps<br>• Tennis (singles)<br>• Vigorous dancing<br>• Bicycling faster than 10 miles per hour<br>• Jumping rope<br>• Heavy yard work (digging or shoveling, with heart rate increases)<br>• Hiking uphill or with a heavy backpack<br>• High-intensity interval training<br>• Exercise classes like vigorous step aerobics or kickboxing |

▼ 0 ... 7

Q20 On average, how many minutes do you engage in physical activity at this level? You are encouraged to look at the data collected by your fitness tracker/smartphone.

_____

Q17 How many days a week do you perform muscle strengthening exercises? A strength exercise involves using your body weight or working against a resistance, such as lifting weights, working with resistance bands, climbing stairs, hill walking, cycling, dancing, push-ups, sit-ups and squats, and yoga.

▼ 0 ... 7

Q11 Are you currently participating or will you participate in any other organized program to increase your physical activity during the study period (Sep. X - Nov. X)? If yes, pleas briefly describe the program.

- ○ Yes. Please briefly describe. (1) _____
- ○ No (2)

**End of Block: Physical activity levels**

**Start of Block: Mental wellbeing**

Q6 Over the last two weeks:

| | At no time (1) | Some of the time (2) | More than half of the time (3) | Most of the time (4) | All the time (5) |
|---|---|---|---|---|---|
| I have felt cheerful and in good spirits (1) | ○ | ○ | ○ | ○ | ○ |
| I have felt calm and relaxed (2) | ○ | ○ | ○ | ○ | ○ |
| I have felt active and vigorous (3) | ○ | ○ | ○ | ○ | ○ |
| I woke up feeling fresh and rested (4) | ○ | ○ | ○ | ○ | ○ |
| My daily life has been filled with things that interest me (5) | ○ | ○ | ○ | ○ | ○ |

**End of Block: Mental wellbeing**

**Start of Block: Self-Efficacy**

Q7 According to Physical Activity Guidelines for Americans, adults should perform at least 150 minutes a week of moderate-intensity, or 75 minutes a week of vigorous-intensity aerobic physical activity, or an equivalent combination of moderate- and vigorous-intensity activity (1 minute of vigorous activity is equal to 2 minutes of moderate activity). In addition, strengthening exercises on 2 or more days a week,

such as bodyweight exercises or resistance training, are recommended. How confident are you right now that you could meet these guidelines if:

| | Not at all confident (1) | Slightly confident (2) | Moderately confident (3) | Very confident (4) | Extremely confident (5) |
|---|---|---|---|---|---|
| The weather was bothering you (1) | ○ | ○ | ○ | ○ | ○ |
| You were bored by the program or activity (2) | ○ | ○ | ○ | ○ | ○ |
| You felt pain when exercising (3) | ○ | ○ | ○ | ○ | ○ |
| You had to exercise alone (4) | ○ | ○ | ○ | ○ | ○ |
| You did not enjoy it (5) | ○ | ○ | ○ | ○ | ○ |
| You were too busy with other activities (6) | ○ | ○ | ○ | ○ | ○ |
| You felt tired (7) | ○ | ○ | ○ | ○ | ○ |
| You felt stressed (8) | ○ | ○ | ○ | ○ | ○ |
| You felt depressed (9) | ○ | ○ | ○ | ○ | ○ |

**End of Block: Self-Efficacy**

**Start of Block: Incentive Motivation**

Q8 I do physical activity because...

| | Strongly disagree (1) | Somewhat disagree (2) | Neither agree nor disagree (3) | Somewhat agree (4) | Strongly agree (5) |
|---|---|---|---|---|---|
| it's fun (1) | ○ | ○ | ○ | ○ | ○ |
| I think it's interesting (2) | ○ | ○ | ○ | ○ | ○ |
| it makes me happy (3) | ○ | ○ | ○ | ○ | ○ |
| I like to do this activity (4) | ○ | ○ | ○ | ○ | ○ |
| I find this activity stimulating (5) | ○ | ○ | ○ | ○ | ○ |
| I enjoy this activity (6) | ○ | ○ | ○ | ○ | ○ |
| I want to be physically fit (7) | ○ | ○ | ○ | ○ | ○ |
| I want to lose or maintain weight (8) | ○ | ○ | ○ | ○ | ○ |
| I want to better cope with stress (9) | ○ | ○ | ○ | ○ | ○ |
| I want to improve my appearance (10) | ○ | ○ | ○ | ○ | ○ |
| I want to have more energy (11) | ○ | ○ | ○ | ○ | ○ |
| I want to define my muscles (12) | ○ | ○ | ○ | ○ | ○ |
| I want to be attractive to others (13) | ○ | ○ | ○ | ○ | ○ |
| I want to improve my body shape (14) | ○ | ○ | ○ | ○ | ○ |
| I will feel ugly if I don't (15) | ○ | ○ | ○ | ○ | ○ |
| I want to improve my cardio fitness (16) | ○ | ○ | ○ | ○ | ○ |

| | | | | | |
|---|---|---|---|---|---|
| I want to get better at my activity (17) | ○ | ○ | ○ | ○ | ○ |
| I want to obtain new skills (18) | ○ | ○ | ○ | ○ | ○ |
| I want to improve my existing skills (19) | ○ | ○ | ○ | ○ | ○ |
| I want to keep up my current skill level (20) | ○ | ○ | ○ | ○ | ○ |
| I like the competition (21) | ○ | ○ | ○ | ○ | ○ |
| I like the challenge (22) | ○ | ○ | ○ | ○ | ○ |
| I like the excitement of participation (23) | ○ | ○ | ○ | ○ | ○ |

**End of Block: Incentive Motivation**

**Start of Block: Social support**

Q9 During the past month, my family (or members of my household) or friends or teammates:

| | 1 None (1) | 2 Rarely (2) | 3 A few times (3) | 4 Often (4) | 5 Very often (5) | Does not apply (6) |
|---|---|---|---|---|---|---|
| exercised with me (1) | ○ | ○ | ○ | ○ | ○ | ○ |
| offered to exercise with me (2) | ○ | ○ | ○ | ○ | ○ | ○ |
| gave me helpful reminders to exercise ("Are you going to exercise tonight?") (3) | ○ | ○ | ○ | ○ | ○ | ○ |
| gave me encouragement to stick with my exercise program (4) | ○ | ○ | ○ | ○ | ○ | ○ |
| changed their schedule so we could exercise together (5) | ○ | ○ | ○ | ○ | ○ | ○ |
| complained about the time I spend exercising (6) | ○ | ○ | ○ | ○ | ○ | ○ |
| criticized me or made fun of me for exercising. (7) | ○ | ○ | ○ | ○ | ○ | ○ |
| gave me rewards for exercising (bought me something or gave me something I like). (8) | ○ | ○ | ○ | ○ | ○ | ○ |
| planned for exercise on recreational outings. (9) | ○ | ○ | ○ | ○ | ○ | ○ |
| helped plan activities around my exercise. (10) | ○ | ○ | ○ | ○ | ○ | ○ |
| asked me for ideas on how they can get more exercise. (11) | ○ | ○ | ○ | ○ | ○ | ○ |
| talked about how much they like to exercise. (12) | ○ | ○ | ○ | ○ | ○ | ○ |

**End of Block: Social support**

**Start of Block: Self-regulation**

Q10 The following questions refer to how you fit exercise into your lifestyle. Please indicate the extent to which each of the statements below describes you:

| | 1 Does not describe (1) | 2 (2) | 3 Describes moderately (3) | 4 (4) | 5 Describes Completely (5) |
|---|---|---|---|---|---|
| I never seem to have enough time to exercise (1) | ○ | ○ | ○ | ○ | ○ |
| Exercise is generally a high priority when I plan my schedule (2) | ○ | ○ | ○ | ○ | ○ |
| Finding time for exercise is not difficult for me (3) | ○ | ○ | ○ | ○ | ○ |
| I schedule all events in my life around my exercise routine (4) | ○ | ○ | ○ | ○ | ○ |
| I schedule my exercise at specific times each week (5) | ○ | ○ | ○ | ○ | ○ |
| I plan my weekly exercise schedule (6) | ○ | ○ | ○ | ○ | ○ |
| When I am very busy, I don’t do much exercise (7) | ○ | ○ | ○ | ○ | ○ |
| Everything is scheduled around my exercise routine—both classes and work (8) | ○ | ○ | ○ | ○ | ○ |
| I try to exercise at the same time and same day each week to keep a routine going (9) | ○ | ○ | ○ | ○ | ○ |
| I write my planned activity sessions in an appointment book or calendar (10) | ○ | ○ | ○ | ○ | ○ |

**End of Block: Self-regulation**

**Start of Block: Demographic questions**

Q15 The following questions ask you to describe yourself

Q1 What is your gender?

- ○ Male (1)
- ○ Female (2)
- ○ Non-binary / third gender (3)
- ○ Prefer not to say (4)

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Q2 What is your age?

_____

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Q3 Are you a person of Hispanic, Latino, or Spanish origin?

- ○ Mexican, Mexican American, Chicano(a) (1)
- ○ Puerto Rican (2)
- ○ Cuban (3)
- ○ Other Hispanic, Latino(a), or Spanish origin (4)
- ○ Not of Hispanic, Latino(a), or Spanish origin (5)

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Q4 What is your race?

- ○ American Indian or Alaska Native (1)
- ○ Asian (2)
- ○ Black, African American (3)
- ○ Native Hawaiian or Pacific Islander (4)
- ○ White, Caucasian (5)
- ○ More than one race (6)
- ○ Other, please specify (7) _____

Q21 Please click the circle that represents your response to the following questions.

| | Never (11) | Sometimes (12) | About half the time (13) | Most of the time (14) | Always (15) |
|---|---|---|---|---|---|
| How often do you have someone help you read hospital materials? (1) | ○ | ○ | ○ | ○ | ○ |
| How often do you have problems learning about your medical condition because of difficulty understanding written information? (2) | ○ | ○ | ○ | ○ | ○ |
| How often do you have a problem understanding what is told to you about your medical condition? (3) | ○ | ○ | ○ | ○ | ○ |

Q22 How confident are you filling out medical forms by yourself?

- ○ Not at all (1)
- ○ Slightly (2)
- ○ Moderately (3)
- ○ Very (4)
- ○ Extremely (5)

Q18 Which program are your enrolled in?

- ○ Harrison College of Pharmacy (1)
- ○ College of Nursing (2)
- ○ The Edward Via College of Osteopathic Medicine-Auburn Campus (3)

**End of Block: Demographic questions**

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**Start of Block: Resources and Contact Info**

Q12 Some of the questions contained in the survey are related to sensitive mental health information. There is a possibility that after thinking more about the behavior you engage in and experiences you have had, you may experience psychological distress, or wonder if there is a resource available that could benefit you. A referral list of mental health providers is included Referral list for your use. If you need immediate assistance, please call the National Crisis Line, which is available 24 hours a day, 7 days a week free of charge at 1-800-273-TALK (8255). In addition, we invite you to search for a local counselor or therapist in your area at the following link: https://therapists.psychologytoday.com/rms/, noting that any cost involved in seeking treatment is at your own expense.

You have now completed the survey. Thank you for your responses. Click on the arrow below and you will be taken to a separate survey to enter your Auburn or VCOM Email address to receive a $5 Amazon gift card. You will receive another $10 Amazon gift card once you complete the second survey in November! Your contact information will not be linked in any way to your responses to this survey.

**End of Block: Resources and Contact Info**

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## Appendix 8. Week-8 Survey for Control Group

Start of Block: intro

Q16 Thank you for participating in this research project. Please answer the following questions. The survey takes approximately 20 minutes to complete. Upon completion of this survey, you will be given the option to provide your contact information for a $10 Amazon gift card, to be delivered to your Auburn/VCOM email.

Q17 How many days a week do you perform muscle strengthening exercises? A strength exercise involves using your body weight or working against a resistance, such as lifting weights, working with resistance bands, climbing stairs, hill walking, cycling, dancing, push-ups, sit-ups and squats, and yoga.

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End of Block: intro

Start of Block: Mental wellbeing

Q6 Over the last two weeks:

| | At no time (1) | Some of the time (2) | More than half of the time (3) | Most of the time (4) | All the time (5) |
|---|---|---|---|---|---|
| I have felt cheerful and in good spirits (1) | ○ | ○ | ○ | ○ | ○ |
| I have felt calm and relaxed (2) | ○ | ○ | ○ | ○ | ○ |
| I have felt active and vigorous (3) | ○ | ○ | ○ | ○ | ○ |
| I woke up feeling fresh and rested (4) | ○ | ○ | ○ | ○ | ○ |
| My daily life has been filled with things that interest me (5) | ○ | ○ | ○ | ○ | ○ |

**End of Block: Mental wellbeing**

**Start of Block: Self-Efficacy**

Q7 According to Physical Activity Guidelines for Americans, adults should perform at least 150 minutes a week of moderate-intensity, or 75 minutes a week of vigorous-intensity aerobic physical activity, or an equivalent combination of moderate- and vigorous-intensity activity (1 minute of vigorous activity is equal to 2 minutes of moderate activity). In addition, strengthening exercises on 2 or more days a week,

such as bodyweight exercises or resistance training, are recommended. How confident are you right now that you could meet these guidelines if:

| | Not at all confident (1) | Slightly confident (2) | Moderately confident (3) | Very confident (4) | Extremely confident (5) |
|---|---|---|---|---|---|
| The weather was bothering you (1) | ○ | ○ | ○ | ○ | ○ |
| You were bored by the program or activity (2) | ○ | ○ | ○ | ○ | ○ |
| You felt pain when exercising (3) | ○ | ○ | ○ | ○ | ○ |
| You had to exercise alone (4) | ○ | ○ | ○ | ○ | ○ |
| You did not enjoy it (5) | ○ | ○ | ○ | ○ | ○ |
| You were too busy with other activities (6) | ○ | ○ | ○ | ○ | ○ |
| You felt tired (7) | ○ | ○ | ○ | ○ | ○ |
| You felt stressed (8) | ○ | ○ | ○ | ○ | ○ |
| You felt depressed (9) | ○ | ○ | ○ | ○ | ○ |

**End of Block: Self-Efficacy**

**Start of Block: Motivational incentives**

Q8 I do physical activity because...

| | Strongly disagree (1) | Somewhat disagree (2) | Neither agree nor disagree (3) | Somewhat agree (4) | Strongly agree (5) |
|---|---|---|---|---|---|
| it's fun (1) | ○ | ○ | ○ | ○ | ○ |
| I think it's interesting (2) | ○ | ○ | ○ | ○ | ○ |
| it makes me happy (3) | ○ | ○ | ○ | ○ | ○ |
| I like to do this activity (4) | ○ | ○ | ○ | ○ | ○ |
| I find this activity stimulating (5) | ○ | ○ | ○ | ○ | ○ |
| I enjoy this activity (6) | ○ | ○ | ○ | ○ | ○ |
| I want to be physically fit (7) | ○ | ○ | ○ | ○ | ○ |
| I want to lose or maintain weight (8) | ○ | ○ | ○ | ○ | ○ |
| I want to better cope with stress (9) | ○ | ○ | ○ | ○ | ○ |
| I want to improve my appearance (10) | ○ | ○ | ○ | ○ | ○ |
| I want to have more energy (11) | ○ | ○ | ○ | ○ | ○ |
| I want to define my muscles (12) | ○ | ○ | ○ | ○ | ○ |
| I want to be attractive to others (13) | ○ | ○ | ○ | ○ | ○ |
| I want to improve my body shape (14) | ○ | ○ | ○ | ○ | ○ |
| I will feel ugly if I don't (15) | ○ | ○ | ○ | ○ | ○ |
| I want to improve my cardio fitness (16) | ○ | ○ | ○ | ○ | ○ |

| | | | | | |
|---|---|---|---|---|---|
| I want to get better at my activity (17) | ○ | ○ | ○ | ○ | ○ |
| I want to obtain new skills (18) | ○ | ○ | ○ | ○ | ○ |
| I want to improve my existing skills (19) | ○ | ○ | ○ | ○ | ○ |
| I want to keep up my current skill level (20) | ○ | ○ | ○ | ○ | ○ |
| I like the competition (21) | ○ | ○ | ○ | ○ | ○ |
| I like the challenge (22) | ○ | ○ | ○ | ○ | ○ |
| I like the excitement of participation (23) | ○ | ○ | ○ | ○ | ○ |

**End of Block: Motivational incentives**

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**Start of Block: Social support**

Q9 During the past month, my family (or members of my household) or friends or teammates:

| | 1 None (1) | 2 Rarely (2) | 3 A few times (3) | 4 Often (4) | 5 Very often (5) | Does not apply (6) |
|---|---|---|---|---|---|---|
| exercised with me (1) | ○ | ○ | ○ | ○ | ○ | ○ |
| offered to exercise with me (2) | ○ | ○ | ○ | ○ | ○ | ○ |
| gave me helpful reminders to exercise ("Are you going to exercise tonight?") (3) | ○ | ○ | ○ | ○ | ○ | ○ |
| gave me encouragement to stick with my exercise program (4) | ○ | ○ | ○ | ○ | ○ | ○ |
| changed their schedule so we could exercise together (5) | ○ | ○ | ○ | ○ | ○ | ○ |
| complained about the time I spend exercising (6) | ○ | ○ | ○ | ○ | ○ | ○ |
| criticized me or made fun of me for exercising. (7) | ○ | ○ | ○ | ○ | ○ | ○ |
| gave me rewards for exercising (bought me something or gave me something I like). (8) | ○ | ○ | ○ | ○ | ○ | ○ |
| planned for exercise on recreational outings. (9) | ○ | ○ | ○ | ○ | ○ | ○ |
| helped plan activities around my exercise. (10) | ○ | ○ | ○ | ○ | ○ | ○ |
| asked me for ideas on how they can get more exercise. (11) | ○ | ○ | ○ | ○ | ○ | ○ |
| talked about how much they like to exercise. (12) | ○ | ○ | ○ | ○ | ○ | ○ |

**End of Block: Social support**

**Start of Block: Self-regulation**

Q10 The following questions refer to how you fit exercise into your lifestyle. Please indicate the extent to which each of the statements below describe you:

| | 1 Does not describe (1) | 2 (2) | 3 Describes moderately (3) | 4 (4) | 5 Describes Completely (5) |
|---|---|---|---|---|---|
| I never seem to have enough time to exercise (1) | ○ | ○ | ○ | ○ | ○ |
| Exercise is generally a high priority when I plan my schedule (2) | ○ | ○ | ○ | ○ | ○ |
| Finding time for exercise is not difficult for me (3) | ○ | ○ | ○ | ○ | ○ |
| I schedule all events in my life around my exercise routine (4) | ○ | ○ | ○ | ○ | ○ |
| I schedule my exercise at specific times each week (5) | ○ | ○ | ○ | ○ | ○ |
| I plan my weekly exercise schedule (6) | ○ | ○ | ○ | ○ | ○ |
| When I am very busy, I don't do much exercise (7) | ○ | ○ | ○ | ○ | ○ |
| Everything is scheduled around my exercise routine—both classes and work (8) | ○ | ○ | ○ | ○ | ○ |
| I try to exercise at the same time and same day each week to keep a routine going (9) | ○ | ○ | ○ | ○ | ○ |
| I write my planned activity sessions in an appointment book or calendar (10) | ○ | ○ | ○ | ○ | ○ |

**End of Block: Self-regulation**

**Start of Block: Resources and Contact Info**

Q12 Some of the questions contained in the survey are related to sensitive mental health information. There is a possibility that after thinking more about the behavior you engage in and experiences you have had, you may experience psychological distress, or wonder if there is a resource available that could benefit you. A referral list of mental health providers is included Referral list for your use. If you need immediate assistance, please call the National Crisis Line, which is available 24 hours a day, 7 days a week free of charge at 1-800-273-TALK (8255). In addition, we invite you to search for a local counselor

or therapist in your area at the following link: https://therapists.psychologytoday.com/rms/, noting that any cost involved in seeking treatment is at your own expense.

You have now completed the survey. Thank you for your responses. Click on the arrow below and you will be taken to a separate survey to enter your Auburn or VCOM Email address to receive a $10 Amazon gift card. If you also completed the first survey at the beginning of this study, you will be entered into the drawing for an opportunity to win an additional $20/$30/$50 Amazon gift card in approximately 4 weeks. We will contact you if you win! Your contact information will not be linked in any way to your responses to this survey.

**End of Block: Resources and Contact Info**

## Appendix 9. Week-8 Survey for DFFC Group

Start of Block: intro

Q16 Thank you for participating in the 2022 Deans' Fit Family Challenge and this research project. Please answer the following questions. The survey takes approximately 20 minutes to complete. Upon completion of this survey, you will be given the option to provide your contact information for a $10 Amazon gift card, to be delivered to you Auburn/VCOM email.

Q17 How many days a week do you perform muscle strengthening exercises? A strength exercise involves using your body weight or working against a resistance, such as lifting weights, working with resistance bands, climbing stairs, hill walking, cycling, dancing, push-ups, sit-ups and squats, and yoga.

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End of Block: intro

Start of Block: Mental wellbeing

Q6 Over the last two weeks:

| | At no time (1) | Some of the time (2) | More than half of the time (3) | Most of the time (4) | All the time (5) |
|---|---|---|---|---|---|
| I have felt cheerful and in good spirits (1) | | | | | |
| I have felt calm and relaxed (2) | | | | | |
| I have felt active and vigorous (3) | | | | | |
| I woke up feeling fresh and rested (4) | | | | | |
| My daily life has been filled with things that interest me (5) | | | | | |

End of Block: Mental wellbeing

Start of Block: Self-Efficacy

Q7 According to Physical Activity Guidelines for Americans, adults should perform at least 150 minutes a week of moderate-intensity, or 75 minutes a week of vigorous-intensity aerobic physical activity, or an equivalent combination of moderate- and vigorous-intensity activity (1 minute of vigorous activity is equal to 2 minutes of moderate activity). In addition, strengthening exercises on 2 or more days a week, such as bodyweight exercises or resistance training, are recommended. How confident are you right now that you could meet these guidelines if:

| | Not at all confident (1) | Slightly confident (2) | Moderately confident (3) | Very confident (4) | Extremely confident (5) |
|---|---|---|---|---|---|
| The weather was bothering you (1) | | | | | |
| You were bored by the program or activity (2) | | | | | |
| You felt pain when exercising (3) | | | | | |
| You had to exercise alone (4) | | | | | |
| You did not enjoy it (5) | | | | | |
| You were too busy with other activities (6) | | | | | |
| You felt tired (7) | | | | | |
| You felt stressed (8) | | | | | |
| You felt depressed (9) | | | | | |

End of Block: Self-Efficacy

Start of Block: Motivational incentives

Q8 I do physical activity because...

| | Strongly disagree (1) | Somewhat disagree (2) | Neither agree nor disagree (3) | Somewhat agree (4) | Strongly agree (5) |
|---|---|---|---|---|---|
| it's fun (1) | | | | | |
| I think it's interesting (2) | | | | | |
| it makes me happy (3) | | | | | |
| I like to do this activity (4) | | | | | |
| I find this activity stimulating (5) | | | | | |
| I enjoy this activity (6) | | | | | |
| I want to be physically fit (7) | | | | | |
| I want to lose or maintain weight (8) | | | | | |
| I want to better cope with stress (9) | | | | | |
| I want to improve my appearance (10) | | | | | |
| I want to have more energy (11) | | | | | |
| I want to define my muscles (12) | | | | | |
| I want to be attractive to others (13) | | | | | |
| I want to improve my body shape (14) | | | | | |
| I will feel ugly if I don't (15) | | | | | |
| I want to improve my cardio fitness (16) | | | | | |
| I want to get better at my activity (17) | | | | | |
| I want to obtain new skills (18) | | | | | |
| I want to improve my existing skills (19) | | | | | |
| I want to keep up my current skill level (20) | | | | | |

| |
|---|
| I like the competition (21) |
| I like the challenge (22) |
| I like the excitement of participation (23) |

End of Block: Motivational incentives

Start of Block: Social support

Q9 During the past month, my family (or members of my household) or friends or teammates:

| | 1 None (1) | 2 Rarely (2) | 3 A few times (3) | 4 Often (4) | 5 Very often (5) | Does not apply (6) |
|---|---|---|---|---|---|---|
| exercised with me (1) | | | | | | |
| offered to exercise with me (2) | | | | | | |
| gave me helpful reminders to exercise ("Are you going to exercise tonight?") (3) | | | | | | |
| gave me encouragement to stick with my exercise program (4) | | | | | | |
| changed their schedule so we could exercise together (5) | | | | | | |
| complained about the time I spend exercising (6) | | | | | | |
| criticized me or made fun of me for exercising. (7) | | | | | | |
| gave me rewards for exercising (bought me something or gave me something I like). (8) | | | | | | |
| planned for exercise on recreational outings. (9) | | | | | | |
| helped plan activities around my exercise. (10) | | | | | | |
| asked me for ideas on how they can get more exercise. (11) | | | | | | |
| talked about how much they like to exercise. (12) | | | | | | |

End of Block: Social support

Start of Block: Self-regulation

Q10 The following questions refer to how you fit exercise into your lifestyle. Please indicate the extent to which each of the statements below describes you:

| | 1 Does not describe (1) | 2 (2) | 3 Describes moderately (3) | 4 (4) | 5 Describes Completely (5) |
|---|---|---|---|---|---|
| I never seem to have enough time to exercise (1) | | | | | |
| Exercise is generally a high priority when I plan my schedule (2) | | | | | |
| Finding time for exercise is not difficult for me (3) | | | | | |
| I schedule all events in my life around my exercise routine (4) | | | | | |
| I schedule my exercise at specific times each week (5) | | | | | |
| I plan my weekly exercise schedule (6) | | | | | |
| When I am very busy, I don't do much exercise (7) | | | | | |
| Everything is scheduled around my exercise routine—both classes and work (8) | | | | | |
| I try to exercise at the same time and same day each week to keep a routine going (9) | | | | | |
| I write my planned activity sessions in an appointment book or calendar (10) | | | | | |

End of Block: Self-regulation

Start of Block: Participants' experiences DFFC (delete for control group)

Q11 What aspects of the Deans' Fit Family Challenge motivate you to exercise?

- [ ] The competitive nature of the Challenge (1)
- [ ] Weekly activity minute logging (2)
- [ ] Weekly motivational email (3)
- [ ] Working with my teammate (4)
- [ ] Group fitness activities (5)
- [ ] Prizes/awards throughout the Challenge (6)
- [ ] Announcement of previous week's winners and their data (7)
- [ ] Marketing materials about physical activity (8)
- [ ] Other, please describe (9)

Q12 Please describe an aspect of 2022 Deans' Fit Family Challenge you enjoyed the most

_____

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Q13 What are the barriers you encounter while doing or scheduling your exercise during 2022 Deans' Fit Family Challenge?

- ☐ Insufficient time (1)
- ☐ Lack of skills and knowledge (2)
- ☐ Lack of motivation (3)
- ☐ Lack of support (4)
- ☐ Lack of access to appropriate facilities (5)
- ☐ Unsafe neighborhoods (6)
- ☐ Poor weather (7)
- ☐ Negative experiences while engaging in physical activity (8)
- ☐ Other, please describe (9) _____

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Q14 Please describe one thing/aspect of the 2022 Deans' Fit Family Challenge you would change to make it better.

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**End of Block: Participants' experiences DFFC (delete for control group)**

**Start of Block: Acceptability (delete if they in control group)**

Q25 Overall, how satisfied were you with the 2022 Deans' Fit Family Challenge

Very dissatisfied (1)
Somewhat dissatisfied (2)
Neither satisfied nor dissatisfied (3)
Somewhat satisfied (4)
Very satisfied (5)

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Q16 How likely are you to participate in next year's 2023 Deans' Fit Family Challenge if you are still eligible?

Extremely unlikely (1)
Somewhat unlikely (2)
Neither likely nor unlikely (3)
Somewhat likely (4)
Extremely likely (5)

**End of Block: Acceptability (delete if they in control group)**

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**Start of Block: Resources and Contact Info**

Q12 Some of the questions contained in the survey are related to sensitive mental health information. There is a possibility that after thinking more about the behavior you engage in and experiences you have had, you may experience psychological distress, or wonder if there is a resource available that could benefit you. A referral list of mental health providers is included Referral list for your use. If you need immediate assistance, please call the National Crisis Line, which is available 24 hours a day, 7 days a week free of charge at 1-800-273-TALK (8255). In addition, we invite you to search for a local counselor or therapist in your area at the following link: https://therapists.psychologytoday.com/rms/, noting that any cost involved in seeking treatment is at your own expense.

You have now completed the survey. Thank you for your responses. Click on the arrow below and you will be taken to a separate survey to enter your Auburn or VCOM Email address to receive a $10 Amazon gift card. If you also completed the first survey at the beginning of this study, you will be entered into the drawing for an opportunity to win an additional $20/$30/$50 Amazon gift card in approximately 4 weeks. We will contact you if you win! Your contact information will not be linked in any way to your responses to this survey.

**End of Block: Resources and Contact Info**

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## Appendix 10. Week-8 Survey for DFFC + Text Group

**Start of Block: intro**

Q16 Thank you for participating in the 2022 Deans' Fit Family Challenge and this research project. Please answer the following questions. The survey takes approximately 20 minutes to complete. Upon completion of this survey, you will be given the option to provide your contact information for a $10 Amazon gift card, to be delivered to you Auburn/VCOM email.

Q17 How many days a week do you perform muscle strengthening exercises? A strength exercise involves using your body weight or working against a resistance, such as lifting weights, working with resistance bands, climbing stairs, hill walking, cycling, dancing, push-ups, sit-ups and squats, and yoga.

▼ 0 ... 7

**End of Block: intro**

**Start of Block: Mental wellbeing**

Q6 Over the last two weeks:

| | At no time (1) | Some of the time (2) | More than half of the time (3) | Most of the time (4) | All the time (5) |
|---|---|---|---|---|---|
| I have felt cheerful and in good spirits (1) | | | | | |
| I have felt calm and relaxed (2) | | | | | |
| I have felt active and vigorous (3) | | | | | |
| I woke up feeling fresh and rested (4) | | | | | |
| My daily life has been filled with things that interest me (5) | | | | | |

**End of Block: Mental wellbeing**

Start of Block: Self-Efficacy

Q7 According to Physical Activity Guidelines for Americans, adults should perform at least 150 minutes a week of moderate-intensity, or 75 minutes a week of vigorous-intensity aerobic physical activity, or an equivalent combination of moderate- and vigorous-intensity activity (1 minute of vigorous activity is equal to 2 minutes of moderate activity). In addition, strengthening exercises on 2 or more days a week, such as bodyweight exercises or resistance training, are recommended. How confident are you right now that you could meet these guidelines if:

| | Not at all confident (1) | Slightly confident (2) | Moderately confident (3) | Very confident (4) | Extremely confident (5) |
|---|---|---|---|---|---|
| The weather was bothering you (1) | | | | | |
| You were bored by the program or activity (2) | | | | | |
| You felt pain when exercising (3) | | | | | |
| You had to exercise alone (4) | | | | | |
| You did not enjoy it (5) | | | | | |
| You were too busy with other activities (6) | | | | | |
| You felt tired (7) | | | | | |
| You felt stressed (8) | | | | | |
| You felt depressed (9) | | | | | |

End of Block: Self-Efficacy

Start of Block: Motivational incentives

Q8 I do physical activity because...

| | Strongly disagree (1) | Somewhat disagree (2) | Neither agree nor disagree (3) | Somewhat agree (4) | Strongly agree (5) |
|---|---|---|---|---|---|
| it's fun (1) | | | | | |
| I think it's interesting (2) | | | | | |
| it makes me happy (3) | | | | | |
| I like to do this activity (4) | | | | | |
| I find this activity stimulating (5) | | | | | |
| I enjoy this activity (6) | | | | | |
| I want to be physically fit (7) | | | | | |
| I want to lose or maintain weight (8) | | | | | |
| I want to better cope with stress (9) | | | | | |
| I want to improve my appearance (10) | | | | | |
| I want to have more energy (11) | | | | | |
| I want to define my muscles (12) | | | | | |
| I want to be attractive to others (13) | | | | | |
| I want to improve my body shape (14) | | | | | |
| I will feel ugly if I don't (15) | | | | | |
| I want to improve my cardio fitness (16) | | | | | |
| I want to get better at my activity (17) | | | | | |
| I want to obtain new skills (18) | | | | | |
| I want to improve my existing skills (19) | | | | | |
| I want to keep up my current skill level (20) | | | | | |

| |
|---|
| I like the competition (21) |
| I like the challenge (22) |
| I like the excitement of participation (23) |

**End of Block: Motivational incentives**

**Start of Block: Social support**

Q9 During the past month, my family (or members of my household) or friends or teammates:

| | 1 None (1) | 2 Rarely (2) | 3 A few times (3) | 4 Often (4) | 5 Very often (5) | Does not apply (6) |
|---|---|---|---|---|---|---|
| exercised with me (1) | | | | | | |
| offered to exercise with me (2) | | | | | | |
| gave me helpful reminders to exercise ("Are you going to exercise tonight?") (3) | | | | | | |
| gave me encouragement to stick with my exercise program (4) | | | | | | |
| changed their schedule so we could exercise together (5) | | | | | | |
| complained about the time I spend exercising (6) | | | | | | |
| criticized me or made fun of me for exercising. (7) | | | | | | |
| gave me rewards for exercising (bought me something or gave me something I like). (8) | | | | | | |
| planned for exercise on recreational outings. (9) | | | | | | |
| helped plan activities around my exercise. (10) | | | | | | |
| asked me for ideas on how they can get more exercise. (11) | | | | | | |
| talked about how much they like to exercise. (12) | | | | | | |

End of Block: Social support

Start of Block: Self-regulation

Q10 The following questions refer to how you fit exercise into your lifestyle. Please indicate the extent to which each of the statements below describes you:

| | 1 Does not describe (1) | 2 (2) | 3 Describes moderately (3) | 4 (4) | 5 Describes Completely (5) |
|---|---|---|---|---|---|
| I never seem to have enough time to exercise (1) | | | | | |
| Exercise is generally a high priority when I plan my schedule (2) | | | | | |
| Finding time for exercise is not difficult for me (3) | | | | | |
| I schedule all events in my life around my exercise routine (4) | | | | | |
| I schedule my exercise at specific times each week (5) | | | | | |
| I plan my weekly exercise schedule (6) | | | | | |
| When I am very busy, I don't do much exercise (7) | | | | | |
| Everything is scheduled around my exercise routine—both classes and work (8) | | | | | |
| I try to exercise at the same time and same day each week to keep a routine going (9) | | | | | |
| I write my planned activity sessions in an appointment book or calendar (10) | | | | | |

End of Block: Self-regulation

Start of Block: Participants' experiences DFFC

Q11 What aspects of the 2022 Deans' Fit Family Challenge motivate you to exercise?

- ☐ The competitive nature of the Challenge (1)
- ☐ Weekly activity minute logging (2)
- ☐ Weekly motivational email (3)
- ☐ Working with my teammate (4)
- ☐ Group fitness activities (5)
- ☐ Prizes/awards throughout the Challenge (6)
- ☐ Announcement of previous week's winners and their data (7)
- ☐ Marketing materials about physical activity (8)
- ☐ Other, please describe (9)

Q12 Please describe an aspect of 2022 Deans' Fit Family Challenge you enjoyed the most

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Q13 What are the barriers you encounter while doing or scheduling your exercise during 2022 Deans' Fit Family Challenge?

- ☐ Insufficient time (1)
- ☐ Lack of skills and knowledge (2)
- ☐ Lack of motivation (3)
- ☐ Lack of support (4)
- ☐ Lack of access to appropriate facilities (5)
- ☐ Unsafe neighborhoods (6)
- ☐ Poor weather (7)
- ☐ Negative experiences while engaging in physical activity (8)
- ☐ Other, please describe (9) _____

Q14 Please describe one thing/aspect of the 2022 Deans' Fit Family Challenge you would change to make it better.

_____

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**End of Block: Participants' experiences DFFC**

**Start of Block: Acceptability**

Q25 Overall, how satisfied were you with the 2022 Deans' Fit Family Challenge

Very dissatisfied (1)
Somewhat dissatisfied (2)
Neither satisfied nor dissatisfied (3)
Somewhat satisfied (4)
Very satisfied (5)

Q16 How likely are you to participate in next year's 2023 Deans' Fit Family Challenge if you are still eligible?

Extremely unlikely (1)
Somewhat unlikely (2)
Neither likely nor unlikely (3)
Somewhat likely (4)
Extremely likely (5)

**End of Block: Acceptability**

**Start of Block: Satisfaction SMS**

Q25 During the Challenge, how would you rate the text messages you received in terms of the activities below?

| | Very unhelpful (1) | Unhelpful (2) | Neutral (3) | Helpful (4) | Very helpful (5) |
|---|---|---|---|---|---|
| motivating me to start exercising (1) | | | | | |
| motivating me to do more exercise (2) | | | | | |
| helping me achieve the 150-minute/week goal (3) | | | | | |

Q24 How satisfied are you with the physical activity text messages you received during the Challenge?

| | Extremely dissatisfied (1) | Somewhat dissatisfied (2) | Neither satisfied nor dissatisfied (3) | Somewhat satisfied (4) | Extremely satisfied (5) |
|---|---|---|---|---|---|
| Frequency of text messages received (1) | | | | | |
| Satisfaction with the understandability of the content of the text messages (2) | | | | | |
| Satisfaction with motivational wording in the text messages (3) | | | | | |
| Overall satisfaction with the text messages (4) | | | | | |

**End of Block: Satisfaction SMS**

**Start of Block: Resources and Contact Info**

Q12 Some of the questions contained in the survey are related to sensitive mental health information. There is a possibility that after thinking more about the behavior you engage in and experiences you have had, you may experience psychological distress, or wonder if there is a resource available that could benefit you. A referral list of mental health providers is included Referral list for your use. If you need immediate assistance, please call the National Crisis Line, which is available 24 hours a day, 7 days a week free of charge at 1-800-273-TALK (8255). In addition, we invite you to search for a local counselor or therapist in your area at the following link: https://therapists.psychologytoday.com/rms/, noting that any cost involved in seeking treatment is at your own expense.

You have now completed the survey. Thank you for your responses. Click on the arrow below and you will be taken to a separate survey to enter your Auburn or VCOM Email address to receive a $10 Amazon gift card. If you also completed the first survey at the beginning of this study, you will be entered into the drawing for an opportunity to win an additional $20/$30/$50 Amazon gift card in approximately 4 weeks. We will contact you if you win! Your contact information will not be linked in any way to your responses to this survey.

**End of Block: Resources and Contact Info**

## Appendix 11. Week -0 Contact Information Survey

Q1 Please enter your Auburn or VCOM Email address to receive a $5 Amazon gift card. Your contact information will not be linked in any way to your responses to this survey.

_____

## Appendix 12. Week -8 Contact Information Survey

Q1 Please enter your Auburn or VCOM Email address to receive a $10 Amazon gift card. Your contact information will not be linked in any way to your responses to this survey.

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## Appendix 13. Referral List for Mental Wellbeing

# Referral List

If you have experienced distress as a result of your participation in this study, a referral list of mental health providers is included below for your use. (Please remember that any cost in seeking medical assistance is at your own expense.)

**On Campus Services:**

| Provider | Phone Number | Cost/Hour |
|---|---|---|
| Auburn University Student Counseling and Psychological Services (SCPS) | 334-844-5123 | Services are no charge for students. Up to 10 sessions allotted per academic year.<br>Crisis walk-in/call-in service during business hours; crisis call-in service after-hours &weekends. |
| Auburn University Psychological Services Center (AUPSC) | 334-844-4889 | First appointment $80<br>Subsequent appointments $30-$60 based on income, or $30 for AU students |
| Auburn University Marriage & Family Center | 334-844-4478 | First appointment $20<br>Subsequent appointments $50 based on income or $20 for AU Students |
| Tiger Education Screening Intervention | 334-844-1311 | No charge for self-referred AU students<br>$125 for mandated referrals |
| Auburn University Public Safety | 334-844-8888 | |
| Auburn University Medical Clinic | 334-844-4416 | |

**Off Campus Services**:

| Provider | Phone Number | Cost/Hour |
|---|---|---|
| Clinical Psychologists, PC | 334-821-3350 | $150, first appointment<br>$130, other appointments<br>Insurance Accepted |
| Auburn Psychology Group, LLC | 334-887-4343 | $160, first appointment<br>$140, other appointments<br>Insurance Accepted |
| East Alabama Mental Health | 800-815-0630<br>334-742-2877<br>334-742-2700 | Help available 24/7<br>$8-$80 based on income |
| East Alabama Alcoholism and Substance Abuse Services | 334-742-2130 | Outpatient and court-ordered referrals; call for a quote |

**Emergency Services:**

| Provider | Phone Number | Cost/Hour |
|---|---|---|
| National Suicide Prevention Lifeline | 1-800-273-TALK (8255) | No charge, This lifeline is FREE, confidential and always available. |
| Emergency Services<br>East Alabama Medical Center Emergency Department | 911<br>334-528-1150 | Dependent on insurance |