

ASSESSING BODY MEASUREMENTS, NUTRITIONAL BEHAVIORS, AND SLEEP
BEHAVIORS FOLLOWING IMPLEMENTATION OF MHEALTH IN APPALACHIAN
STATE UNIVERSITY COLLEGE STUDENTS

A Thesis
by
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Abstract

ASSESSING BODY MEASUREMENTS, NUTRITIONAL BEHAVIORS, AND SLEEO BEHAVIORS FOLLOWING IMPLEMENTATION OF MHEALTTH IN APPALACHIAN STATE UNIVERSITY COLLEGE STUDENTS

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Chronic diseases such as obesity are now more common in college students. College students struggle to develop strategies to maintain healthy weight and lifestyle behaviors when adapting to a college lifestyle and routine. mHealth programs are accessible to college students' schedules and routines due to the high usage of mobile devices. *My Quest in the High Country* collaborated with Appalachian State University (ASU) Student Health Services and the Blue Cross Institute for Health and Human Services Interprofessional Clinic to create a 24-week mHealth intervention to improve weight status, health behaviors, sleep status and biometrics in ASU students.

Recruitment of ASU students occurred from November 2020-January 2021 through flyers, social media, and email. During pre-assessment, eligibility was confirmed; afterward informed consent, biometrics, and a pre-assessment survey were collected. Participants received a scale, Fitbit, and caloric intake goals. From weeks 1-12, participants received text messages (n=1/day), eNewsletters (n=1/wk), and physical activity feedback based on

individual physical activity and step counts.. At midpoint, Fitbits were returned, biometrics were taken, and a midpoint survey was completed. From weeks 13-24, text messages and eNewsletters continued. At post-assessment, biometrics and post-assessment surveys were collected. Statistical analyses included Wilcoxon Signed Rank, McNemar, paired *t*-test, and descriptives. Significance was set at $p < .05$.

Participants ($n=11$) were female (72.7%), non-Hispanic (82%), and Caucasian (64%), with a mean age of 23.4 (6.2). Significant ($p < .05$) improvements were observed in body weight, BMI, diastolic blood pressure, fruit and vegetable intake, and sedentary time. No significant changes occurred in systolic blood pressure, step count, physical activity minutes, or sleep score.

An mHealth intervention in college students may have a positive impact on health and behavior change. Progress dropped after returning the Fitbit at week 12. In future studies, a larger student email list may increase sample size and participant diversity. Wearing the Fitbit for 24 weeks would be preferable.

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Table of Contents

Abstract	iv
Acknowledgments.....	vi
List of Tables	ix
Foreword.....	x
Chapter 1: Introduction	1
References	19
Chapter 2: Article.....	24
References	35
Chapter 3: Summary of Findings and Limitations.....	38
References	43
Appendix A.....	45
Appendix B.....	46
Appendix C.....	48
Appendix D.....	51
Appendix E	53
Appendix F	54
Appendix G.....	56
Appendix H.....	58
Appendix I	60

Appendix J.....	74
Appendix K.....	80
Appendix L.....	83
Vita.....	85

List of Tables

Table 1. Text Response for Body Weight of My Quest in the High Country.....	80
Table 2. Participant Social Cognitive Theory Construct Stores Before and After <i>My Quest in the High Country</i>	80
Table 3: Anthropometric and Physical Activity Characteristics of <i>My Quest in the High-Country</i> Participants at Pre-assessment and Post-assessment	81
Table 4: Demographic Characteristics of <i>My Quest in the High-Country</i> Participant at Pre-assessment.....	82

Foreword

Chapter 2 of this Thesis will be submitted to the *Journal of American College Health*. It has been formatted according to the style guide of that journal.

Chapter 1: Introduction

Background

The American population has greatly suffered from the prevalence of obesity within the past several decades.¹ The issue has also impacted young adults. Now, 30-35% of college students have been characterized as overweight or obese.² As young adults enter into a college lifestyle, new habits are learned and old habits are forgotten due to social and environmental influences.² There has also been a greater gap in health knowledge, healthy behaviors, and sleep behaviors among college students.

Chronic diseases have become more common at a younger age as obesity encompasses the younger population. In addition, medical costs of those individuals will impact their quality of life.² College students experience a tough transition to independence and often struggle to develop good strategies to maintain a healthy weight and lifestyle behaviors.³ Technology has become a prominent part of the young adult lifestyle. Students are always involved and engaged in technology, especially smartphones, therefore a tailored health behavior and weight management intervention using technology may be more practical for this population. Incorporating technology-based interventions such as text-messaging, personal fitness trackers, and eNewsletters into a weight loss/management program may improve health behaviors and well-being of many young individuals.⁴ A text message-based weight and health management program can be cost effective and easily adhered to on college campuses. A mobile health (mHealth) initiative is easily accessed and adaptable to the busy schedule of a college student and can make lasting impacts to health education and health status.⁵⁻⁸ A tailored and daily text message-based intervention for

college students can encourage healthy weight loss and promote the incorporation of healthy diet and lifestyle behaviors.

Appalachian State University Statistics and Information

Appalachian State University is located in Boone, North Carolina. The town of Boone is within rural Watauga County. As of 2020, the population of Boone was 19,965.⁹ In Fall 2020, 20,023 students were enrolled at Appalachian State University, with a total of 18,061 being undergraduate students and 1962 graduate students. It is also important to note that 5,992 students are from rural populations, and 6,100 students are first generation undergraduates.¹⁰

Literature Review

Obesity in America

Obesity has become a critical disease that affects many individuals worldwide. The Centers for Disease Control and Prevention (CDC) defines overweight and obesity as a body mass index (BMI) of greater than or equal to 25 and greater than or equal to 30, respectively.¹ Individuals with high BMI often have extra fat deposits, especially in the abdominal region.¹ Men with a waist circumference greater than 40 inches and women with a waist circumference greater than 35 inches are at risk of comorbidities tied to being overweight or obese.^{1,11} Direct medical expenses, indirect costs such as time off work, and other correlated conditions are also experienced in those who are obese or overweight. Obesity has been correlated with increased risk of chronic diseases such as cardiovascular diseases, stroke, diabetes, hypertension, cancer, and many others. Moreover, the financial

costs associated with obesity are extreme, with estimated annual costs of \$3.38 to \$6.38 billion.¹¹ In a comparison of National Health and Nutrition Examination Survey (NHANES) data from years 1999-2000 and 2007-2008, specifically 33.8% of participants were obese in the 2007-2008 data compared to 30.5% in 1999-2000.¹² In a global MEDLINE literature search, rates of obesity in 2030 were estimated to be increased by 45%.¹³ Social and financial lifestyles are affected even more among young adults or college students, who have had a higher prevalence of being overweight or obese than in previous years.¹⁴

Obesity in College Students

Among many college students, there has been an increase in body weight and obesity. The significance of obesity in this age group has been influenced by poor eating and lifestyle habits. In a previous report by Harrington and Ickes, 30-35% of college students have been characterized as overweight or obese.² College students overall have been exposed to or exhibit poor eating and lifestyle habits.²

In a four-year study of 131 college students, basic anthropometric measurements, body composition, and body shape were taken at two time points: start of freshman year and end of senior year.¹⁵ College students were more likely to significantly gain weight, increase BMI, and increase body fat mass, with males having a greater increase in each. Weight change ranged from a decrease of 8.7kg to an increase of 16.8kg increase in some individuals, with weight gain observed in 70% of the participants.¹⁵

Social Cognitive Theory

The Social Cognitive Theory (SCT) addresses psychosocial factors for behavior change, and is often used in nutrition education and physical activity programs.¹⁶ The theory focuses on the personal, behavioral, and environmental factors that influence change and development of human behaviors.¹⁷ Personal factors include feelings, expectations, and attitudes. Behavioral factors are aspects of self-efficacy and developing skills to obtain a new health behavior. Environmental factors are the social and community influences on health behaviors.¹⁷ While developing a solid foundation within each factor is important, self efficacy to engage in the behavior change is imperative.¹⁷ Self efficacy is the personal belief of being able to execute and maintain behavior change.¹⁶ Having the confidence to take a step towards better health is where behavior change begins. In combination with self efficacy, it is crucial to acknowledge perceived benefits in new behaviors. Having factors such as social support, implementation of nutrition and health education, and using personal fitness trackers could show improvements in health behaviors.¹⁸

Health Behaviors Among College Students

The transition from home to independence plays an important role in healthy behavior choices. There is an increase in unhealthy eating or snacking, and a decrease in consumption of fruits and vegetables. Skipping breakfast is also common. Well known barriers of a healthy lifestyle are a lack of time or time-management, high pricing of foods, and the lack of motivation or knowledge of cooking foods. It is commonly reported that social peer groups and friends positively impacted healthy behavior choices, especially exercise. Parents are also considered a supporting factor in some students, however others reported the opposite.

The common “all you can eat” meal plans at many college campuses negatively affect some students who feel the need to get what is paid for, while some see it to be more flexible in choosing a healthier diet.³

It is important to assess the health and eating behaviors of college students to better understand the pervasiveness of obesity in this age group. In a cross-sectional survey of 736 college students aged 18-27, Huang and colleagues considered the intake of fruit and vegetable servings.¹⁹ Most participants did not meet the recommended 5 servings a day of fruits and vegetables, nor 20g of dietary fiber a day. Most participants, especially those older than 20, did not meet the physical activity recommendations of at least 150 minutes of moderate intensity aerobic activity per week, and muscle strengthening activities at least twice per week.^{11,19}

In a second study that used an ecological framework, behavioral influences such as food preferences, self-control or discipline, motivation, and time constraints were common factors that college students became aware of during their transition to independent living.²⁰ The study also aimed to evaluate interventions to help college students manage choices pertaining to improving self-regulation and eating choices. Students felt a necessary first step was to increase the knowledge of healthy decisions. Students also felt that intrinsic motivation and offering a wider variety of healthy menu and vending items on campus would assist with making healthier choices. Students in the study expressed the barrier of time and price of foods as mentioned in the previous study. While focusing on the time and pricing constraints, students expressed the idea of lowering the prices of the healthy food options on campus to increase intake of low-fat foods and fruits or vegetables.²⁰

Sleep Behaviors Among College Students

Irregular sleep patterns also need to be considered with weight management. The Pittsburgh Sleep Quality Index (PSQI) assesses components such as sleep quality, sleep latency, sleep duration, sleep efficiency, sleep disturbances, use of sleep aid(s), and daytime dysfunction.²¹ The PSQI questions are scored based on a Likert Scale of 0-3, with 0 meaning no difficulty in the specified component, and 3 meaning severe difficulty. The PSQI score ranges from 0 to 21, with a score of greater than 5 signifying a poor-quality sleeper, and a score of 5 or less signifying a good-quality sleeper.^{21, 22} In a study focusing on the sleep quality of college aged students, the PSQI was distributed as a survey. Many (60%) students were categorized as poor-quality sleepers, with an average 7.02 hours per night for all participants.²² Young adults, ages 18-25, are recommended to have 7-9 hours of sleep per night.²³

Sleep deprivation is associated with becoming overweight or obese in many college students.²⁴ Students are unaware of how sleep and good health are correlated, and many students often pull all night study sessions.²⁴ Population focused interventions are an important consideration to improving the health and well-being of college students. These interventions must consider a student's busy schedule, as well as adapting to common lifestyle choices and habits.

In a cross-sectional study of 9 universities in the United States, sleep scores were assessed using the PSQI. Results showed that 49% of the participants recorded having less than 7 hours of sleep each night and had a mean PSQI score of greater than or equal to 5, indicating poor overall sleep quality.²³ Additionally, 10% of students experienced sleep disturbances, 6% used medications to enhance sleep, and 64% had daytime dysfunction, or

trouble staying awake throughout the day. Sleep duration and sleep quality were equally important to overall health.

Ludy and colleagues evaluated the correlation between sleep duration, dietary behaviors, and body composition.²⁴ Sleep quality and diet was assessed through survey questions, while body composition was determined through anthropometric measures of weight, height, and percent body fat. After data analysis, hierarchical cluster analysis (HCA) determined three groups based on weight change observed: maintainers, modest gainers, and major gainers. Maintainers had a weight change of $0.1 \pm 1.3\text{kg}$, modest gainers had a weight change of $2.0 \pm 1.7\text{kg}$, and major gainers had a weight change of $3.8 \pm 1.8\text{kg}$.²⁴ The average sleep duration decreased by approximately one hour in those of the major gainer group. Those in the maintainer group increased sleep duration from 7.3 hours to 7.6 hours ($p=0.048$). The cause of increased weight was tied to a more sedentary lifestyle. Feeling fatigued, increased appetite and energy intake, and the alteration of appetite hormones, such as leptin and ghrelin, are affected by sleep quality and quantity and hunger regulation is decreased. Ghrelin was increased and leptin was decreased, which stimulated an increased appetite. Participants reported that an email message about the importance of a good quality sleep helped them maintain their sleep duration throughout the study.²⁴

Text Message Intervention for College Students

Text messaging and technology-based interventions have been effective in many populations. Text messages have also been found to sustain weight loss, encouraging individuals to maintain the healthy habits learned during a weight loss process.⁸ Technology has been a progressive route for weight management and improvement of health-related

behaviors because of how integrated technology has become in the lives of college students. In a study that distributed a survey to determine technology access and use in 1,371 students aged 18-25, 99.5% of the participants owned smartphones, 96.8% used texting, and 97.2% used mobile apps. Many college students, with differing demographics, regularly used smartphones and thought mHealth interventions would be useful.²⁵ In addition, one qualitative study focused on mobile health and mindfulness among college students 18 years and older. Results found that students would be most receptive to a simple mobile application format, a low pressure intervention, and easy suggestions that are applicable to them using a friendly tone.²⁶ In another qualitative study on mHealth for college students, focus groups determined the importance of personalization of texts for areas such as stage of readiness or gender, texts tailored around differing support needs, using local context (i.e. local recreation centers), and emphasizing positive messages as opposed to negative.²⁷

One pilot study examined the adherence of the mobile application of “My Meal Mate.” These results showed that program adherence declined over the six months of the study. Behavior change with a mobile application has not always shown change among individuals. Staying motivated through lack of results, getting bored, and not being able to resist cravings throughout a weight loss journey showed that health education alone is not effective.²⁸ However, a study focused on decreasing “risky alcohol use” used a mobile application called “SmarTrek” to track behavior, collect data, and give educational materials to college students. The majority of participants (90%) thought the application was easy to use, and half of participants felt that they did drink less.²⁹

Shapiro used a text-message and newsletter intervention, “Text4Diet,” to mediate weight loss in adults aged 21-65 years old. Text messages provided tips, facts, and

motivation to participants. Participants were also given a pedometer and scale if needed.

Although the intervention did not mediate weight loss, the adherence rate of the intervention was 60-69%. Qualitative feedback reported participants found the intervention acceptable and feasible. Notably, there was some weight loss among those who found the intervention useful.⁶

In a randomized controlled study of 62 young adults aged 18-25, a text-message and smartphone intervention resulted in a significant ($p < .05$) decrease in weight, BMI, and waist circumference in the treatment compared to control group.⁷ The study aimed to have participants lose 1-2 pounds each week, while also increasing physical activity. Participants attended a single counseling session that discussed healthy eating and regular physical activity. Participants were put into a control group, or a Smartphone + Health Coach intervention which included another counseling session and encouragement to download “Lose it!”, a mobile app, to monitor nutrition and physical activity. The group also received text messages from a health coach. Those in the treatment group had improvements in health behaviors such as increased consumption of fruits, vegetables, fiber, and protein, while decreasing total carbohydrate intake and added sugars.⁷ Participant feedback reported that tailoring a text message intervention to the individual and remaining consistent with the amount of texts sent helped improve their weight and health status, without getting overwhelmed.⁷

Fitness Tracking Intervention for College Students

Along with a text messaging intervention, using a personal activity tracker can help college students independently track and monitor steps and exercise. In a controlled trial of college students ($n=56$), students were required to wear a pedometer at the beginning and the

end of the intervention to track changes in physical activity. In addition, students were assigned to one of three groups 1) health education only, 2) health education and a Fitbit (health education + Fitbit), or 3) control group.³⁰ Students in the health education only group were enrolled in an introductory health course which provided health and nutrition topics. The health education + Fitbit group were required to wear the Fitbit every day during the Spring semester, while also reading 3-4 articles on predetermined health topics. The control group was in a humanities course and received no intervention. The study confirmed that the use of a personal activity tracker, or Fitbit, and enrollment in a health course increased physical activity by 1,078 steps per day, which is about half a mile in steps. In comparison, those in the control group decreased by 751 steps per day. Those in the health education only group did not significantly increase physical activity, therefore the health education with the addition of the Fitbit increased physical activity. Students also commented they enjoyed using the variety of applications that come with a personal fitness tracker such as tracking diet, steps, physical activity minutes, and much more.³⁰

Methodology

Participants

Beginning November 15, 2020 flyers and handouts (Appendix A) were distributed through ASU Student Health Services, the Facebook page “App State Classified,” and a randomized sample of 500 student emails. Participants interested in MQHC Group 4 Students (MQHCG4S) contacted the researchers via email or phone. Once contacted, a researcher emailed the potential participant a standardized recruitment script (Appendix B) to confirm interest. Once interest was confirmed, a pre-screening Zoom meeting was scheduled

to confirm partial eligibility using an Eligibility Checklist (Appendix C). At the pre-assessment appointment, interested participants completed an online pre assessment survey and provided consent to participate in the study. Participants recruited during the pre assessment appointment were assigned to Group 4 of the on-going *My Quest in the High Country* intervention.

Study Design:

The current study, *My Quest in the High Country*, was modeled from the methodology design of Griffin et al.'s *My Quest*.^{4,31} The previous study was conducted in Alabama and measured weight status, health behavior change, and physical activity within a mHealth text-message based intervention. Participants received text messages and eNewsletters that were based on weekly education themes (Appendix D).

My Quest in the High Country (MQHC) at Appalachian State University (ASU) forged collaborations with ASU Student Health, ASU Health Promotion for Faculty and Staff, Blue Cross Institute for Health and Human Services Interprofessional Clinic (IHHS IPC), and the Department of Nutrition and Health Care Management. *MQHC* at Appalachian State is part of a multi-site study, which includes Appalachian State University and High Country Community Health, a Federally Qualified Health Center. For this current project, identified as MQHC Group 4 Students (MQHCG4S), participants were recruited from the Appalachian State University student population.

MQHCG4S was a 24-week one-group, pre-post-test study that evaluated changes in dietary and physical activity behaviors, and sleep scores in college students. MQHCG4S was based on the SCT, specifically emphasizing goal setting, self-efficacy, behavioral and

environmental factors, and self-monitoring. The MQHCG4S intervention was delivered through daily text messages (n=1-2/day) and eNeweletter (n=1/week).

Population

A power analysis using SAS was performed and set at 80% power to get a sample size of 1,700. However, the sample size was limited to the number of Fitbits available, making the sample size 40 at a given time. Recruitment began November 15, 2020.

Inclusion criteria for MQHCG4S included:

1. Age 18-69
2. Appalachian State undergraduate or graduate student registered for spring 2021 classes
3. Cell phone with text messaging
4. Active email address
5. Low risk for medical complications as determined by the Physical Activity Readiness Questionnaire (PAR-Q) or provide signed medical clearance from your primary care provider
6. BMI \geq 24
7. Not pregnant or planning to become pregnant during the study
8. *Have not previously participated in My Quest in the High Country*

Procedures

Beginning November 15, 2020 flyers and handouts (Appendix A) were distributed through ASU Student Health Services, the Facebook page “App State Classified,” and a randomized sample of 500 student emails. Participants interested in MQHCG4S contacted

the researchers via email or phone. Once contacted, a researcher emailed the potential participant a standardized recruitment script (Appendix B) to confirm interest. Once interest was confirmed, a pre-screening Zoom meeting was scheduled to confirm partial eligibility using an Eligibility Checklist (Appendix C).

Potentially eligible participants were scheduled for a pre-assessment appointment at the IHHS IPC. Upon arrival at the pre-assessment appointment, participants completed a COVID-19 pre-screening and temperature check. If the participant cleared the COVID-19 pre-screening, the pre-assessment appointment proceeded. If the participant did not clear the COVID-19 pre-screening, the pre-assessment was rescheduled. Per the COVID-19 Risk Mitigation plan, researchers frequently washed and/or sanitized hands, donned clean gloves and gown, and wore a securely fitting face mask and face shield while working with each participant. All of the equipment, tables, and chairs in each exam room were wiped down with Vindicator⁺ between each participant.

Pre-assessment Appointment

A researcher escorted the participant to a designated exam room. The researcher completed the Eligibility Checklist with each participant. Participants completed a Physical Activity Readiness Questionnaire (PAR-Q form at the initial assessment as well.³² The PAR-Q is a self-administered questionnaire used to assess an individual's readiness to participate in more physical activity or engage in a physical activity program. Weight and height were captured using standardized procedures. Weight and height were then entered into a handheld Bioelectrical Impedance Analysis-BIA (OMRON HBF-306) to calculate BMI and body fat percentage. Findings were recorded on the PAR-Q form as well. Any participant with a BMI <24 was ineligible to participate in the study. Participants were allowed to rest for 2-5

minutes before the researcher took and recorded blood pressure using a standardized procedure. Participants with a blood pressure reading $>135/80$ were ineligible for the study without medical clearance. The researcher then reviewed the 24-week intervention program, and confirmed the completed PAR-Q was accurate.

Next, participants provided Informed Consent and completed the pre-assessment survey. Participants were given an Ipad to complete a Qualtrics pre-assessment survey, which took about 10 to 15 minutes. Informed Consent was embedded within the pre-assessment survey. After the pre-assessment survey was completed, participants completed the Fitbit User Agreement, and provided their cell phone number and email address. Participants were assigned a FitBit to track physical activity, step counts, heart rate, and sleep scores for the first 12 weeks of the study. The participant was asked to download the FitBit app. Researchers walked each participant through proper set up and use of the Fitbit. This included wearing the Fitbit at all times, including when sleeping, with the exception of when bathing. Participants were reminded that the Fitbit will be returned to the IHHS IPC at the end of the 12 weeks or within 7 days of opting out of the program. If the Fitbit was lost or not returned, the participant was required to pay the replacement cost of \$100 per the signed Fitbit User Agreement. The participant was then opted-in to the text messaging program using a short code and key. Participants received a bath scale (Etekcity EB4410B), to keep, to self-monitor weekly body weight. Participants received 1-2 text messages/day during MQHCG4S.

Participants' daily caloric intake was determined by using a 9.1-11.4 kcal/lb formula. Daily calorie intake for participants with a BMI >30 was based on adjusted body weight using an average of the Hamwi Formula and current body weight. The MyPlate MyPlan was

used to recommend a daily meal pattern for each participant based on their calculated daily caloric intake.³³ After the first 12 weeks of the intervention, participants were scheduled for an appointment at the IHHS IPC to complete a mid-point assessment and to return the Fitbit. Participants continued to receive daily text messages (n=1-2/day) and eNewsletters (n=1/week) and responded to text message prompts for the remaining 12 weeks of the study.

Text Message Intervention

The intervention began January 31, 2021. Participants received 1-2 text messages each day. Text messages were tailored around the nutrition or health education topic of the week and other upcoming or previous topics. Text messages occasionally included weblinks such as short YouTube video clips of exercises, nutrition and health behaviors, tips, or easy cooking videos. There were also 2-3 self-monitoring text messages per week targeting step counts or physical activity minutes, and self-reporting body weight.

eNewsletter Intervention

Participants also received one weekly eNewsletter every Sunday through email that encompassed the topic of the week. Each eNewsletter included tips, reminders, and a low-cost healthy recipe.

Researchers downloaded weekly step counts, physical activity minutes, heart rate, and sleep scores from the Fitbit dashboard. After evaluation of the downloaded Fitbit data, researchers sent a tailored weekly physical activity feedback text to each participant. At week 12, participants received a text message with a link to a midpoint “check in” questionnaire composed of ten questions to monitor behavior change. The researchers also scheduled an appointment for each participant to return the Fitbit to the IHHS IPC. Participant body

weight was also captured at this midpoint check. From this point forward, the text messages and eNewsletters continued as the primary intervention.

Post-assessment

At week 24, the post assessment screening visit was scheduled at the IHHS IPC. Again, height, body weight, BMI, BIA, and blood pressure were taken and recorded. Participants completed the post-assessment survey on a provided iPad. Participants who completed the pre- and post-assessment survey were entered into a drawing for a \$50 Walmart gift card.

Data Analysis

Descriptive statistics were used for demographic and physical characteristics in this study. BMI was calculated using baseline and post assessment height and weight. The data for primary outcome measures were weight, BMI, sleep scores, and behavioral change all measured through a pre and post assessment. Analyses were conducted using Wilcoxon signed rank test (ordinal data), McNemar test (dichotomous data) and paired t-test or Repeated measures analysis of variance (continuous data). Statistical significance was set at $p < .05$. Statistical analyses were performed with SPSS software (version 27, IBM Corp, Armonk, NY, 2020).

This study was approved under Appalachian State University IRB 20-0201.

Research Purpose and Questions

Chronic diseases will become more common at a younger age as obesity encompasses the younger population. In addition, medical costs of those individuals will impact their

quality of life.² College students experience a tough transition to independence and often struggle to develop good strategies to maintain a healthy weight and lifestyle behaviors.³ Technology has become a prominent part of the young adult lifestyle. Students are always involved and engaged in technology, especially smartphones, therefore a tailored health behavior and weight management intervention using technology may be more practical for this population. Incorporating technology interventions such as text-messaging, personal fitness trackers, and eNewsletters into a weight loss/management program may improve health behaviors and well-being of many young individuals.⁴ A text message-based weight and health management program can be cost effective and easily adhered to on college campuses. A mobile health (mHealth) initiative is easily accessed and adaptable to the busy schedule of a college student and can make lasting impacts to health education and health status.⁵⁻⁸ A tailored and daily text message-based intervention for college students can encourage healthy weight loss and promote the incorporation of healthy diet and lifestyle behaviors.

Study Objectives

1. Use of a mHealth, text-message and eNewsletter based intervention, to decrease weight, BMI, and blood pressure from pre- to post assessment in Appalachian State college students.
2. Implement positive nutrition behavior change and sleeping habits in Appalachian State college students from pre- to post assessment.
3. Increase step counts and physical activity from pre- to post assessment.
4. Implement self-monitoring body weight and physical activity in Appalachian State college students from pre- to post assessment.

Research Questions

1. Will a text-message and eNewsletter mHealth-based intervention (MQHCG4S), facilitate improvement in body weight, BMI, and blood pressure in college students at Appalachian State University from a pre- to post assessment?
2. Will a text message and eNewsletter mHealth-based intervention (MQHCG4S), facilitate positive nutrition and health behavior change and improve sleep status in college students at Appalachian State University from pre- to post assessment?

Study Hypotheses

1. mHealth will significantly decrease weight and improve BMI of Appalachian State college students from a 24-week pre to post assessment.
2. mHealth will significantly improve nutritional behavior and sleep status in Appalachian State college students from a 24-week pre to post assessment.

Significance of Study

This study is significant because it focuses on the impact mHealth may have on college students' health behaviors and biometrics. Many college students struggle to develop health behavior skills with the transition to independence, which can greatly impact their overall health. Technology is a prominent part of many college student's lifestyles. This study aims to encourage participants and promote self-efficacy while improving health and lifestyle behaviors and biometrics. Students are constantly on mobile devices, therefore, *My Quest in the High Country's* approach of mobile health information may promote health behaviors and improve biometrics in college students.

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Chapter 2: Article

Abstract

Chronic diseases such as obesity are now more common in college students. With an impactful transition in life, college students struggle to develop strategies to maintain healthy weight and lifestyle behaviors when adapting to college and new routines. mHealth programs are accessible to college students' schedules and habits due to the high usage of mobile devices. *My Quest in the High Country* collaborated with Appalachian State University (ASU) Student Health Services and the Blue Cross Institute for Health and Human Services Interprofessional Clinic to create a 24-week mHealth intervention to improve weight and sleep status, health behaviors, and biometrics in ASU students.

Recruitment of ASU students occurred from November 2020-January 2021 through flyers, social media, and email. During pre-assessment, eligibility was confirmed; afterward Informed Consent, biometrics, and a pre-assessment survey were collected. Participants received a scale, Fitbit, and caloric intake goals. From weeks 1-12, participants received text messages (n=1/day), eNewsletters (n=1/wk), and physical activity feedback based on individual physical activity and step counts.. At midpoint, Fitbits were returned, biometrics were taken, and a midpoint survey was completed. From weeks 13-24, text messages and eNewsletters continued. At post-assessment, biometrics and post-assessment surveys were collected. Statistical analyses included Wilcoxon Signed Rank, McNemar, paired *t*-test, and descriptives. Significance was set at $p < .05$.

Participants (n=11) were female (72.7%), non-Hispanic (82%), and Caucasian (64%), with a mean age of 23.4 (6.2). Significant ($p < .05$) improvements were observed in body weight, BMI, diastolic blood pressure, fruit and vegetable intake, and sedentary time. No

significant changes occurred in systolic blood pressure, step count, physical activity minutes, or sleep score.

An mHealth intervention in college students may have a positive impact on health and behavior change. Progress dropped after returning the Fitbit at week 12. In future studies, a larger student email list may increase sample size and participant diversity. Wearing the Fitbit for 24 weeks would be preferable.

Introduction

The American population has greatly suffered from the prevalence of obesity within the past several decades.¹ The issue has also impacted young adults. Now, 30-35% of college students are characterized as overweight or obese.² As young adults enter into a college lifestyle, new habits are learned and old habits are forgotten due to social and environmental influences.² There has also been a greater gap in health knowledge, healthy behaviors, and sleep behaviors among college students.

Irregular sleep patterns also need to be considered with weight management. The Pittsburgh Sleep Quality Index (PSQI) assesses components such as sleep quality, sleep latency, sleep duration, sleep efficiency, sleep disturbances, use of sleep aid(s), and daytime dysfunction.³ The PSQI questions are scored based on a Likert Scale of 0-3, with 0 meaning no difficulty in the specified component, and 3 meaning severe difficulty. The PSQI score ranges from 0 to 21, with a score of greater than 5 signifying a poor-quality sleeper, and a score of 5 or less signifying a good-quality sleeper.^{3,4} In a study focusing on the sleep quality of college aged students, the PSQI was distributed as a survey. Many (60%) students were categorized as poor-quality sleepers, with an average 7.02 hours per night for all

participants.⁴ Young adults, ages 18-25, are recommended to have 7-9 hours of sleep per night.⁵

Sleep deprivation is associated with becoming overweight or obese in many college students.⁶ Students are unaware of how sleep and good health are correlated, and many students often pull all night study sessions.⁶ Population focused interventions are an important consideration to improving the health and well-being of college students. These interventions must consider a student's busy schedule, as well as adapting to common lifestyle choices and habits.

Chronic diseases will become more common at a younger age as obesity encompasses the younger population. Obesity has been correlated with increased risk of chronic diseases such as cardiovascular diseases, stroke, diabetes, hypertension, cancer, and many others.¹ In addition, medical costs of those individuals will impact their quality of life.² College students experience a challenging transition to independence and often struggle to develop good strategies to maintain a healthy weight and lifestyle behaviors.⁷ In a four-year study of 131 college students, basic anthropometric measurements, body composition, and body shape were taken at two time points: start of freshman year and end of senior year.⁸ College students were more likely to significantly gain weight, increase BMI, and increase body fat mass, with males having a greater increase in each. Weight change ranged from a decrease of 8.7kg to an increase of 16.8kg increase in some individuals, with weight gain observed in 70% of the participants.⁸

Technology has become a prominent part of the young adult lifestyle. Students are always involved and engaged in technology, especially smartphones, therefore a tailored health behavior and weight management intervention using technology may be more

practical for this population. Incorporating technology interventions such as text-messaging, personal fitness trackers, and eNewsletters into a weight loss/management program may improve health behaviors and well-being of many young individuals.⁹ A text message-based weight and health management program can be cost effective and easily adhered to on college campuses. A mobile health (mHealth) initiative is easily accessed and adaptable to the busy schedule of a college student and can make lasting impacts to health education and health status.¹⁰⁻¹³ A tailored and daily text message-based intervention for college students can encourage healthy weight loss and promote the incorporation of healthy diet and lifestyle behaviors.

The purpose of this study was to decrease weight, BMI, blood pressure, and implement a positive nutrition behavior change and sleeping habit intervention in Appalachian State college students through a mobile health (mHealth) initiative, *My Quest in the High Country (MQHC)*. My Quest in the High Country is a community-based 24-week pre- to post-test weight loss, dietary, and physical activity behavior change intervention developed using the Social Cognitive Theory (SCT).¹⁴ The SCT focuses on goal setting, self efficacy, self-monitoring, and behavior.

Primary outcomes included significant changes in biometrics, specifically weight, body mass index, and blood pressure (systolic and diastolic). Secondary outcomes included an improvement in health behaviors and sleep scores.

Methods

Participants

Recruitment was from November 2020- January 2021. Flyers and handouts were distributed through ASU Student Health Services, the Facebook page “App State Classified,”

and a randomized sample of 500 student emails. Participants meeting study criteria and interested in participating then took the online pre-assessment survey during the pre-assessment appointment with the researcher. Informed Consent was embedded within the online survey and participants that completed the survey provided consent to participate in *MQHC*. Participants (n=11) who completed the pre-assessment survey and provided consent received a Fitbit (model: Inspire 2) to wear during weeks 1-12 of the study, and a bath scale (Etekcity EB4410B) to provide a weekly body weight. Participants were assigned to Group 4S of the on-going *MQHC* intervention.

Inclusion criteria included: age 18-69 years, Appalachian State undergraduate or graduate student registered for spring 2021 classes, own a personal cell phone with text messaging, an active email address, low risk for medical complications as determined by the physical activity readiness questionnaire (PAR-Q) or provide signed medical clearance from your primary care provider, a BMI ≥ 24 , not pregnant or planning to become pregnant during the study, and have not previously participated in *My Quest in the High Country*.

Prior to data collection, the Appalachian State IRB approved this human subject study.

Intervention

Students were recruited through flyers and handouts on campus, social media advertisements, and a randomized sample of 500 student emails. Interested students contacted the researchers via phone or email and completed a preliminary screening with the researcher. Potential eligible participants attended a pre-assessment appointment on campus to complete the eligibility screening. At the pre-assessment appointment, researchers recorded body weight, height, body mass index (BMI), body fat percent through bioelectric

impedance analysis (BIA), and blood pressure using standardized procedures, and collected a Physical Activity Readiness Questionnaire (PAR-Q).¹⁵ The PAR-Q was a self-administered questionnaire used to assess an individual's readiness to safely participate in more physical activity or engage in a physical activity program to confirm eligibility for the study. Eligible participants provided consent, completed the online pre-assessment survey and were given a Fitbit (model: Inspire 2) to track physical activity, step counts, heart rate, and sleep scores for weeks 1-12 of the study. Participants signed a Fitbit User Agreement and created a unique Fitbit login for researchers to access and download all information for each week. Participants then opted-in to the text messaging program. Participants received a bath scale (model: Etekcity EB4410B) to self-monitor weekly body weight. Participants received 1-2 text messages/day and one eNewsletter/week during My Quest in the High Country Group 4 Students (MQHCG4S).

Participants' daily caloric intake were determined by using a 9.1-11.4 kcal/lb formula. Daily calorie intake for participants with a BMI >30 were based on adjusted body weight using an average of the Hamwi Formula and current body weight. The MyPlate MyPlan that coincided with the participant's daily calorie intake was used as a recommended daily meal pattern.¹⁶

After the first 12 weeks of the intervention, participants were scheduled for an mid-assessment appointment to return the Fitbit and have weight, BMI, BIA, and blood pressure recorded. Participants continued to receive daily text messages (n=1-2/day), eNewsletters (n=1/week) and respond to weekly text message prompts for the remaining 12 weeks of the study.

At week 24, participants attended a post assessment appointment. Height, body weight, BMI, BIA, and blood pressure were taken by the researcher and recorded. Participants were provided a link via text to complete the post assessment survey before the appointment. Participants who completed the pre- and post-assessment survey were entered into a drawing for a \$50 Walmart gift card.

Text Message Intervention

Participants received 1-2 text messages each day. Text messages were tailored around a nutrition or health education topic of the week and other upcoming or previous topics. Text messages occasionally included weblinks, such as short YouTube video clips of exercises, nutrition and health behaviors, tips, or easy cooking videos. There were also 2-3 self-monitoring text messages per week targeting step counts or physical activity minutes, and a self-reported body weight each Sunday morning.

eNewsletter Intervention

Participants also received one weekly eNewsletter every Sunday through email that encompassed the education topic of the week. Examples of topics include Food Journaling, Importance of Sleep, Portion Control, Exercising in Small Spaces, Increasing Water Intake, Reducing Intake of Sugar Sweetened Beverages, Meal Planning, and more. Each eNewsletter includes tips, reminders, and a low-cost healthy recipe.

Fitness-Tracker Data (Fitbit)

Physical activity data was recorded weekly by researchers for weeks 1-12. Researchers downloaded weekly step counts, physical activity minutes, heart rate, and sleep

scores from the Fitbit dashboard. After evaluation of the downloaded Fitbit data, researchers sent a tailored weekly physical activity feedback text to each participant.

Statistical Analysis

Descriptive statistics were used for demographic and physical characteristics in this study. Researchers collected weight, height, and BMI. BMI was calculated using baseline and post assessment height and weight. The data for primary outcome measures were weight, BMI, sleep scores, and behavioral change all measured through a pre and post assessment. Health behavior changes were collected through an online self-reported Qualtrics survey. Step counts, sleep score, and physical activity were collected via each participant's Fitbit dashboard. Analyses were conducted using Wilcoxon signed rank test (ordinal data), McNemar test (dichotomous data) and paired t-test or Repeated measures analysis of variance (continuous data). Statistical significance was set at $p < .05$. Statistical analyses will be performed with SPSS software (version 27, IBM Corp, Armonk, NY, 2020).

Results

A total of 11 participants were eligible for the study and provided consent. At post-assessment, 10 participants completed the study (91% retention). One participant did not complete the post-assessment survey nor did they attend the post-assessment appointment and were not included in the final analysis.

Participants ($n=11$) were female (72.7%), non-Hispanic (82%), and Caucasian (64%), 2 year degree/some college or more (81.8%), unemployed (54.5%), income less than \$15,000 per year (90.9%), single (90.9%) vs married (9.1%) and a mean age of 23.4 (6.2). From pre- to post-assessment, dietary and physical activity behaviors, and sleep scores in college students were assessed. From pre- to post- assessment, biometrics outcomes showed

significantly improved weight ($p=0.05$), BMI ($p=0.03$), and diastolic blood pressure ($p=0.02$) [Table 3]. There were no significant improvements in systolic blood pressure ($p=1.00$) [Table 3].

Nutrition and health behaviors were also assessed. In a pre- and post- assessment survey, participants were asked, “How many servings of vegetables do you eat each day? A serving of vegetables is 3 heaped tablespoons of green or root vegetables like peas, baked beans, or sweet corn; or a medium bowl of salad (lettuce, tomatoes, etc.)”, “How many servings of fruits do you eat each day? A serving of fruit is an apple or banana, small bowl of grapes, or tablespoons of canned fruit”, “In a typical day, how much time do you usually spend sitting (in hours)”. Improvement in participants’ vegetable and fruit consumption were observed, however not significantly. Significant improvement in sedentary time ($p=0.02$) from pre- to post assessment was observed.

Step count, physical activity, and sleep score were considered to be a major indicator of health behaviors and in recent studies have played a role in biometric data.^{11, 17-19} Step count, physical activity, and sleep score did not improve significantly from pre to post assessment. However, heart rate significantly improved ($p=0.03$) from pre to post assessment [Table 3].

Comment

This study showed that an mHealth intervention would be impactful for the college student population. Step count increased by 2,607.72 steps within the first 6 weeks of intervention, which is an increase in about a mile of walking on average. Many participants shared at the midpoint assessment that the event of academic finals caused a decrease in physical activity. Participant feedback showed that the FitBit and text message intervention may be helpful with advancing behavior change and improving biometrics such as weight,

BMI, and blood pressure. One participant noted that “the FitBit was the most powerful part of my behavior change and weight loss.” Many participants (82%) plan to or already have purchased an activity tracker. Overall participants found the text messages to be *extremely helpful* or *little helpful* (55%). Participants also found the weekly newsletters to also be *extremely helpful* or *a little helpful* (50%). One participant noted that the “text messages provided some new information” that they have not heard before. However, another participant thought “the newsletters and text messages could have had more challenging information for a college student population.”

Retention for the current study was greater than that of previous mHealth studies to promote biometric and health behavior improvements (90.1% as compared to 68-96%).⁸ Participants were provided a Fitbit fitness tracker and a bath scale to self-monitor weight and physical activity. Participants receiving the equipment allowed the researchers to obtain individualized weekly feedback throughout the study. This allowed participants and researchers to engage with each other during the 24-week program.

Limitations

Sample size was small which can limit generalizability to other populations. Next, the entire study occurred during the COVID-19 pandemic. The study became delayed due to the university’s approval process for beginning human research studies. This start delay from November 2020 to January 2021 ultimately extended the study into the summer when many college students were away from campus. The study had a self-reporting behavioral response rate for weeks 1-12 (during the school year) of 70.1% and a response rate of 47.3% during weeks 13-24. A similar decrease in response rates were found in comparable studies.^{8,10}

Conclusions

The MQHC intervention showed statistically significant ($p > .05$) improvements in body weight, BMI, diastolic blood pressure and heart rate. These factors are biometrics that young adults are beginning to struggle with at an earlier age.^{2,7} The results did not show a significant change in step counts, physical activity, and sleep scores, however participants did feel that turning in the Fitbit half way through impacted the motivation of physical activity (70%). This suggests that mHealth interventions using a self-monitoring tool throughout the entire study can be impactful in college students. In future studies, altering text message and newsletter topics to focus on gaps in college student knowledge may retain more focus and increase response rates. A larger student email list may increase sample size and participant diversity.

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Chapter 3: Summary of Findings and Limitations

Results:

Participants (n=11) were female (72.7%), non-Hispanic (82%), and Caucasian (64%), 2 year degree/some college or more (81.8%), unemployed (54.5%), income less than \$15,000 per year (90.9%), married (9.1%) and a mean age of 23.4.

Biometric and Anthropometric Data

From pre- to post assessment, dietary and physical activity behaviors, and sleep scores in college students were assessed. From pre- to post- assessment, biometrics outcomes showed significantly improved weight ($p=0.05$), BMI ($p=0.03$), and diastolic blood pressure ($p=0.02$) [Table 3]. There were no significant improvements in systolic blood pressure ($p=1.00$) [Table 3].

Health-Related Behavior Change

Nutrition and health behaviors were also assessed. In a pre- and post- assessment survey, participants were asked, “How many servings of vegetables do you eat each day? A serving of vegetables is 3 heaped tablespoons of green or root vegetables like peas, baked beans, or sweet corn; or a medium bowl of salad (lettuce, tomatoes, etc.)”, “How many servings of fruits do you eat each day? A serving of fruit is an apple or banana, small bowl of grapes, or tablespoons of canned fruit”, “In a typical day, how much time do you usually spend sitting (in hours)”. Improvement in participants’ vegetable consumption, fruit consumption were observed, however not significantly. Significant improvement in sedentary time ($p=0.02$) from pre- to post assessment were observed.

Physical Activity and Sleep Score Data

Step count, physical activity, and sleep score were considered to be a major indicator of health behaviors and in recent studies have played a role in biometric data.¹⁻⁴ Step count, physical activity, and sleep score did not improve significantly from pre to post assessment. However, heart rate significantly improved from pre to post assessment.

Research Purpose and Questions

Chronic diseases will become more common at a younger age as obesity encompasses the younger population. In addition, medical costs of those individuals will impact their quality of life.⁵ College students experience a tough transition to independence and often struggle to develop good strategies to maintain a healthy weight and lifestyle behaviors.⁶ Technology has become a prominent part of the young adult lifestyle. Students are always involved and engaged in technology, especially smartphones, therefore a tailored health behavior and weight management intervention using technology may be more practical for this population. Incorporating technology interventions such as text-messaging, personal fitness trackers, and eNewsletters into a weight loss/management program may improve health behaviors and well-being of many young individuals.⁷ A text message-based weight and health management program can be cost effective and easily adhered to on college campuses. A mobile health (mHealth) initiative is easily accessed and adaptable to the busy schedule of a college student and can make lasting impacts to health education and health status.^{1, 8-10} A tailored and daily text message-based intervention for college students can encourage healthy weight loss and promote the incorporation of healthy diet and lifestyle behaviors.

Study Objectives

1. Use mHealth, a text-message and eNewsletter based intervention, to decrease weight, BMI, and blood pressure from pre- to post assessment in Appalachian State college students.
2. Implement positive nutrition behavior change and sleeping habits in Appalachian State college students from pre- to post assessment.
3. Increase step counts and physical activity from pre- to post assessment
4. Implement self-monitoring body weight and physical activity

Research Questions

1. Will a text-message and eNewsletter mHealth-based intervention (MQHCG4S), facilitate improvement in body weight, BMI, and blood pressure in college students at Appalachian State University from a pre- to post assessment?

Significant findings ($p < .05$) were found in improvement of weight, BMI, and diastolic blood pressure. There were no significant findings in improvement of systolic blood pressure.

2. Will a text message and eNewsletter mHealth-based intervention (MQHCG4S), facilitate positive nutrition and health behavior change and improve sleep status in college students at Appalachian State University from pre- to post assessment?

Overall the participants found the text messages to be a little helpful (50%) and found the weekly newsletters to also be a little helpful (50%). Participants did feel that turning in the fitbit half way through impacted the motivation of physical activity (70%). This suggests that the mHealth interventions can be impactful in college

students. Sleep scores did not significantly improve from pre- to post- assessment. Many students expressed the end of semester priorities can often affect health behaviors and sleep quality and quantity.

Limitations

The study was not without limitations. First, the sample size was small which can limit generalizability to other populations. Next, the entire study occurred during the COVID-19 pandemic. The study became delayed due to the university's approval process for beginning human research studies. This start delay from November 2020 to January 2021 ultimately extended the study into the summer when many college students are away from campus. The study had a self reporting behavioral response rate for weeks 1-12 (during the school year) of 70.1% and a response rate of 47.3% during weeks 13-24. A similar decrease in response rates were found in comparable studies.^{7,9}

Conclusion

The MQHC intervention showed statistically significant ($p > .05$) improvements in body weight, BMI, diastolic blood pressure and heart rate. These factors are biometrics that young adults are beginning to struggle with at an earlier age.^{5,6} The results did not show a significant change in step counts, physical activity, and sleep scores, however participants did feel that turning in the Fitbit half way through impacted the motivation of physical activity (70%). This suggests that mHealth interventions with use of a self monitoring tool throughout the entire study can be impactful in college students. In future studies, altering text message and newsletter topics to focus on gaps in college student knowledge may retain

more focus and increase response rates. A larger student email list may increase sample size and participant diversity.

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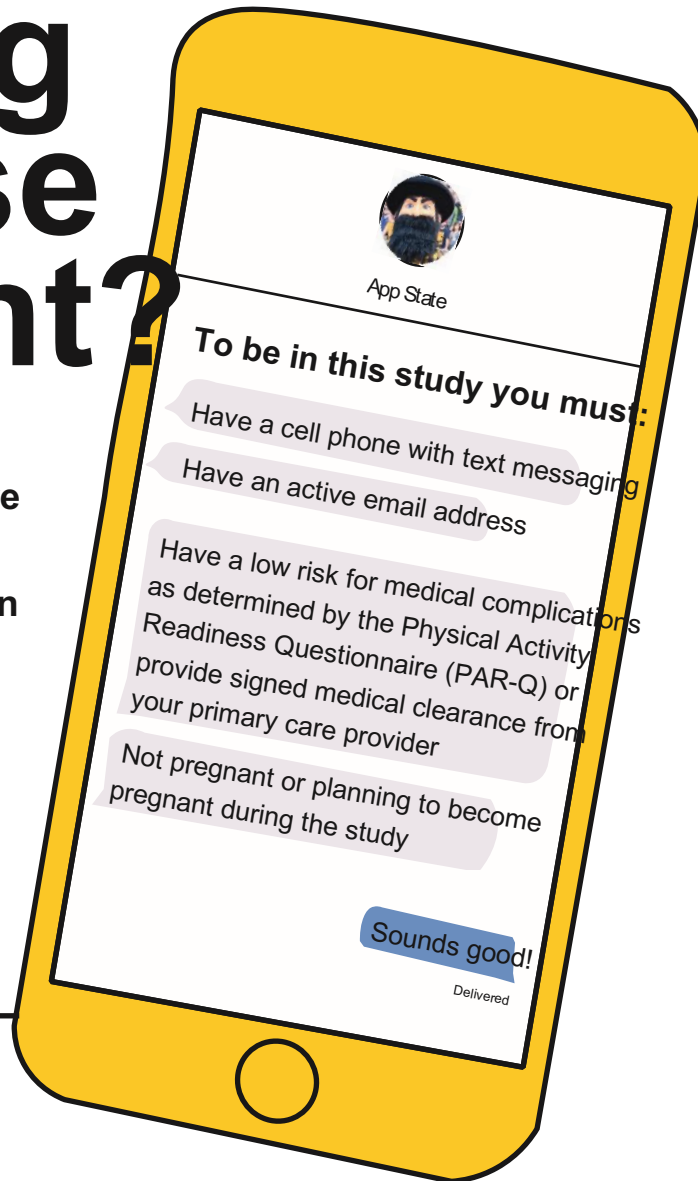
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Appendices

Appendix A. Recruitment Flyer:

Trying to lose weight?

We're looking for App State students who are trying or want to lose weight to participate in a research study that will determine if text messaging is a good way to help men and women trying to lose weight.



CONTACT

Andrea Lockard
Graduate Student Researcher

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Jamie Griffin, PHD, RDN, LDN
Researcher & Assistant Professor

828-262-8534 griffinjb@appstate.edu

Appendix B. Recruitment Script

“My Quest in the High Country (MQHC): A mHealth (text messaging) program to promote weight loss and improve dietary and health behaviors in adults aged 18-69 years.”

Thank you for your interest in *MQHC*. Are you trying to lose weight? Do you want support losing weight? Do you like getting text messages? If so, we invite you to participate in a research study that will determine if text messaging is a good way to help men and women trying to lose weight. For this study, we are looking for patients aged 18-69 years who are trying or want to lose weight.

To be in this study you must be:

- Age 18-69
- An App State student registered for spring 2021 classes -or-
- Eligible for App State Health Promotion for Faculty and Staff
- Have a cell phone with text messaging
- Have an active email address
- Have a low risk for medical complications as determined by the Physical Activity Readiness Questionnaire (PAR-Q) or provide signed medical clearance from your primary care provider
- BMI ≥ 24
- Not pregnant or planning to become pregnant during the study
- *Have not previously participated in My Quest in the High Country*

Being in this study is completely voluntary. The next step is for us to schedule a time to meet via Zoom to complete a full Eligibility Screening. This will include answering a few questions to determine if you can safely participate in the program. **Would you be available <give a day/time> to schedule a Zoom video conference.** If you are eligible, then a one-hour pre-assessment appointment at the Beaver College Interprofessional Clinic will be scheduled. A follow-up visit will be scheduled after 12 weeks and 24 weeks. During the pre-assessment you will complete the Eligibility Checklist, and sign the Physical Activity Readiness Questionnaire (PAR-Q) to determine if you can safely complete this program. You will also read and electronically sign an Informed Consent form. Once you provide Informed Consent you take an online survey. You will also opt-in to the text message program using a short code. You will be assigned a Fitbit to wear everyday during the study to monitor physical activity and step counts.

You will be asked to take seven online surveys. You will take the first one during your initial assessment. You will take the second survey during the mid-program period, which is also when the FitBit will be returned. The second survey will be sent on April 25, 2021 to the

email address you enter in the online survey. The third survey will be sent on July 18, 2021. You will also receive a text message to schedule your post-assessment visit. The remaining surveys will arrive in your email box annually beginning February 1, 2022. Each survey should take no longer than 15 minutes to finish. Everything will be kept private and confidential.

You will need a cell phone that can receive and send text messages. You will get 1-2 short text messages each day with tips, reminders or questions about exercise and healthy eating, or self-monitoring prompts for your body weight, step counts, or physical activity minutes.

You will get a weekly eNewsletter that contains tips and recipes. Each newsletter will have links to web pages. Click on the **blue web links** for helpful websites to visit.

Participating in the study is completely voluntary. Even if you decide to participate now, you can change your mind and stop at any time. Participating in this study will not make a difference in how you are treated by Jamie Griffin and researchers at Appalachian State University, or Appalachian State University.

Reasons not to participate: there is a slight risk of mild discomfort in the beginning of this study as you start being more physically active. This discomfort usually gets better as physical endurance and lung capacity improve.

Appendix C. Eligibility Checklist

Participant Initials:

DOB: (MMYY):

Eligibility Checklist

Ask potential participants the following questions and fill in or highlight their answers.

1. Are you currently a student or Faculty/Staff (or eligible to use Health Promotion for Faculty and Staff facilities) at ASU?

- ☐ No (Stop. The person does not meet eligibility criteria for this study)
- ☐ Yes (Ask if they are residing in Boone or able to come to Boone 3 times)
 - ☐ No (Stop. The person does not meet eligibility criteria for this study)
 - ☐ Yes (Proceed to number 2)

2. Do you currently wear an Apple Watch?

- ☐ No (Proceed to number 3)
- ☐ Yes (Ask if willing to wear the Fitbit daily for 12 weeks)
 - ☐ No (Stop. The person does not meet eligibility criteria for this study)
 - ☐ Yes (Proceed to number 3)

3. Are you between the ages of 18-69 years?

- ☐ No (Stop. The person does not meet eligibility criteria for this study)
- ☐ Yes (Proceed to number 3)

4. Does your weight affect the way you feel about yourself?

- ☐ No (Proceed to number 5)
- ☐ Yes (Proceed to number 4)

5. Do you worry you have lost control over how much you eat?

- ☐ No (Proceed to number 5)
- ☐ Yes (Stop. The person does not meet eligibility criteria for this study)
- ☐ If participant unsure or questionable complete [EEQ](#)

6. Does the participant score between 0-20 on the EEQ?
- ☐ No (Stop. The person does not meet eligibility criteria for this study)
 - ☐ Yes (proceed to number 7)
7. Have you tried to lose weight in the past 3 months? Or, have you been enrolled in a weight loss program such as Nutrisystem, Noom, Weight Watchers, etc. in the past 3 months?
- ☐ No (Go to the PAR-Q Questionnaire)
 - ☐ Yes (Stop. The person does not meet eligibility criteria for this study)
8. Capture self-report height and weight. Does the person have a BMI <24?
- ☐ No (Proceed to number 9)
 - ☐ Yes (Stop. The person does not meet eligibility criteria for this study)
9. Complete the PAR-Q. Did person answer "Yes" to any PAR-Q question?
- ☐ No (Schedule Pre-assessment appointment)
 - ☐ Yes, (Stop. The person does not meet eligibility criteria for this study)
10. Confirm BMI ≥ 24 . Capture height, weight and BIA.
- ☐ No (Stop. The person does not meet eligibility criteria for this study)
 - ☐ Yes (Proceed to number 11)
11. Confirm blood pressure normal (<135/80); Confirm low risk per PAR-Q.
- ☐ No (Stop. The person does not meet eligibility criteria for this study)
 - ☐ Yes (Proceed to pre-assessment survey/Informed Consent)
12. Did person provide Informed Consent?
- ☐ No (Stop. Without Informed Consent form, the person is not eligible for this study.)
 - ☐ Yes (Proceed to number 13.)
13. Did participant opt-in to the text message program?

- ☐ No (Stop. Without an opt-in to text message program, the person is not eligible to receive a Fitbit. Help the participant opt-in to the text program.)
- ☐ Yes. Have participant immediately text their body weight.

14. Write down age, height, initial body weight, and body composition on PAR-Q. Write down cell phone number, and email address on the Fitbit Agreement.

15. Assign Fitbit. Fill out 2 copies of the Fitbit User Agreement with the Fitbit ID number. Have participant sign both agreement forms.

16. Give participant their individual calorie intake level. Then email it to them.

17. Have participant sign the log that they received a bath scale. Give bath scale.

18. Send home with participant one Fitbit User Agreement form, Fitbit and a bath scale.

Keep ALL Eligibility Checklists for participants. These forms will be given to Dr. Griffin for storage.

Research Team Member:

Date:

Appendix D. Example Weekly Newsletter:

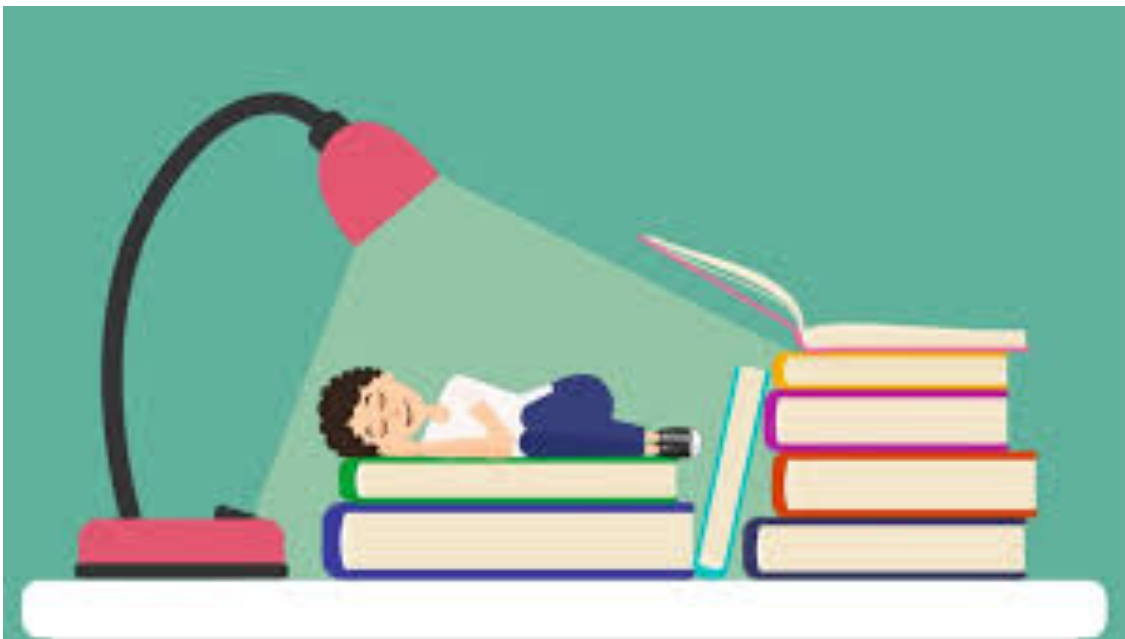
Week 5

My Quest

Date: February 28, 2021

Sleep

Quote of the Week: “Do it now. Sometimes later, becomes never.” -Unknown



Sleep is an essential part of everyday life, especially when juggling a busy work or school schedule. For optimal health and weight management, it is crucial to have a balance of diet, exercise, and sleep. Take away any one of these three qualities, and it will likely lead to imbalance in the others. If sleep quality is not where it should be, it can impact diet. You may not eat enough, or you may eat

too much, and you may not feel up to being active that day. When the body begins to lack sleep, leptin (the hormone that regulates appetite) levels will drop, and appetite increases, leading to eating too much. Oftentimes the foods chosen are convenience foods. Getting adequate sleep lets your body refuel and repair many vital bodily functions and can help with weight management. For more information visit the [Sleep Foundation](#) website.

Tip of the Week: Batch cook: Cooking every night can seem tedious. When you cook, double, triple, or even quadruple recipes, portion out servings, and freeze them for no-fuss meals in a pinch!

Recipe of the Week: Banana Oatmeal Pancakes

2 cups complete whole wheat pancake mix (can use regular all purpose flour)

1 large firm banana, finely chopped

½ cup old-fashioned oats

¼ cup chopped walnuts (or pecans)

Prepare pancake batter according to the provided instructions on the box. Stir in the banana, oats, and walnuts. Pour batter by ¼ cup onto a hot griddle coated with cooking spray; flip the pancakes when bubbles form on the top. Cook until the second side is golden brown. Top with your favorite nuts!

Appendix E. Timeline of Project

Date	Time Duration	Activity
August 17-October 1, 2020	1 ½ months	Planning and IRB submission, edits, and approval
October 1-November 15, 2020	1 ½ months	COVID-19 Mitigations, planning, developing and editing research protocol (procedures and materials)
November 15, 2020 -January 27, 2021	2 months 1 week	Recruitment
January 19-January 29, 2021	1 ½ weeks	Pre- Assessment data collection at IHHS IPC clinic
January 31- April 25,2021	12 week	First 12 weeks begin; participants wear Fitbit daily. Participants receive 1-2 text messages/day, 1 eNewsletter/week, 1-2 text prompts/week, 1 body weight prompt/week, 1 physical activity feedback text/week
April 26-30, 2021	1 week	12 week midpoint check and Fitbit drop off at IHHS IPC clinic
May 2-July 25, 2021	12 weeks	Second 12 weeks intervention and data collection
July 25-July 30	1 week	Post Assessment 24 week data collection at the IHHS IPC clinic
July 25-October, 2021	2-3 months	Data Analysis

Appendix F. PAR-Q

Physical Activity Readiness Questionnaire (PAR-Q) and You

Regular physical activity is fun and healthy. More people are starting to become more active each day. Being more active is very safe for most people. However, some people should check with the doctor before they start becoming more physically active.

If you plan to become more physically active than you are now, start by answering the eight questions in the box below. If you are between the ages of 15 and 69, the PAR-Q will tell you if you should check with your doctor before you start.

Common sense is your best guide when you answer these questions. Please read the questions carefully and answers each one honestly:

YES

NO

- | | | |
|--------------------------|--------------------------|--|
| <input type="checkbox"/> | <input type="checkbox"/> | 1. Has your doctor ever said that you have a heart condition <u>and</u> that you should only do physical activity recommended by a doctor? |
| <input type="checkbox"/> | <input type="checkbox"/> | 2. Do you feel pain in your chest when you do physical activity? |
| <input type="checkbox"/> | <input type="checkbox"/> | 3. In the past month, have you had chest pain when you were not doing physical activity? |
| <input type="checkbox"/> | <input type="checkbox"/> | 4. Do you lose your balance because of dizziness or do you ever lose consciousness? |
| <input type="checkbox"/> | <input type="checkbox"/> | 5. Do you have a bone or joint problem that could be made worse by a change in your physical activity? |
| <input type="checkbox"/> | <input type="checkbox"/> | 6. Is your doctor currently prescribing drugs (for example, water pills) for your blood pressure or heart condition? |
| <input type="checkbox"/> | <input type="checkbox"/> | 7. Do you know of <u>any other reason</u> why you should not do physical activity? |
| <input type="checkbox"/> | <input type="checkbox"/> | 8. Are you pregnant or plan to become pregnant during this study? |

<p>If you answered:</p>	<p>YES to one or more questions</p> <p>Talk to your doctor BEFORE you start becoming more physically active or BEFORE you have a fitness appraisal. Tell your doctor about the PAR-Q and which questions you answered YES.</p> <ul style="list-style-type: none"> • You may be able to do any activity you want-as long as you start slowly and build up gradually. Or, you may need to restrict your activities to those which are safe for you. Talk with your doctor about the kinds of activities you wish to participate in and follow his/her advice. • Find out which community programs are safe and helpful for you.
<p>NO to all questions</p>	<p>Delay becoming much more active:</p> <ul style="list-style-type: none"> • If you are not feeling well because of a temporary illness such as a cold or a fever- wait until you feel better; or • If you are or may become pregnant-talk to your doctor before you start becoming more active.
<p>If you answered NO honestly to all PAR-Q questions, you can be reasonably sure that you can:</p> <ul style="list-style-type: none"> • Start becoming much more physically active-begin slowly and build up gradually. This is the safest and easiest way to go. • Take part in a fitness appraisal- this is an excellent way to determine your basic fitness so that you can plan the best way for you to live actively. 	<p>Please note: If your health changes so that you answer YES to any of the above questions, tell your fitness or health professional. Ask whether you should change your physical activity plan.</p>

Appendix G. Pre-assessment Appointment Email Reminder Script:

Department of Nutrition &
Health Care Management

BEAVER COLLEGE OF HEALTH SCIENCES
APPALACHIAN STATE UNIVERSITY

Welcome to *My Quest in the High Country* (#MQHC)

Thank you for participating in *MQHC*. You are scheduled for a pre-assessment appointment at the Blue Cross NC Institute for Health and Human Services Interprofessional Clinic (IPC) on <DATE>. The IPC is in Room 132 Leon Levine Hall, located at 1179 State Farm Road.

Preparing for the pre-assessment appointment.

- ☐ Wear comfortable clothing. Workout attire is best.
- ☐ Avoid wearing a lot of jewelry.
- ☐ Bring your cell phone.
- ☐ Bring a mask
 - ☐ You must wear a mask at all times while in Leon Levine Hall.
- ☐ Arrive 10 minutes early to come into the clinic to
 - ☐ Complete a COVID temperature check screening
 - ☐ Answer COVID exposure questions
 - ☐ Pick up a parking permit that will hang in your front window while you are in Leon Levine Hall.
 - ☐ Ensure you park in one of the marked IPC Clinic parking spots.

During the pre-assessment appointment-what to expect:

- ☐ Complete a COVID temperature check and answer COVID exposure questions
- ☐ Have body weight and height taken
- ☐ Confirm Eligibility
 - ☐ Including but not limited to: BMI ≥ 24 and Blood Pressure $< 135/80$
- ☐ Complete the Informed Consent Process and Pre-assessment survey
- ☐ Have a resting blood pressure reading taken
- ☐ Have body composition taken using bioelectric impedance analysis (BIA)
- ☐ Opt-in to the text message program
- ☐ Text initial body weight

- ☐ Receive a FitBit to use during the intervention
- ☐ Set up the Fitbit on your cell phone through the FitBit App
- ☐ Receive a bath scale to keep to self-monitor and report body weight

MQHC will begin on January 31, 2021.

If you have questions or need to reschedule this appointment please immediately reach out to Dr. Jamie Griffin by email (griffinjb@appstate.edu) or phone (828.262.8534) or Andrea Lockard by email (lockarda@appstate.edu) or phone (828.262.8534).

Thank you and we look forward to seeing you soon.

Dr. Griffin and the MQHC research team

Appendix H. Pre-assessment Appointment Day of Script:



Welcome to *My Quest in the High Country*. We are glad you chose to take this step towards better health and wellness.

Today, Dr. Jamie Griffin, Andrea Lockard or a member of the research team will complete your pre-assessment visit. During this visit, your height, weight, body composition, and blood pressure will be collected using standardized procedures. This information will be used to confirm study eligibility. You will be provided with an iPad to complete the online Qualtrics-based Informed Consent and pre-assessment survey.

Dr. Jamie Griffin, Andrea Lockard, or a research team member will assist you in opting-in to the text message program. After opt-in, you will text your body weight to practice self-reporting using the text message program.

Dr. Jamie Griffin, Andrea Lockard or a research team member will assign you a Fit Bit **to borrow** during the *MQHC* study. They will walk you through setting up the FitBit on your Smartphone. You will wear this Fit Bit each day until April 25, 2021. Make sure you wear the Fit Bit at all times, except when you are bathing. Note: A signed Fit Bit User Agreement is required before receiving the Fitbit.

IMPORTANT: The Fit Bit will be returned to Dr. Jamie Griffin or Andrea Lockard between April 26, 2021-May 5, 2021. If you choose to drop out of the *MQHC* program, you are required to return the Fit Bit to Dr. Griffin or Andrea immediately. If you move out of the area, you are required to return the FitBit to Dr. Griffin or Andrea immediately before leaving the area.

You will be given a bath scale to keep. You will use the bath scale to weigh yourself each week and self-report body weight, when prompted.

On January 31, 2021, you will begin getting 1-2 text messages each day, a weekly eNewsletter, and weekly feedback on your physical activity that is recorded in the Fit Bit.

On April 25, 2021, you will get a text message that will include a link to a quick mid-program online survey. Please take this survey as soon as possible. It is very important you take this survey within a day or two of it arriving. You will also need to

schedule a visit to the IPC to return the Fit Bit to Jamie or Andrea as soon as possible. The FitBit should be returned no later than May 5, 2021. You will continue to receive 1-2 text messages each day and a weekly eNewsletter.

On July 19, 2021 you will receive a text message that includes a link to a third online survey. Please take this survey as soon as possible. It is very important you take this survey within a day or two of it arriving. **Once you take the online survey you will be put into a drawing for a \$50 Walmart gift card.** Note: You must complete both the first survey and the third survey AND return the FitBit to Dr. Griffin or Andrea to be eligible for the \$50 Walmart gift card drawing.

You will continue to get 3-4 text messages each week to help keep you on track.

If your cell phone number is disconnected or changes at ANY TIME during MQHC, immediately tell Jamie Griffin (griffinjb@appstate.edu; 828-262-8534) or Andrea Lockard (lockarda@appstate.edu).

In health!

Dr. Griffin and the MQHC research team

Appendix I. Pre and post assessment survey tool with Imbedded Consent:

For these questions, think about your feelings towards exercise. How much do you agree with the following statements?

1. Exercise lets me have contact with friends and people I enjoy.
 - a. Strongly disagree
 - b. Disagree
 - c. Neither agree nor disagree
 - d. Agree
 - e. Strongly agree
2. Exercise makes me feel better physically.
 - a. Strongly disagree
 - b. Disagree
 - c. Neither agree nor disagree
 - d. Agree
 - e. Strongly agree
3. Walking an extra 500 steps each day will help me lose weight.\
 - a. Strongly disagree
 - b. Disagree
 - c. Neither agree nor disagree
 - d. Agree
 - e. Strongly agree

For these questions, think about your feelings towards exercise. How much do you agree with the following statements?

4. It costs too much to exercise.
 - a. Strongly disagree
 - b. Disagree
 - c. Neither agree nor disagree
 - d. Agree
 - e. Strongly agree
5. Exercise is an activity I enjoy doing.

- a. Strongly disagree
 - b. Disagree
 - c. Neither agree nor disagree
 - d. Agree
 - e. Strongly agree
6. Exercise improves my ability to perform daily activities (such as cooking, shopping or light cleaning).
- a. Strongly disagree
 - b. Disagree
 - c. Neither agree nor disagree
 - d. Agree
 - e. Strongly agree

For these questions, think about your feelings towards exercise. How much do you agree with the following statements?

7. I want to exercise 30 minutes or more each day.
- a. Strongly disagree
 - b. Disagree
 - c. Neither agree nor disagree
 - d. Agree
 - e. Strongly agree
8. I can exercise 30 minutes or more each day when I'm tired, upset or stressed.
- a. Strongly disagree
 - b. Disagree
 - c. Neither agree nor disagree
 - d. Agree
 - e. Strongly agree
9. I want to walk 10,000 steps each day.
- a. Strongly disagree

- b. Disagree
- c. Neither agree nor disagree
- d. Agree
- e. Strongly agree

Now, think about the foods you eat. How much do you agree with the following statements?

10. I have control over what foods are served in my home.

- a. Strongly disagree
- b. Disagree
- c. Neither agree nor disagree
- d. Agree
- e. Strongly agree

11. Writing down the foods I eat will help me lose weight.

- a. Strongly disagree
- b. Disagree
- c. Neither agree nor disagree
- d. Agree
- e. Strongly agree

12. My family members think I should offer fruits and vegetables more often.

- a. Strongly disagree
- b. Disagree
- c. Neither agree nor disagree
- d. Agree
- e. Strongly agree

13. I want to eat more fruits and vegetables each day

- a. Strongly disagree
- b. Disagree
- c. Neither agree nor disagree
- d. Agree
- e. Strongly agree

14. It is mostly up to me what to make for meals.

- a. Strongly disagree
- b. Disagree
- c. Neither agree nor disagree
- d. Agree
- e. Strongly agree

15. Eating fruits and vegetables is enjoyable.

- a. Strongly disagree
- b. Disagree
- c. Neither agree nor disagree
- d. Agree
- e. Strongly agree

Q22 Now, think about the foods you eat. How much do you agree with the following statements?

16. I want to write down my foods each day to know how many calories I am eating.

- a. Strongly disagree
- b. Disagree
- c. Neither agree nor disagree
- d. Agree
- e. Strongly agree

17. I can eat fruits and vegetables each day when I am nervous, upset or stressed.

- a. Strongly disagree
- b. Disagree
- c. Neither agree nor disagree
- d. Agree
- e. Strongly agree

18. Replacing one sugar-sweetened beverage (such as sweet tea, soft drinks, fruit drinks or sports drinks) a day with water will help me lose weight.

- a. Strongly disagree
- b. Disagree

- c. Neither agree nor disagree
 - d. Agree
 - e. Strongly agree
19. Eating fruits and vegetables is needed for good health.
- a. Strongly disagree
 - b. Disagree
 - c. Neither agree nor disagree
 - d. Agree
 - e. Strongly agree

For the next few questions, think about how sure you are of the following statements.

20. I know how to set goals to increase my physical activity.
- a. Not sure at all
 - b. Not sure
 - c. Neither not sure nor sure
 - d. Sure
 - e. Extremely sure
21. I can have fruits and vegetables when I am in a rush.
- a. Not sure at all
 - b. Not sure
 - c. Neither not sure nor Sure
 - d. Sure
 - e. Extremely sure
22. I can eat 5 servings of fruits and vegetables most days.
- a. Not sure at all
 - b. Not sure
 - c. Neither not sure nor Sure
 - d. Sure
 - e. Extremely sure
23. I can eat high fiber foods.
- a. Not sure at all

- b. Not sure
 - c. Neither not sure nor Sure
 - d. Sure
 - e. Extremely sure
24. I know how many calories I should eat each day to manage my weight.
- a. Not sure at all
 - b. Not sure
 - c. Neither not sure nor Sure
 - d. Sure
 - e. Extremely sure
25. I can select foods from all food groups that are rich in nutrients and lower in calories (such as fruits and vegetables, whole grains, lean meats, low-fat dairy).
- a. Not sure at all
 - b. Not sure
 - c. Neither not sure nor Sure
 - d. Sure
 - e. Extremely sure

For the next few questions, think about how sure you are of the following statements.

26. I can control my food portions to control my weight.
- a. Not sure at all
 - b. Not sure
 - c. Neither not sure nor Sure
 - d. Sure
 - e. Extremely sure
27. I know what a single serving is for my favorite food
- a. Not sure at all
 - b. Not sure
 - c. Neither not sure nor Sure
 - d. Sure
 - e. Extremely sure

28. I know how to read food labels to pick foods lower in calories.
- a. Not sure at all
 - b. Not sure
 - c. Neither not sure nor Sure
 - d. Sure
 - e. Extremely sure
29. I know I can make small changes in my eating to make my health better.
- a. Not sure at all
 - b. Not sure
 - c. Neither not sure nor Sure
 - d. Sure
 - e. Extremely sure

How often do you do the following?

30. Make a grocery shopping list?
- a. Never
 - b. Less than once a month
 - c. Once a month
 - d. 2-3 times a month
 - e. Once a week
 - f. 2-3 times a week
 - g. Daily
31. Plan your meals ahead?
- a. Never
 - b. Less than once a month
 - c. Once a month
 - d. 2-3 times a month
 - e. Once a week
 - f. 2-3 times a week
 - g. Daily
32. Have fruits and vegetables ready to eat as a snack?

- a. Never
- b. Less than once a month
- c. Once a month
- d. 2-3 times a month
- e. Once a week
- f. 2-3 times a week
- g. Daily

How often do you do the following?

33. Have sugar-sweetened beverages (such as sweet tea, soft drinks, fruit drinks or sports drinks) in your home?
- a. Never
 - b. Less than once a month
 - c. Once a month
 - d. 2-3 times a month
 - e. Once a week
 - f. 2-3 times a week
 - g. Daily
34. Eat fruits and vegetables as a snack?
- a. Never
 - b. Less than once a month
 - c. Once a month
 - d. 2-3 times a month
 - e. Once a week
 - f. 2-3 times a week
 - g. Daily
35. Drink water instead of sugar-sweetened beverages (such as sweet tea, soft drinks, fruit drinks or sports drinks)?
- a. Never
 - b. Less than once a month
 - c. Once a month

- d. 2-3 times a month
- e. Once a week
- f. 2-3 times a week
- g. Daily

Respond "Yes" or "No" to the following questions.

- 36. Yesterday, I exercised for 30 or more minutes.
 - a. Yes
 - b. No
- 37. Next week, I will exercise 30 minutes or more each day.
 - a. Yes
 - b. No
- 38. I know the number of steps I walked yesterday.
 - a. Yes
 - b. No
- 39. Next week, I will walk 500 more steps each day.
 - a. Yes
 - b. No
- 40. Next week, I will write down my steps each day.
 - a. Yes
 - b. No
- 41. Yesterday, I wrote down what I ate and drank.
 - a. Yes
 - b. No
- 42. Next week, I will write down what I eat and drink each day.
 - a. Yes
 - b. No

Now, think about the foods you usually eat and drink.

- 43. How many servings of fruits do you eat each day? A serving of fruit is an apple or banana, a small bowl of grapes, or 3 tablespoons of canned fruit

- a. None
 - b. Less than 1 per day
 - c. 1-2 per day
 - d. 3-4 per day
 - e. 5 or more per day
44. How many servings of vegetables do you eat each day? A serving of vegetables is 3 heaped tablespoons of green or root vegetables like peas, baked beans, or sweet corn; or a medium bowl of salad (lettuce, tomatoes, etc.)
- a. None
 - b. Less than 1 per day
 - c. 1-2 per day
 - d. 3-4 per day
 - e. 5 or more per day

Now, think about the foods you usually eat and drink.

45. How many sugar-sweetened beverages (such as sweet tea, soft drinks, fruit drinks or sports drinks) do you drink each day?
- a. None
 - b. Less than 1 per day
 - c. 1-2 per day
 - d. 3-4 per day
 - e. 5 or more per day

Think about the foods you usually eat and drink.

46. How often do you eat high-fat meats (such as hot dogs, bologna, bacon, sausage, pepperoni, BBQ or fried chicken)?
- a. None
 - b. 1-2 times per week
 - c. 3-4 times per week
 - d. 5-6 times per week
 - e. 1 or more each day

47. How often do you eat refined grains (such as white bread, white rice or pasta)?

- a. None
- b. 1-2 times per week
- c. 3-4 times per week
- d. 5-6 times per week
- e. 1 or more each day

Think about the time you spend sitting (such as at work, home or traveling).

48. On a typical day, how much time do you usually spend sitting (in hours)?

- a. None
- b. Less than 1 hour per day
- c. 1-2 hours per day
- d. 3-4 hours per day
- e. 5-6 hours per day
- f. 7-8 hours per day
- g. 9 or more hours per day

Think about the time you spend sitting (such as at work, home or traveling).

49. How much time do you usually spend sitting watching television, playing video games or searching the internet (computer, tablet or cell phone)?

- a. None
- b. Less than 1 hour per day
- c. 1-2 hours per day
- d. 3-4 hours per day
- e. 5-6 hours per day
- f. 7-8 hours per day
- g. 9 or more hours per day

In the next week, how many hours do you plan to do the following?

50. Strenuous exercise (heart beats rapidly) ex: biking fast, hiking, running, jogging, swimming laps, etc.

- a. None
- b. Less than 1 hour per week
- c. 1-2 hours per week
- d. 3-4 hours per week
- e. 5-6 hours per week
- f. 7-8 hours per week
- g. 9 or more hours per week

51. Moderate exercise (not exhausting) Ex: walking quickly, dancing, team sports, weight lifting, etc.

- a. None
- b. Less than 1 hour per week
- c. 1-2 hours per week
- d. 3-4 hours per week
- e. 5-6 hours per week
- f. 7-8 hours per week
- g. 9 or more hours per week

52. Mild exercise (little effort) Ex: walking slowly, gardening, cleaning house, vacuuming, golf, fishing, yoga, etc.

- a. None
- b. Less than 1 hour per week
- c. 1-2 hours per week
- d. 3-4 hours per week
- e. 5-6 hours per week
- f. 7-8 hours per week
- g. 9 or more hours per week

For the next few questions think about your sleep routine and habits.

53. On average, how many hours of sleep do you get most nights?

- a. less than 5 hours
- b. 5-6 hours
- c. 7-8 hours

d. more than 8 hours

54. How would you rate the quality of your sleeping habits?

a. very good

b. fairly good

c. fairly bad

d. very bad

Respond "Yes" or "No" to the following questions:

55. I do not know how to purchase food.

a. Yes

b. No

56. I do not know how to prepare or cook food.

a. Yes

b. No

You are almost finished. This is the last set of questions. Make sure to complete the survey.

57. What is your age?

58. What is your height? (in inches) Example: If you are 5 feet and 6 inches, you will enter 66"

59. What is your weight? (in pounds)

60. Are you?

a. Male

b. Female

61. What is your race? (Check all that apply)

a. White Caucasian

b. Black/African American

c. Native American/Alaska Native

d. Native Hawaiian or Other Pacific Islander

e. Asian

f. Other

62. For work, are you employed?

- a. Full-time
 - b. Part-time
 - c. Unemployed
63. Have you *tried to lose weight* within the past three months?
- a. Yes
 - b. No
64. Have you been in a weight loss program such as Weight Watchers, NutriSystem, etc. in the past three months
- a. Yes
 - b. No
65. Have you *lost weight* within the past three months?
- a. Yes
 - b. No
66. What is your cell phone number? Ex: 828-234-5678 Please note: Your phone number will not be shared with anyone. This information will be used to ensure you have successfully opted-in to the text message program.

Appendix J. Weekly education topic and objectives:

Week	Goal	Objectives
1 Food Journaling	Educate participants on the value of food journaling and why it may be used for weight loss	<ol style="list-style-type: none">1. Participants will keep a food journal at least one full day during this study2. Participants will identify food habits that encourages weight gain/inhibit weight loss
2 Portion Control	Educate participants on plate method and how to portion home cooked meals when serving to their family	<ol style="list-style-type: none">1. Participants will know an approximate serving size of each macronutrient2. Participants will be able to construct a balanced plate
3 SMART Goals	Educate participants on the five pillars of goal setting: Specific, Measurable, Attainable, Relevant, Time sensitive	<ol style="list-style-type: none">1. Participants will be able to identify and set goals that adhere to the SMART acronym
4 Pedometer	Educate on the health benefits of walking	<ol style="list-style-type: none">1. Participants will increase step counts weekly2. Participants will be able to identify three health benefits of walking daily.
5 Sleep	Educate participants on ways to improve sleep habits and the importance of having adequate sleep.	<ol style="list-style-type: none">1. Participants will put electronics away 30 minutes before going to bed2. Participants will improve sleep score by 5 points weekly

6 Nutrition Facts Label	Educate participants on how to read a nutrition facts label, specifically, what serving size and %dv numbers mean on an English food label	<ol style="list-style-type: none"> 1. Participants will be able to identify serving size on a nutrition facts label 2. Participants will be able to identify saturated fat, trans fat and sodium on a nutrition facts label and know goal amounts for items
7 Fitness Tracker	Educate participants on the Physical Activity Guidelines for Americans for promotion of weight loss (30 minutes per day/5 days per week)	<ol style="list-style-type: none"> 1. Participants will meet 80% of the set Physical Activity Guidelines by week 12 2. Participants will be able to use alternative forms of physical activity to ensure movement throughout the week (dance, hiking, swimming, cleaning the house, etc).
8 RPE/Steps	Educate participants on RPE and the talk test as it relates to being active	<ol style="list-style-type: none"> 1. Participant RPE score will improve as regular physical activity increases
9 Rethink Your Drink	Educate participants on the benefits of water intake and its effect on health status.	<ol style="list-style-type: none"> 1. Participants will increase water intake compared to previous weeks of intervention 2. Participants will identify other sources of water within their

		diet (i.e fruits, soups, vegetables)
10 Protein	Educate participants on the importance of protein in the diet for growth and satiety at meal times.	<ol style="list-style-type: none"> 1. Participants will be able to identify protein sources within their diet 2. Participants will include a protein source at breakfast every day
11 Fats	Educate participants on fat as a macronutrient and its role in our health	<ol style="list-style-type: none"> 1. Participants will be able to identify saturated and unsaturated fat sources within their diet 2. Participants will limit saturated fat sources to 7% of their daily caloric intake by week 12
12 Carbohydrates	Educate participants on carbohydrate use and function in the body as energy.	<ol style="list-style-type: none"> 1. Participants will be able to identify carbohydrate sources in their diet 2. Participants will know when to eat carbohydrate sources for energy
13 Reduce SSB	Educate participants on SSB, their calorie content, and the effects it can have on weight loss and health	<ol style="list-style-type: none"> 1. Participants will reduce SSB consumption by 50% by week 12 2. Participants will identify sources of SSB in their diet

14 Small Spaces	Educate participants on ways to cook and stay active in small spaces	<ol style="list-style-type: none"> 1. Participants will have more knowledge of ways to exercise in an apartment or dorm 2. Participants will have more confidence cooking without a full kitchen or adequate kitchen equipment.
15 Fiber	Educate participants on the benefits of including fiber in their diet	<ol style="list-style-type: none"> 1. Participants will be able to identify sources of soluble and insoluble fiber. 2. Participants will increase fiber intake in their daily diet.
16 Fruits and Vegetables	Educate participants on CDC guidelines for 5 servings of fruit and vegetables per day, even during fall and winter, and the role they play in health and weight loss	<ol style="list-style-type: none"> 1. Participants will increase fruit and vegetable intake to five servings per day 2. Participants will be able to identify fruits and vegetables in season for fall/winter
17 Vit D/ Calcium	Educate participants on the importance of vitamin D and calcium in the diet as it relates to bone health.	<ol style="list-style-type: none"> 1. Participants will be able to identify food sources of vitamin D and calcium in their diet
18 Added Sugar	Educate participants on what added sugars are and how they negatively affect our health and weight	<ol style="list-style-type: none"> 1. Participants will be able to identify sources of added sugars in their current diet 2. Participants will limit amount of added

		sugars in their diet to less than 10% of total caloric intake
19 Iron	Educate participants on iron's role within the body	1. Participants will be able to identify sources of heme and nonheme iron
20 Healthy Snack	Educate participants on how to create a healthy snack	1. Participants will be able to identify healthy snack options that combine macronutrients to increase satiety
21 Vitamin C	Educate participants on the role vitamin C plays in health status	1. Participants will be able to identify multiple sources of vitamin C.
22 Summer BBQ	Educate participants on how to choose healthy, nutrient-dense options during holiday mealtimes. Educate participants on food safety during summer BBQs.	1. Participants will be able to implement the plate method during summer picnics barbecues for consistent weight management.
23 Screen Time	Educate participants on the adverse effects of excessive screen time	<ol style="list-style-type: none"> 1. Participants will stand/move each hour 2. Participants will reduce screen time by 1 hour each week
24 Sodium	Educate participants on the risk of a high sodium diet	1. Participants will be able to identify high sodium foods (including but not limited to, processed

		<p>meats, instant rice, pre-packaged foods, frozen meals, sauces, dressings, etc)</p> <p>2. Participants will see a positive change in blood pressure over the 12 week research period</p>
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Appendix K. Tables

Table 1. Text Response for Body Weight of <i>My Quest in the High Country</i>			
	Total Text Prompts Sent (n)	Total Text Responses Received (n)	Text Response Received (%)
Body Weight (Week 1-12)	132	117	88.6%
Behavioral Response (Week 1-12)	77	54	70.1%
Behavioral Response (Week 13-24)	55	26	47.3%

Table 2. Participant Social Cognitive Theory Construct Scores Before and After *My Quest in the High Country*

	Pre Mean	Post Mean	P-value
Behavioral Factors			
Physical Activity			
Next week, I will exercise 30 minutes. ^{1,a}	0.91(0.302)	0.90(0.316)	1.000
I know the number of steps I walked yesterday. ^{1,a}	0.45(0.522)	0.60(0.516)	1.000
Sedentary Behaviors			
In a typical day, how many hours do you spend sitting? ^{3,c}	8.60(2.591)	5.85(2.604)	.024*
How much time do you usually spend sitting watching television, playing video games, or searching the internet (computer, tablet or cell phone)? ^{2,d}	4.50(.707)	4.00(1.054)	0.403
Environmental Factors			
Sugar-Sweetened Beverages			
How often do you drink water instead of sugar sweetened beverages (such as sweet tea, soft drinks, fruit drinks or sport drinks)? ^{2,d}	6.91(.302)	6.90 (.316)	1.000

¹McNemar Test; ²Wilcoxon Signed Rank test; ³Paired t-test

^aResponse scale: 0=No, 1=Yes; ^bResponse scale: 1=Never, 7=Daily; ^cResponse: Open-ended question; ^dResponse scale: 1=None, 7=9 or more hours per day.

†Standard Deviation was not produced in SPSS outputs

*p<.05, **p<.01, ***p<.001

Table 3. Anthropometric and Physical Activity Characteristics of *My Quest in the High Country* Participants at Pre-assessment and Post-assessment

	Pre-assessment	Post-assessment	
Characteristic	(n=11)	(n=10)	p-value
Anthropometric ^a			
Weight [lb (SD)]	186.12(51.125)	177.61(44.184)	.05* ^c
BMI [kg/m ² (SD)]	30.56(6.959)	29.24(6.364)	.03* ^c
Systolic Blood Pressure [mmHg (SD)]	111.89(6.809)	111.89(11.879)	1.00
Diastolic Blood Pressure [mmHg (SD)]	78.67(8.337)	66.89(7.928)	.02* ^c
Physical Activity ^b			
Physical Activity (minutes/week)	84.6(102.5)	130.3(187.7)	.45 ^c
Step Counts (steps/day)	4389.7(2885.1)	5073.7(1372.2)	.93 ^c
Sleep Scores (score out of 100)	79.27(2.533)	75.33(7.228)	.153 ^c
Heart Rate (beats per minute)	70.55 (9.202)	66.36 (8.465)	.031* ^c

^a Data collected from Electronic Medical Record

^b Data collected from Fitbit Dashboard

^c paired *t*-test (pre- post data from 10 participants who completed MQHC)

*p<.05; **p<.01; ***p<.001

Table 4. Demographic Characteristics of *My Quest in the High Country* Participants at Pre-assessment

Pre-assessment	
Characteristic	(n=11)
Age [y (\pm , \bar{X})]	23.4(6.2)
Gender [n (%)]	
Female	8(72.7)
Male	3(27.3)
Race [n (%)]	
White	7(63.6)
Black or African American	1(9.1)
Asian	1(9.1)
Other	1(9.1)
2 or more	1(9.1)
Hispanic or Latino [n(%)]	
Yes	2(18.2)
Education [n (%)]	
High School or GED	2(18.2)
2 year/Some College	7(63.6)
4 year degree or more	2(18.2)
Marital Status [n (%)]	
Single	10(90.9)
Married	1(9.1)
Income [n (%)]	
<\$15,000/year	10 (90.9)
\$25,001-\$50,000/year	1(9.1)
Employment [n(%)]	
Unemployed	6(54.5)
Part time	5(45.5)

Appendix L. North Carolina Academy of Nutrition and Dietetics (NCAND), Lightning Slide Poster (Presented September 17, 2021):

Assessing Biometrics, Nutritional Behaviors, and Sleep Behaviors Following Implementation of mHealth in College Students.

Andrea Lockard, Appalachian State University; Melissa Gutschall, Ph.D., RDN, LDN, FAND, Appalachian State University; Bryan Belcher, MPH, Appalachian State University; Jamie B. Griffin, Ph.D., RDN, LDN, Appalachian State University

Purpose:

- Chronic diseases such as obesity are common in college students.
- College students also struggle to develop strategies to maintain healthy weight and lifestyle behaviors.
- *My Quest in the High Country* created a 24-week mHealth intervention to improve weight status, health behaviors and biometrics in ASU students.

Materials and Methods:

- College students of all years were recruited through medias
- **Pre-assessment:** biometrics and survey. Participants received a scaled, Fitbit, and caloric intakes.
- **Weeks 1-12:** participants received texts, eNewsletters, and physical activity feedback.
- **Midpoint:** Fitbits returned; biometrics and survey collected
- **Weeks 13-24:** Texts and eNewsletters continued
- **Post-assessment:** biometrics and surveys collected
- **Statistical analyses:** Wilcoxon Signed Rank, McNemar, paired *t*-test, and descriptives. Significance was set at $p < .05$.

Results:

- Participants ($n=11$) were female (72.7%), non-Hispanic (82%), and Caucasian (64%), with a mean age of 23.4.
- Significant ($p < .05$) improvements: body weight, DMI, diastolic BP, fruit/vegetable intake, and sedentary time
- No significant changes: systolic BP, step count, PA minutes, sleep score

Discussion:

- Progress dropped after returning the Fitbit at week 12.
- In future studies, a larger student email list may increase sample size and participant diversity.

Assessing Body Measurements, Nutritional Behaviors, And Sleep Behaviors Following Implementation Of Mhealth In Appalachian State University College Students

Andrea Lockard¹; Melissa Gutschall, Ph.D., RDN, LDN¹; Bryan Belcher, MPH¹; Jamie B. Griffin, Ph.D., RDN, LDN¹
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INTRODUCTION

The American population has suffered from the prevalence of obesity within the past several decades.¹ Now, 30-35% of college students are characterized as overweight or obese.² As young adults enter into a college lifestyle, new habits are learned and old habits are forgotten due to social and environmental influences.³ There has also been a greater gap in health knowledge, healthy behaviors, and sleep behaviors among college students.

Irregular sleep patterns also need to be considered with weight management. The Pittsburgh Sleep Quality Index (PSQI) assesses components such as sleep quality, sleep latency, sleep duration, sleep efficiency, sleep disturbances, use of sleep aids, and daytime dysfunction.⁴ In a study focusing on the sleep quality of college aged students, the PSQI was distributed as a survey. Many (60%) students were categorized as poor-quality sleepers, with an average 7.02 hours per night for all participants.⁵ Young adults, ages 18-25, are recommended to have 7-9 hours of sleep per night.⁶ Sleep deprivation is associated with becoming overweight or obese in many college students.⁶

Technology has become a prominent part of the young adult lifestyle, therefore a tailored health behavior and weight management intervention using technology may be more practical for this population. Incorporating technology interventions such as text-messaging, personal fitness trackers, and eNewsletters into a weight loss/management program may improve health behaviors of many young individuals.⁷

A text message-based weight and health management program can be cost effective and easily adhered to on college campuses. A tailored mobile health (mHealth) initiative for college students can promote the incorporation of healthy weight, diet and lifestyle behaviors.

PURPOSE

The purpose of this study was to decrease weight, BMI, blood pressure, and implement a positive nutrition behavior change and sleeping habit intervention in Appalachian State college students through a mobile health (mHealth) initiative, *My Quest in the High Country* (MQHC).

METHODS

Students were recruited (November 2020-2021) through flyers, handouts, and a randomized sample of 500 student emails. Interested participants meeting study criteria took an online pre-assessment survey and provided Informed Consent. Eligible participants (n=11) received a Fitbit to wear during weeks 1-12 of the study, and a bath scale to provide a weekly body weight.

At the pre-assessment appointment, researchers recorded weight, height, body mass index (BMI), body fat percent through bioelectric impedance analysis (BIA), and blood pressure using standardized procedures, and collected a Physical Activity Readiness Questionnaire (PAR-Q). The MyPlate MyPlan that coincided with the participant's daily calorie intake was used as a recommended daily meal pattern.⁸ At week 12, participants attended a mid-assessment appointment to return the Fitbit and have weight, BMI, BIA, and blood pressure recorded. Text messages (n=1-2/day) and eNewsletters (n=1/week) continued. At week 24, participants attended a post-assessment appointment. Weight, BMI, BIA, and blood pressure were taken. Participants also completed a post-assessment survey.

Participants received 1-2 SMS texts each day and one weekly eNewsletter every Sunday. Text messages and eNewsletters were tailored around a nutrition or health education topic such as: Importance of Sleep, Exercising in Small Spaces, and Water Intake. Participants received There were also 2-3 self-monitoring text messages per week and a self-reported body weight each Sunday morning.

Physical activity data was recorded weekly by researchers for weeks 1-12. Researchers downloaded weekly step counts, physical activity minutes, heart rate, and sleep scores from the Fitbit dashboard. After evaluation of the downloaded Fitbit data, researchers sent a tailored weekly physical activity feedback text to each participant.

Analyses were conducted using Wilcoxon signed rank test (ordinal data), McNemar test (dichotomous data) and paired t-test or Repeated measures analysis of variance (continuous data). Statistical significance was set at p< .05.

RESULTS

A total of 11 participants were eligible for the study and provided consent. At post, 10 participants completed the study (91% retention). One participant did not complete the post-assessment survey nor did they attend the post assessment appointment and were not included in the final analysis.

Table 1. Participant Demographics (n=11)

Age, Years	23.4 (8.2)
Gender	
Female	4 (72.7%)
Male	7 (63.6%)
2 year/Some College	7 (63.6%)
Single	10 (90.9%)
<15,000/year	10 (90.9%)

Overall, how would you rate the MyQuest in the High Country program with respect to helping develop healthier habits?

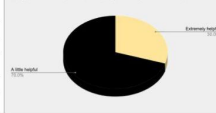


Table 1. Anthropometric and Biometric Characteristics

Characteristic	Pre Assessment (n=10)	Post Assessment (n=10)	p-value
Body Weight (lbs)	186.12 (31.128)	177.61 (44.184)	p=0.08*
BMI	30.58 (8.866)	29.24 (8.364)	p=0.03*
Blood Pressure Systolic	111.89 (8.809)	111.89 (11.879)	p=1.00
Blood Pressure Diastolic	78.67 (8.337)	66.89 (7.628)	p=0.02*

Table 3. Health Behavior Outcomes

Qualtrics Question	Pre Assessment (n=10)	Post Assessment (n=10)	p-value
Text Week 1: I exercise 30 minutes	0.91 (0.302)	0.90 (0.316)	p=1.000
Know the number of steps I walked yesterday	0.45 (0.522)	0.60 (0.516)	p=1.000
In a typical day, how much do you usually spend sitting (in hours)?	8.60 (2.591)	8.55 (2.604)	p=0.92
How much time do you usually spend sitting watching television, playing video games, or searching the Internet (computer, tablet, or cell phone)?	4.50 (7.07)	4.00 (1.054)	p=0.403
How often do you drink water instead of sugar sweetened beverages (such as sweet tea, soft drinks, fruit drinks or sport drinks)?	6.91 (3.02)	6.90 (3.16)	p=1.000
How many servings of vegetables do you eat each day?	3.00 (1.866)	3.20 (1.549)	p=0.509
How many servings of fruits do you eat each day? (A serving of fruit is the size of an apple, a small bowl of grapes, or 3 tablespoons of canned fruit)	2.30 (1.684)	2.40 (1.308)	p=0.632

Table 2. Fitbit Data of My Quest in the High Country Control and Text Message Participants at Pre-assessment and Post-assessment

Characteristic	Pre Assessment (n=10)	Post Assessment (n=10)	p-value
Step Counts	48074.58 (23115.657)	40000.09 (24890.575)	p=0.912
Physical Activity Minutes	352.18 (282.742)	340.45 (318.989)	p=0.858
Sleep Scores	79.272 (533)	75.33 (7.228)	p=0.153
Heart Rate	70.55 (8.202)	66.36 (8.465)	p=0.031*

DISCUSSION

While the results were a mix of significant and insignificant improvements in biometrics and health behaviors, there is implication that an mHealth intervention would be impactful for the college student population. Step count increased by 2,607.72 steps within the first 6 weeks of intervention, which is an increase in about a mile of walking on average.

Many participants shared at the midpoint assessment that the event of academic finals caused a decrease in physical activity. Participant feedback showed that the Fitbit and text message intervention may be helpful with advancing behavior change and improving biometrics such as weight, BMI, and blood pressure. One participant noted that "the Fitbit was the most powerful part of my behavior change and weight loss." Many participants (82%) plan to or already have purchased an activity tracker. Overall participants found the text messages to be extremely helpful or little helpful (55%). Participants also found the weekly newsletters to also be extremely helpful or a little helpful (50%). One participant noted that the "text messages provided some new information" that they have not heard before. However, another participant thought "the newsletters and text messages could have had more challenging information for a college student population."

Retention for the current study was greater than that of previous mHealth studies to promote biometric and health behavior improvements (90.1% as compared to 68-96%).⁷ Participants were provided a Fitbit fitness tracker and a bath scale to self-monitor weight and physical activity. Participants receiving the equipment allowed the researchers to obtain individualized weekly feedback throughout the study. This allowed participants and researchers to engage with each other during the 24 week program.

CONCLUSION

The MQHC intervention showed statistically significant (p<.05) improvements in body weight, BMI, diastolic blood pressure and heart rate. These factors are biometrics that young adults are beginning to struggle with at an earlier age.²⁻⁶ The results did not show a significant change in step counts, physical activity, and sleep scores, however participants did feel that having the Fitbit half way through impacted the motivation of physical activity (70%). This suggests that mHealth interventions using a self-monitoring tool throughout the entire study can be impactful in college students. In future studies, altering text message and newsletter topics to focus on gaps in college student knowledge may retain more focus and increase response rates. A larger student email list may increase sample size and participant diversity.

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VITA

Andrea Lockard was born in Salt Lake City, Utah and is the daughter of Tim and Colleen Lockard. Growing up she lived in Utah, Alabama, Florida, Washington State, and North Carolina, graduating from Freedom High School in 2016. Andrea continued her education at Appalachian State University where she graduated with a Bachelor of Science degree in Nutrition and Dietetics in May 2020. She furthered her education at Appalachian State University where she received her Master of Science in Nutrition and Dietetics in May 2022. Andrea will pursue her career as a Registered Dietitian Nutritionist.