PROJECT GIRLTALK: TARGETING PHYSICAL ACTIVITY FOR LONGTERM KNOW-HOW IN GIRLS

by

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ABSTRACT

Background: Community-based interventions targeting both increased physical activity (PA) and improved diet quality (DQ) are needed in the middle school girl population, and self-efficacy, a primary construct of Social Cognitive Theory (SCT), predicts PA in this group. **Primary Aims**: 1) Examine changes in both objectively measured moderate to vigorous PA (MVPA) and DQ, and 2) Explore relationships between changes in PA self-efficacy and changes in PA. **Methods**: Girls (n = 56; 11.6 ± 1.0 years) attended a 5-day summer camp framed in both SCT and the Simple 7 for Kids and were then cluster-randomized into 1 of 3 groups for the fall semester: 1) Social Media (SM) [n = 27]: 3 group meetings, 5 Facebook contacts weekly, JawBone up worn daily, testing visits; 2) Control (CON) [n = 22]: testing visits only; 3) Modified Control (CON-MOD) [n = 7]: JawBone up worn daily, testing visits. Data were collected assessing: A) PA via accelerometry, B) DQ via dietary recall, and C) psychosocial outcomes. **Results for Aim 1**: In Phase 1, no acute change in MVPA occurred ($p > 0.05$), with 34.7% increasing and 65.3% decreasing MVPA after camp. Energy intake, consumption of added sugars and refined grain intake all decreased (10.9%, 17.1%, and 16.4%, respectively; all $p < 0.05$). Phase 2 revealed no Group by Time or main effects of Group or Time for MVPA (all p

> 0.05). For added sugars, there were no Group by Time or Group effects; but, there was a main effect of Time with added sugar intake increasing over the fall term ($p = 0.04$). **<u>Results for Aim 2</u>**: Phase 1 revealed no changes in PA or PA self-efficacy (both $p > 0.05$); but, change in PA self-efficacy was associated with change in PA ($r = 0.27$; $p = 0.06$). In Phase 1, outcome expectancy-value decreased by 22.8% and self-management increased by 6% (both $p < 0.05$). Phase 2 showed no significant Group by Time or Group effects for psychosocial outcomes (all $p < 0.05$). **<u>Conclusion</u>:** Although it remains challenging to improve PA and DQ behaviors in middle school girls, novel community-based interventions are warranted.

INDEX WORDS: middle school girls, adolescents, physical activity, diet quality, overweight, obesity

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CHAPTER 1

INTRODUCTION

1.1 Public Health Significance

Interventions designed to enhance the health status of middle school-aged children are of high public health interest due to the increasing prevalence of physical inactivity [1], overweight/obesity [2], and decreased diet quality [3] in this cohort. Recently available data in 2012 indicate that 18% of children (ages 6-11), and 21% of adolescents (ages 12-19) were classified as obese. Females fare worse than their male counterparts across the age spectrum from childhood to older adulthood with regards to risk for overweight and obesity; in middle school specifically, 33% of girls and 27% of boys are classified as overweight or obese [1]. There is a well-established link between childhood and adolescent obesity and increased prevalence of risk factors for cardio-metabolic diseases earlier in adulthood including cardiovascular disease, type 2 diabetes, metabolic syndrome, several types of cancer, and a host of social and psychological disorders [4-7]. Potential contributing factors to the marked rise in obesity in childhood and adolescence include lower levels of habitual physical activity (PA) [1, 8], higher daily calorie intake [9], and increases in sedentary time [10]. Development of healthy lifestyle habits during this pivotal life stage, including habitual PA and healthy eating, can lower the risk of becoming obese and developing related conditions [5].

Due to the adolescent obesity epidemic, there have been a number of both studies and systematic reviews/meta-analyses in recent years examining relationships between PA, diet quality (DQ) and adolescent obesity [11, 12]. However, the majority of interventions targeting this population have been conducted within school settings [13]. While these efforts have been moderately successful in increasing PA duration and intensity during the school day, they have not regularly shown increases in PA or improved DQ outside of the school setting, on the weekends, or into the summer months [14, 15]. Thus, the United States Department of Health and Human Services (USDHHS) recently urged researchers and practitioners to devote more efforts to community-based interventions, specifically within domains of summer camps, youth organizations and other community-based programs [16]. Specifically, current research within the community domain does not provide convincing evidence of a positive effect of community strategies on PA in youth , and longer-term follow-up of intervention participants, as well as adoption of innovative intervention strategies, is encouraged [16].

Of note, contemporary public health and PA interventions are aimed at incorporating the use of social technologies [12, 17]. Text messaging, commercial grade fitness trackers with social platforms, and internet-based programs have the potential to influence health behaviors in a larger number of people by reducing perceived barriers to PA participation, such as monetary cost, program availability, transportation concerns, and space and time constraints when compared to traditional laboratory-based randomized controlled trials [18, 19]. Research shows that approximately three fourths of children and adolescents aged 10-17 are regularly online, and among those, two thirds report using the Internet to search for information about health behaviors [20]. Smartphones are used by over two thirds of the U.S. population, and ~75% of youth aged 12-17 report owning a smartphone [21]. Companies producing commercial fitness trackers, including FitBit and JawBone, have increased revenues by over 200% in the past year [22], which demonstrates their growing popularity among all age groups. Recent work exploring the utility of social technology, including both text messaging and social media, to improve health behaviors in overweight adolescents and college-aged students has found mixed results [12, 17, 20, 23, 24]. However, published literature that incorporates commercial fitness trackers and their respective social platforms to change behavior is limited within the adolescent population.

The evidence base linking social technology interventions to PA and DQ is growing; however, there have been few theoretical attempts to inform the design and delivery of health behavior change programs [25]. Incorporating behavioral theories, such as Social Cognitive Theory (SCT) [26], within the design of behavior change interventions could assist in further establishing social technology interventions as translational and sustainable programs for this cohort. SCT includes identifiable and modifiable constructs predictive of behavior change (e.g., self-efficacy, outcome expectations, goal setting, social support), all of which can be targeted and manipulated using the interactive communication features of both social media and text messaging [26, 27]. Previous work framed in SCT has demonstrated that self-monitoring, which can include recording dietary intake and/or observing PA on a wearable device to increase awareness in this context, is effective in promoting behavior change [28]. Notably, both Healthy People 2010 [29] and Sallis et al. [30] acknowledge that self-efficacy, the main component of SCT, has been strongly associated with and predictive of PA in adolescents. It is recognized that theory-driven strategies for increasing PA and DQ should be utilized when developing and implementing innovative behavior change interventions in adolescents [27].

Furthermore, national surveys consistently reveal that girls report engaging in less PA than boys, and that girls experience a sharp decline in PA between the pivotal ages of 10 to 14 [13]. Additionally, girls cite motivations for engaging in PA as an opportunity to be social with friends and family and to manage weight, while boys report both winning and competition as their motivators for being physically active [13]. As middle school girls are at a particularly high risk for physical inactivity, researchers have devoted significant efforts to both the development implementation of PA interventions in this cohort. A recent meta-analysis quantified the effect of PA interventions on adolescent girls and revealed a Hedge's g effect size of 0.35 ($p < 0.05$), in favor of girls randomized to an intervention group increasing PA when compared to control conditions [11]. Thus, research has demonstrated that interventions in the middle school girl population, though challenging, are feasible and moderately effective.

The efficacy of community-based efforts to increase PA and DQ in middle school-aged girls are not well characterized due to: 1) a lack of successful data reporting in community domains such as summer camps and other outreach programs, 2) many existing studies within this cohort report subjective rather than objectively measured PA data, 3) lack of theory-based design and implementation of social technology interventions, and 4) scarcity of published literature using social technology intervention approaches combing both PA and DQ. To our knowledge, there is minimal reported data regarding a summer-camp stimulus, followed by a social technology intervention within adolescent girls that is grounded in theory and targets both PA and DQ.

In this context, the overarching purpose of this pilot project was to examine the relative efficacy of a PA and healthy behaviors camp-based stimulus in three groups of adolescent girls, 1) a group who received a summer camp, 12 weeks of follow-up contact including 3 face-to-face meetings, 5 social media + text messaging contacts per week and a commercial fitness tracker (SM), 2) a control group (CON) who received a camp-only stimulus, and 3) a modified control group (CON-MOD) who received camp stimulus and a commercial fitness tracker, on objectively measured PA and DQ behaviors in middle school-aged girls. The longer-term goal of this study is to generate pilot data that would be influential in a) enhancing the design of a clinical trial incorporating summer camp and social technology to target health behaviors, and b) designing a summer outreach program in the target population within this community. With a focus not only on objectively measured PA, but also on DQ, this interdisciplinary project will generate critical informative data for the design of effective and innovative future health interventions within this cohort.

1.2 Specific and Secondary Aims

Specific Aim 1: <u>To examine the effect of a 5-day summer camp on immediate changes (i.e. one week post camp) in both A) objectively measured moderate to vigorous physical activity (MVPA), and B) diet quality, specifically saturated fat, fruits/vegetables, refined carbohydrates, calcium and vitamin D in adolescent females</u>. It was hypothesized that A) MVPA would significantly increase post-camp compared to pre-camp and B) DQ would significantly improve post-camp compared to pre-camp as evidenced by lower saturated fat intake, greater servings of fruits/vegetables, less refined carbohydrates, and greater calcium and vitamin D intake.

Specific Aim 2: <u>To examine the effect of a 12-week intervention occurring post summer camp in the fall school term, comprised of limited in person visits and frequent social media contact (SM), compared to both a control condition (CON) and a modified control condition (CON-MOD), to elicit changes in A) MVPA, and B) DQ, specifically saturated fat, fruits/vegetables, refined carbohydrates, calcium and vitamin D, in adolescent females</u>. It was hypothesized that A) the SM group would have greater MVPA compared to both the CON and CON-MOD groups at post-test and B) the SM group would have better DQ as evidenced by lower saturated fat intake, greater servings of fruits/vegetables, less refined carbohydrates, and greater calcium and vitamin D intake compared to both the CON and CON-MOD group at post-test.

Secondary Aim: To explore the relationships between changes in PA self-efficacy and related constructs (e.g. outcome expectancy, perceived social support, self-management, perceived barriers and enjoyment) and change in MVPA. It was anticipated that changes in PA self-efficacy would be moderately and positively related to changes in MVPA.

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CHAPTER 2

LITERATURE REVIEW

2.1 Obesity Prevalence in Adolescent Girls

The prevalence of overweight and obesity in adolescents continues to be a public health concern across gender, socioeconomic and ethnic strata. According to the 2009-2010 National Health and Nutrition Examination Survey, 18% of children aged 6-11 and 18.4% of adolescents aged 12-19 were obese, and this upward trend is expected to continue [1]. Indeed, the prevalence of obesity among children and adolescents has tripled since 1980 [2]. In adolescent girls specifically, 32% are overweight (body mass index [BMI] between 85th and 95th percentile or obese (BMI $\geq$ 95th percentile) [1]. Data reveal that ethnic adolescent girls are at a heightened risk for obesity, such that 25.6% of white female adolescents are overweight or obese compared to 41.3% of Black girls and 38.6% of Hispanic girls, respectively [3].

This obesity pandemic is problematic, as being overweight or obese leads to an increased risk for youths developing various physiologic and psychological health problems including type 2 diabetes, cardiovascular disease, asthma, some cancers, depression, and anxiety [4-6]. Adolescent obesity is also associated with increased absenteeism from school [7] and decreased quality of life [8]. Importantly, overweight and obese youths are more likely to be overweight and obese during adulthood than their normal weight counterparts [1]. Energy imbalance is believed to be a primary contributing factor to the marked rise in childhood and adolescent obesity, as evidenced by decreased habitual physical activity (PA) [1, 9, 10], higher and less nutrient-dense daily calorie intake [11, 12], and more reported time spent engaged in sedentary activities [13]. As adolescence is deemed a crucial risk period for the development of obesity and its related health consequences[14], both prevention and treatment of pediatric obesity are imperative.

2.2 Physical Activity Status and Related Interventions in Adolescent Girls

The physiological and psychological benefits of habitual PA have been widely documented across the lifespan [15]. There is strong evidence to support that regular PA improves cardiorespiratory fitness, muscular fitness, bone health, metabolic health markers, and promotes favorable body composition in children and adolescents [16]. Additionally, moderate evidence suggests that active children and adolescents are less likely to suffer from depressive symptoms than inactive children and adolescents [16]. Importantly, studies indicate that youth who are habitually active are more likely to be active into adulthood [15, 16]. The United States Department of Health and Human Services' 2008 national PA guidelines recommend a dose equivalent to at least 60 minutes of moderate to vigorous PA daily for children and adolescents [16]. As part of these 60 daily minutes, children and adolescents should include bone-strengthening PA (e.g., jumping, hopping, climbing) on at least 3 days of the week [16]. The release of these national guidelines is of significance to clinicians and research scientists, as it indicates the prominence of PA promotion as a national health goal [16].

Despite both the slew of convincing health related benefits of PA and the release of these national guidelines, PA behaviors are at an all-time low in the United States among all age and gender groups [15, 17], with less than 20% of American adolescents meeting PA guidelines [17]. National surveys consistently show that adolescent girls are significantly less active than their male counterparts, and that PA behaviors decline most sharply in girls between ages 10 and 14

[18]. Longitudinal studies using objectively measured PA methods have also shown sharp declines (21%) in habitual PA between the ages of 12 and 14 years [9]. Specifically, the Trial for Adolescent Girls (TAAG), a multi-center U.S. trial, followed 589 girls from sixth grade through the high school transition and found that girls who were inactive in middle school were also likely to be inactive in high school [1]. Results from TAAG also indicate that even girls who met PA guidelines in middle school were likely to become less active during the transition to high school; only 5% of girls met PA guidelines at both time-points [1]. Notably, national surveys suggest that adolescent boys and girls indicate participation in different types of PA; the majority of girls report performing dance, gymnastics and aerobics, while boys predominantly participate in sports like soccer and basketball [18]. Also, boys cite competition, strength and winning as their motivators for PA, while girls noted weight management and social reasons [18]. This suggests that middle school-aged girls not only remain a vulnerable group with regard to decreasing PA, but also that they may benefit from intervention efforts designed specifically for them.

As middle school girls are at a particularly high risk for physical inactivity, researchers and practitioners have recently devoted significant effort to PA intervention development and implementation within this cohort. A recent meta-analysis by Pearson et al. aimed to quantify the effect of PA interventions on adolescent girls by including both randomized and non-randomized trials comparing an intervention group to a control condition [19]. The research team systematically selected 34 effect sizes from which to summarize the mean effect of a PA intervention on adolescent girls. Results showed a small, but significant, Hedges' g effect size of 0.35 ($p < 0.05$), in favor of girls in the intervention groups increasing PA levels at post-testing when compared to control conditions [19]. Indeed, the random effects model was moderated such that larger effect sizes were found when interventions were 1) theory based, 2) multi-component interventions (e.g. included diet component), 3) performed with girls only, and 4) focused on adolescents rather than older teenage girls [19]. This study purports that behavior change intervention in this cohort, though challenging, is certainly feasible and holds significant public health promise and importance. Future researchers were encouraged to use objective measures of PA when possible, to more clearly report their implementation methods, and to assess potential moderators of PA behavior change within their respective samples of the population.

2.3 Diet Quality Status and Multi-Component Interventions in Adolescent Girls

The 2015 Dietary Guidelines recognize the vital role that optimum nutrition plays throughout the lifespan and state that poor nutrition during childhood and adolescence is linked to increased prevalence of adult disease diagnoses in this population [20]. Constant energy imbalance, in regard to consuming more calories than expending, is a primary cause of youth obesity, and it is well recognized that obesity during this life stage is linked to several cardio-metabolic diseases, poor psychological health, and a host of other conditions [1, 3]. Many adolescents do not meet national health guidelines for nutrition, including recommendations for dietary fats, refined carbohydrates (e.g. sugared sodas), fruits and vegetables, and calcium/vitamin D [21]. Known barriers to dietary interventions often include socioeconomic status, ethnicity, and external factors like built environment and social support [12]. When working to intervene with adolescents, it is imperative to consider their limited freedom in purchasing and preparing healthy foods, as they remain under adult supervision. However, research shows that the progression in age from 11 to 14 years is associated with increased independence and curiosity regarding food consumption; thus, intervention during this middle school stage is warranted [22]. Indeed, dietary behaviors have been found to track in individuals over time [23, 24], which lends additional support to intervening during the critical time of adolescence.

To date, changes in diet following intervention have shown modest results, and longer-term follow-ups have been lacking in the adolescent population [25]. Individuals often struggle with multiple unhealthful behaviors, and among adolescents there is evidence of a clustering of poor dietary patterns and inadequate levels of habitual PA [26]. For example, research suggests that physically inactive children tend to eat fewer fruits and vegetables than their active counterparts [27]. Interventions that target both PA and dietary factors have the potential to offer greater health benefits to adolescents, more adequately address participants' behavioral profiles, and maximize health promotion opportunities. Multicomponent behavioral interventions, however, may also overwhelm participants, be too time demanding, and fail to address any single behavior in sufficient depth [28]. Multi-component interventions have had mixed success; however, it is promising that researchers have reported decreased sugar intake [29], decreased calorie intake [30, 31], and decreased fat intake [31] from multi-component interventions within adolescent samples. To assist with implementation of multi-behavioral interventions, the American Heart Association recently released the "Simple 7 Guidelines for Kids", which presents age and reading level specific language addressing exercise recommendations and diet-specific public health information, including eating a heart healthy diet and maintaining recommended levels of total cholesterol and blood glucose levels [32]. Thus, the incorporation of education from both the Dietary Guidelines and the Simple 7 Guide for Kids within a theory based health behavior change intervention has the potential for a well-rounded approach to reducing obesity and enhancing health in adolescents.

2.4 Community-Based Behavior Change Interventions in Adolescent Girls

In an effort to increase PA levels among children and adolescents, researchers have developed and tested various interventions, the majority of which have been implemented within school settings [33]. While these interventions have proven moderately effective in increasing the intensity and duration of PA during physical education classes and in after school programs, they have been less effective with increasing habitual PA outside of the school setting, on the weekends, or during summer months [34, 35]. As both children and adolescents spend a large portion of their waking time outside of the school domain, community-based interventions resulting in improvements in PA behaviors are needed.

Currently, there is a paucity of data focused on community-based interventions in the adolescent cohort [33], as was reflected in the 2012 U.S. Department of Health and Human Services update on the PA guidelines for youth, which summarized evidence for PA interventions in a variety of settings [36]. The Midcourse Report revealed insufficient evidence to determine whether community-based interventions were successful in increasing PA among youth. Specifically, authors recommended that future studies should 1) examine ways to convert summer camp experiences into habitual PA and lifestyle changes, 2) include designs with longer-term interventions and enhanced follow-up plans, and 3) include diverse samples of children and adolescents [36]. Similarly, the Dietary Guidelines recommend that researchers conduct rigorous studies examining new community-based approaches targeting nutrition behaviors in children and adolescents as they transition into middle and high school [12].

A systematic review by Jago et al. [37] concluded that summer day camps offered potential for increasing activity of youth; however, studies included in the review were not directly comparable in methodology or intervention length, so no quantitative measure of effect was given. The authors suggested that further research is required to determine how best to convert camp activity into increased post-camp habitual PA. Similarly, work by Pate et al. examined the efficacy of a 2-year community-based PA intervention, which targeted PA behaviors in multiple life domains in both boys and girls (age at post-testing 12.7 years), by implementing PA strategies after school hours, at home, and at a summer camp [33]. Though not successful in significantly increasing PA behaviors in this sample of children with any of the strategies employed, the authors concluded that further work in this area is warranted.

2.5 Social Cognitive Theory as a Framework for Interventions in Adolescent Girls

Incorporating behavioral theories, such as Social Cognitive Theory (SCT) [38], within the design of behavior change interventions should assist in further establishing social technology interventions as effective and sustainable programs in this cohort. Specifically, SCT includes identifiable and modifiable constructs predictive of behavior change (e.g., self-efficacy, outcome expectations, goal setting), all of which can be easily targeted and manipulated using innovative, community-based interventions [38, 39]. Notably, both Healthy People 2010 [21] and Sallis et al. [40] acknowledge that self-efficacy has been strongly associated with and predictive of both PA and healthy diets in adolescents. Self-efficacy theoretically affects health behaviors both directly and indirectly by influencing how adolescents react to their respective environments [41]. It is recognized that theory-driven strategies for increasing PA and DQ should be utilized when developing and implementing behavior change interventions in adolescents [39].

Recent work examined potential SCT-based mediators of ~300 adolescent girls' dietary behavior throughout a nutrition-based obesity intervention [42]. Researchers found that changes in SCT mediators (e.g. self-efficacy) were associated with changes in key dietary behaviors [42].

Additionally, work by Dewar et al. tested SCT's ability to explain PA changes in adolescent girls from low-income communities after a 12-month follow-up period from a PA and dietary intervention [43]. While self-efficacy was associated with PA after the 12-month period, the authors suggested that additional testing was needed in order to confirm other components of SCT, including intention, outcome expectations, and social support [43].

The evidence base linking social technology interventions to PA and DQ is growing; however, there have been few theoretical attempts to inform the design and delivery of health behavior change programs [44]. Recent work by Yan et al. found that a text message PA intervention rooted in SCT was well-received by college freshman participants and incorporates several examples of theory-based messages utilized in that population [45]. Additionally, the Active Winners study [33] employed SCT as the conceptual framework for their community-based PA intervention with n middle-schoolers and found evidence of some SCT-related psychosocial outcomes improving in the intervention group compared to the control condition. The appendix of 2015 Dietary Guidelines calls for researchers to conduct randomized controlled trials based on sound behavioral change theories that incorporate self-monitoring, on the effects of mobile health technologies on dietary and weight-management related outcomes [12]. As work in the field of innovative PA/DQ interventions continues to abound within the middle school girl cohort, researchers should further investigate relationships between SCT components and PA/DQ.

2.6 Objectively Measured Physical Activity

Due to the widely documented health-related benefits of regular PA, accurately measuring PA behaviors before, during, and post-interventions is essential, and many PA measurement tools exist. There are two main categories of PA measurement tools: 1) subjective measures, and 2) objective measures. Gabriel et al. provides a logical framework for researchers and clinicians to follow when selecting an appropriate subjective instrument [46]. Subjective PA instruments are beneficial in that they are unobtrusive, inexpensive, are associated with low subject burden, can be administered to large samples with relative ease, and they provide information about many aspects of PA with a single measure (e.g. domain, type, context, etc.) [46]. Importantly, activity patterns of youth have been characterized as intermittent or sporadic, as they display brief spurts of intense movement followed by either light PA or sedentary behavior [47]. Thus, children and adolescents may experience recall bias, reactivity, and/or experimenter bias when completing subjective measures given the nature of their sporadic PA [48]. Given these known limitations of self-report (i.e. questionnaires), and the high cost and subject burden of other objective measures (heart rate monitors, doubly labeled water or direct calorimetry), pedometers and accelerometers have increased in popularity as choice tools for measuring PA in this group [49, 50]. Indeed, evidence suggests that objective measures, rather than subjective tools, are more likely to detect statistical relationships between PA and health outcomes in children and adolescents [49]. Thus, many recent studies have utilized either pedometers or accelerometers to objectively measure PA [51].

Major limitations of device-based monitors in general include the inability to provide information about both the PA context and PA type, and the incapability to accurately measure non-ambulatory PA (i.e. weight lifting, cycling, yoga) [52]. A primary disadvantage of using pedometers is their inability to provide information regarding PA intensity; the most common outcome variable reported from studies using pedometers is total daily step count [52]. Notably, though, pedometer output correlates strongly to many accelerometers, which are able to go one step farther and collect both time and intensity information related to PA [53]. Due to the storage data capacity of accelerometers, it is possible to monitor behavior over extended periods of time and easily download data to a computer for processing and analyses. Accelerometers have substantially enhanced our ability to obtain precise measurements of pattern, frequency, volume, intensity and duration of youth PA behaviors in free-living settings [53].

Many types and brands of accelerometers exist currently; however, the Actigraph has been most widely adopted by scientists in current literature [50]. There has been much debate regarding the best way to convert the main output variable from Actigraph, counts, into accurate and usable estimates of PA in children and adolescents [54]. Thus, researchers have independently developed five different sets of intensity-related cut points using regression equations [55-59]. Each equation accounts for some degree of physical growth and its relationship to energy expenditure, and a recent methodological review [50] outlines similarities and differences between each equation. For the methodological review, ~200 participants from age 5 to 15 completed 12 physical activities while wearing both Actigraph accelerometers and a portable metabolic system. Subsequently, their respective data were analyzed using each of the five regression equation approaches. Evenson cut points were most successful at accurately classifying MVPA, which is a commonly targeted and measured behavior in intervention work with this cohort [50, 55].

2.7 Commercial Fitness Trackers in Research

In recent years, commercial fitness tracking technology has become pervasive across the country. Relatively inexpensive tools and their corresponding mobile applications, including the FitBit, MyFitnessPal, and the Jawbone UP Move can provide information to consumers regarding total daily steps taken, amount of calories expended throughout the day, diet tracking, and sleep patterns. These commercial monitors, used as part of a guided self-monitoring, feedback, and goal-setting process, provide up-to-the-minute information to users [60]. One additional benefit to adopting use of commercial fitness trackers is their ability to eliminate many barriers to traditional interventions, including accessibility, cost, transportation, and environment [61]. Thus, these technologies are emerging as part of innovative PA intervention work in community settings. The majority of existing published research using commercial fitness trackers has focused on validating various instruments against research-grade, objective PA monitors in adult populations [60, 62-64]. To our knowledge, the use of these commercial trackers in adolescents has been limited to validation of the sleep tracking technology feature of the JawBone Up [65]. Additional work using commercial trackers in the adolescent population may be warranted, especially considering their propensity for technology and mobile phone use.

2.8 Subjectively Measured Energy Intake in Adolescents

Similar to other population cohorts, collecting accurate and reliable dietary intake data from children and adolescents is challenging, and data show consistent under-reporting from youth populations [66]. Recall accuracy, limitations of vocabulary, social desirability, and the ability to identify different foods and beverages are some of the relevant difficulties faced when using self-report to estimate energy intake within this cohort [66, 67]. Additionally, parents or guardians tend to interject alternate information during completion of self-report instruments, which can decrease accuracy when the child starts to gain independence in food selection during adolescence [68]. Popular methods of self-report include: food frequency questionnaires, 24-hour recalls, household food surveys, estimated and/or weighed food records, and multiple pass recalls. Each method is associated with respective pros and cons, and investigators must work carefully to select an appropriate method for his respective target population, budget, and outcome variables of interest.

A recent review investigated several methods of self-report and compared them against doubly labeled water, the current gold standard of energy intake estimation [67]. The review concluded that using the multiple pass method over at least a 3-day time period, that includes both weekdays and a weekend day, completed with the aid of parents/guardians, is the most accurate choice for children aged 4-11 years [67]. For older adolescents, a diet history questionnaire tended to be the most reliable choice, with the multiple pass method also being an acceptable option [67].

Multiple systems are currently available with which to analyze self-reported energy intake data from food logs, and one that has received considerable attention is the Nutrition Data System for Research (NDSR) (University of Minnesota, 2010, 2013). NDSR uses the United States Department of Agriculture (USDA) Nutrient Data Laboratory and the USDA Food and Nutrient Database for Dietary Studies to obtain nutrient content of foods. The program assesses food group consumption information along with daily macro- and micro-nutrient totals. Researchers and clinicians are able to input data from participant-kept daily food logs using the multiple pass method, and the system prompts for additional clarification regarding food and beverage consumption, timing of intake, and use of vitamins and supplements.

2.9 Social Technology Public Health Interventions in Adolescent Girls

Both SMS text messaging and internet-based exercise and health promotion programs have the potential to reach a large number of people by reducing perceived barriers to PA participation, such as monetary cost, program availability, transportation concerns, and space and time constraints when compared to traditional laboratory-based randomized controlled trials [69, 70]. Research shows that approximately three fourths of children and adolescents aged 10-17 are regularly online, and among those, two thirds report using the Internet to search for information about health behaviors [71].

The majority of mobile health research within the adolescent cohort to date has focused on substance abuse and sexual health [72-74]. Excitedly, emerging evidence suggests that SMS text messaging is an appealing and sustainable PA and DQ intervention strategy in the population of interest [75]. For example, recent work by Shapiro et al. [76] concluded that SMS text messaging was a useful adherence and self-monitoring tool for increasing healthful behaviors, namely increased PA and decreased intake of sugar-sweetened beverages, in a cohort of children and adolescents. Similarly, Cavallo et al. [77] performed a social media based (e.g. Facebook) PA intervention with a cohort of female young adults and found a small effect size of 0.18 in favor of the social media intervention increasing PA when compared to the control condition. One study created a mobile application to deliver a PA and DQ intervention for high school students and found that members of the intervention group consumed less fast food and reported more PA than their counterparts [78]. Authors agree that future work using social media and text messaging to change personal health behaviors and combat the obesity epidemic is promising [76-78].

Although social media and text message interventions have been increasingly performed on children and adolescents in the last 10 years, the field lacks a published meta-analysis quantifying the effect of SMS text messaging and internet-based interventions on PA and DQ in female adolescents. This is largely due to a number of factors, including considerable differences in methodology, scarcity of quality studies, and lack of true control groups. A very recent systematic review summarizing the innovative approaches using mobile technology found that no significant between-group differences were found across the majority of studies considered [79]. However, a meta-analysis examining traditional methods of PA intervention delivery in adolescent girls found the mean Hedges' g effect size to be 0.35, favoring membership in the intervention group [19]. This demonstrates that successful intervention in this cohort is certainly possible; however, the social technology methods for use of increasing PA levels and improving diet behaviors in adolescents potentially need to be refined and standardized to produce similar effects [19].

2.10 Summary

In light of the continued obesity pandemic, interventions targeting both increased PA and improved DQ are warranted within the adolescent girl cohort. Much work has been done over the past 15 years to advance the field of study; however, national data consistently fail to show improvements in PA or DQ behaviors in the adolescent girl population. Gaps in the current literature include: 1) a paucity of studies examining the conversion of summer camp into habitual PA 2) a lack of published data using mobile health/technology based interventions within the adolescent cohort, and 3) scarce use of commercial fitness trackers as motivational tools within the SCT framework of intervention delivery. Perhaps an innovative, community-based approach, which is grounded in behavior change theory and delivered using summer camp plus social technology, will provide some additional insight into translatable and sustainable approaches in this population.

2.11 References

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CHAPTER 3

THE EFFECTS OF A CONTEMPORARY SUMMER CAMP AND TECHNOLOGY-BASED FOLLOW-UP INTERVENTION ON PHYSICAL ACTIVITY AND DIET QUALITY IN GIRLS

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3.1 Abstract

Background: Contemporary, community-based interventions that target energy balance via both increased physical activity (PA) and diet quality (DQ) are needed in the adolescent female population. Thus, the primary aim of this study was to examine the effect of a 5-day summer camp, with and without a 3-month social media component, on both immediate and longer-term changes in A) objectively measured moderate to vigorous physical activity (MVPA), and B) DQ, specifically saturated fat, fruits/vegetables, refined carbohydrates, calcium and vitamin D, in adolescent females. **Methods:** Adolescent females (n = 56; 11.6 $\pm$ 1.0 years; BMI 22.8 $\pm$ 5.7 kg/m^2) were recruited to attend a 5-day summer camp framed using Social Cognitive Theory and structured around the American Heart Association's Simple 7 for Kids. Following camp, participants were cluster-randomized into one of 3 treatment groups: 1) Social Media Group (SM) [n = 27]: three face-to-face group meetings, 5 text message/Facebook contacts per week, JawBone Up commercial PA monitor worn daily, completion of testing visits; 2) Control Group (CON) [n = 22]: completion of testing visits only; 3) Modified Control Group (CON-MOD) [n = 7]: JawBone Up commercial PA monitor worn daily, completion of testing visits. In addition to conventional anthropometric measures, PA was measured using accelerometry, and DQ was determined using 3-day dietary recall. All measures were completed before and after Phase 1 (pre- camp and post-camp) and then again before and after Phase 2 (pre and post the 12-week intervention which occurred in the Fall school semester). **Results:** During Phase 1, there was no acute change in MVPA overall ($p > 0.05$) with 34.7% increasing and 65.3% decreasing MVPA following camp. Following summer camp, energy intake decreased by 10.9%, consumption of added sugars decreased by 17.1%, and refined grain intake decreased by 16.4% (all $p < 0.05$). During Phase 2, MVPA did not change between or within treatment groups (p >

0.05), and self-reported consumption of added sugar increased within the SM group ($p = 0.04$). Overall, DQ-related outcomes were more responsive to the intervention than MVPA.

Conclusions: Acute benefits of summer camp were evident in DQ-related variables; however, future work is needed to determine the efficacy of similar designs in regard to longer-term changes in both MVPA and DQ. Although it remains challenging to change PA and DQ behaviors in the adolescent female population, novel community-based interventions for adolescent females warrant further study.

3.2 Introduction

In the United States, obesity has more than doubled in children and has quadrupled in adolescents over the past 30 years [1, 2]. Specifically, more than 21% of adolescents were classified as obese (defined clinically as $\geq 95^{th}$ percentile for age, weight and height) in 2012, and female adolescents fare worse than their male counterparts [1]. Research has linked adolescent obesity to an increased risk for cardio-metabolic diseases earlier in adulthood including cardiovascular disease, type 2 diabetes, metabolic syndrome, several types of cancer, and various social and psychological disorders [3-6]. Development of healthy lifestyle habits, including regular participation in both physical activity (PA) and healthy eating, can decrease the risk for obesity and related conditions [4]. In this context, interventions designed to increase both PA and diet quality (DQ) in middle-school aged girls are of high public health importance due to the increasing prevalence of physical inactivity [7], obesity, and subsequent increased risk of chronic disease within this cohort [1, 3].

It is recognized that habitual PA is associated with significant physiological and psychological benefits across the lifespan; however, PA remains low in the United States across all age and gender strata. Indeed, less than 20% of American adolescents meet the United States Department of Health and Human Services' national guidelines to be active for at least sixty minutes each day [8, 9]. National surveys consistently reveal that adolescent girls are less active than their male counterparts and that PA behaviors decline most sharply in girls between the pivotal ages of 10 and 14 [7, 10]. As middle school girls are at a particularly high risk for physical inactivity, researchers and practitioners have devoted significant efforts to both the development and implementation of PA interventions in this cohort. A recent meta-analysis quantified the effect of PA interventions on adolescent girls and revealed a Hedge's g effect size of 0.35 ($p < 0.05$), in favor of girls randomized to an intervention group increasing PA [11]. Thus, research has shown that intervention in this cohort, though challenging, is certainly feasible and effective.

Among adolescents, researchers report a clustering of poor DQ with inadequate PA, such that inactive adolescents tend to consume fewer fruits and vegetables than active adolescents [12, 13]. The 2015 Dietary Guidelines recognize the vital role that optimum nutrition plays throughout the lifespan, and state that poor nutrition during adolescence is linked to increased prevalence of adult disease diagnoses [14]. In light of the fact that many middle school-aged adolescents lack nutrient dense diets, improved treatments are needed for body composition related outcomes including intake of dietary fats, refined carbohydrates (e.g. sugared sodas) and calcium/vitamin D, the latter being particularly important for bone health [15]. Interventions that target both PA and DQ have the potential to offer greater health benefits to adolescents, more adequately address participants' behavioral profiles, and maximize health promotion opportunities.

The majority of both PA and DQ intervention work in this population has been implemented within the school setting [16]. While these efforts have been moderately effective in increasing PA and DQ during the school day, there is a paucity of data focused on community-based interventions seeking to change behavior outside of the school day [16]. One understudied method to potentially reach adolescents outside of school is the use of summer day camps to initiate behavior change. Recent work has shown the potential for summer camps to improve PA and DQ, but more work, with improved methods of study design and data collection, is needed in this area [17, 18].

Contemporary health behavior interventions are utilizing social technologies. Notably, 75% of the adolescent female cohort reports regular cell phone usage and significant non-school time spent on the internet [19]. Recent work exploring the utility of social technology, including both SMS text messaging and social media, to improve health behaviors has found mixed results [19-21]. It is promising that recent work [20] concluded that SMS text messaging was an effective adherence and self-monitoring tool for increasing healthful behaviors, namely increased PA and decreased intake of sugar-sweetened beverages in children and adolescents. Further work is needed regarding both the effectiveness of summer camp and incorporation of social technology into community-based efforts to improve PA and DQ related behaviors in the middle-school girl cohort.

Given the well-established link between physical inactivity and poor DQ in this cohort, along with increasing daily use of social technologies, further translational research at the community level targeting adolescent girls with an innovative summer camp and follow-up social technology intervention is warranted. Thus, in this context, the primary aim of this study was to examine the effect of a 5-day summer camp on both immediate changes (one week post camp; Phase 1) and longer-term changes (after a 12-week follow-up intervention during the fall semester; Phase 2) in A) objectively measured moderate to vigorous physical activity (MVPA), and B) DQ, specifically saturated fat, fruits/vegetables, refined carbohydrates, calcium and vitamin D in adolescent females.

3.3 Methods

3.3A Participants

Middle school girls (n = 56; ages 10-14 years) from the greater Athens community were recruited for this study. Rising sixth, seventh and eighth grade girls were targeted through paid advertisements, e-mail contact through relevant community and university listservs, and through both recruitment visits and information sessions at local middle schools. Inclusion criteria included the following: 1) English speaking, 2) living in the greater Athens community for the duration of the project, 3) non-smoking, 4) have SMS text messaging on a personal cell phone, 5) permitted by guardians to use social media platforms, and 5) have adult-provided transportation to all study-related visits. Importantly, participants were ineligible for inclusion if they currently met the youth section of the Physical Activity Guidelines for Americans (e.g. 60 minutes of moderate to vigorous physical activity each day), were unwilling to be randomized into treatment groups, or had pre-existing medical conditions that prohibited safe PA or adherence to study-related protocols. The Institutional Review Board (IRB) of the University of Georgia approved all procedures used in the study, and all participants signed IRB approved child assent forms, with their parents/guardians providing written informed consent, prior to study enrollment.

3.3B Procedures and Study Design

With guidance from parents or legal guardians, participants completed online screening questionnaires through Qualtrics for inclusion and exclusion criteria. Eligible participants were then scheduled for in-person screening visits, during which online screening information was confirmed, study-related questions were answered, child assent and parental consent forms were signed and reviewed, and demographic information was collected. At this time, participants also completed a modified Physical Activity Readiness Questionnaire to ensure both minimal risk and safe participation in PA. Participants were then scheduled for two baseline testing visits. During baseline testing, participants 1) had anthropometric data collected, 2) completed several psychological questionnaires in the laboratory under consistent ambient conditions, 3) completed 3-day dietary records, and 4) wore Actigraph GT3X+ accelerometers for a period of 7-10 days.

After baseline testing, a two-phase cluster-randomized controlled trial was employed. Phase 1 consisted of four waves of a five-day summer camp (8am-5pm), which was framed around the American Heart Association's Simple 7 for Kids to expose participants to both PA and DQ content and behavioral management strategies. Social Cognitive Theory (SCT) provided the theoretical framework for delivery of summer camp content, and example camp activities included: goal setting to be active every day, healthy snack cooking demonstrations by a registered dietitian, repeated exposure to yoga, an added sugar measuring activity, relay games, basketball and trail walking, a healthy blood pressure lab-based experiment, and education on the importance of social support from friends and family. Participants' parents self-selected the camp week that their daughters attended, and both the itinerary and staff were consistent across all camp weeks. Post-camp testing, which replicated baseline testing, was completed for all participants the week immediately following their respective camp attendance.

Following completion of Phase 1, camp week groups were cluster-randomized into one of three treatment groups for Phase 2 of the study design, which occurred for twelve weeks during the fall school semester: 1) <u>Social Media Group (SM) [2 weeks of campers; n = 27]</u>: three face-to-face group meetings, 5 text message/Facebook contacts per week, JawBone up commercial physical activity monitor worn daily, completion of testing visits; 2) <u>Control Group</u>

(CON) [1 week of campers; n = 22]: completion of testing visits only; 3) Modified Control Group (CON-MOD) [1 week of campers; n = 7]: JawBone up commercial PA monitor worn daily, completion of testing visits. Group meetings, Facebook group page participation, and text message contact for SM reinforced camp-related SCT content regarding positive behavior change for energy balance. Some example Facebook posts made by the study team were "Ladies! It can be hard to be active on rainy days without a plan! What's your favorite way to be active on rainy days with your family? Share a picture of your favorite activity on our page," and "Today I made 'ants on a log' with celery, peanut butter and tiny chocolate chips. It was a great way to get some veggies in! What other toppings would you pick for this snack?" Compliance to the intervention group in regard to Facebook participation, text message participation and JawBone Up Move wear-time was manually recorded each week by the study team; participants in SM were required to participate 80% of the time to remain in the project. Post-intervention testing occurred during weeks 12 and 13 of Phase 2 and replicated both baseline and post-camp testing.

3.3C Anthropometric Measures and Puberty Status

Standing height and weight were measured with subjects wearing light-weight clothing and no shoes. Height, as measured to the nearest 0.1cm, was obtained using a stadiometer (Seca, Model 242), while weight was measured using a calibrated digital scale (Tanita, Model WB-110A). Body Mass Index (BMI) was assessed according to the Centers for Disease Control and Prevention BMI-for-age growth chart. Waist circumference was measured to the nearest 0.1cm using a tape measure (Gulick II Tape Measure); three measurements were taken at both the hip and natural waist, and an average of the closest two measures at each location was used for analyses. Additionally, adiposity (%Fat) was estimated using bioelectrical impedance with subjects wearing light-weight clothing and no shoes (Tanita, WB-110A Class III).

Parents of all participants completed the Pubertal Development Scale (PDS), developed as a non-invasive version of the Tanner Stage Questionnaire, at the in-person screening visit. The PDS minimizes exposure to graphic pictures and eliminates the need for a medical doctor to administer a puberty-focused questionnaire. The questionnaire asks about physical characteristics, including growth spurt in height, skin changes and body hair for boys and girls, breast development and menarche in girls, and voice change and facial-hair growth in boys. The PDS has been demonstrated to be both a valid and reliable measure of pubertal development in children, showing high levels of consistency with other more direct measures of development [22].

3.3D Objective Physical Activity

At all four testing time points, participants wore Actigraph GT3X+ accelerometers during all waking hours, with an exception of during water-based activities, for a 7-10 day period, assuring at least 1 valid weekend day of wear. Participants used a written log to note 1) time of day monitor was put on, 2) time of day monitor was removed, and 3) breaks from wearing monitor during the day. Data were processed using ActiLife version 6 software and the Evenson cutpoints for children, which have recently been shown to be valid and reliable [23]. A minimum of three days (two weekdays and one weekend day) of valid data were required for inclusion in analyses. A valid day required a minimum of 10 hours of wear [24]. Days with inadequate wear time and/or a step count less than 500 were set to missing values. Total time spent in MVPA, and related variables (e.g. light physical activity, moderate physical activity, and vigorous physical activity), were calculated using a weighted average approach [(Weekday average * 5) + (Weekend average *2)]/7.

3.3E Self-Reported Energy Intake

Participants were simultaneously asked to complete self-reported three-day paper food diaries at four study time points: 1) baseline, 2) post summer camp, 3) Phase 2 week 0, and 4) Phase 2 week 12, to determine total energy intake and macro- and micronutrient consumption for outcomes of interest. Participants were asked to record all food and beverages consumed on 2 weekdays and 1 weekend day at each data collection time point. All food logs were reviewed face-to-face by a trained graduate student for completeness and accuracy prior to data entry into the Nutrition Data System for Research (NDSR) (University of Minnesota, 2013). Data were entered by a trained investigator, and then quality control checked by a second investigator to minimize researcher errors. NDSR utilizes the United States Department of Agriculture (USDA) Nutrient Data Laboratory and the USDA Food and Nutrient Database for Dietary Studies to obtain nutrient content of foods. Daily energy intake, macro and micronutrient composition, and food group totals (e.g. total fruit intake in cups/day and total vegetable intake in cups/day) were averaged among the three days to create one composite score for each time point of data collection per participant.

3.3F Statistical Approach

The study was powered on the primary aim to detect a change in MVPA following a summer camp and 12-week follow-up intervention. An a priori power analysis revealed a sample of 24 participants per treatment group (80% adherence) was sufficient to detect a small to moderate effect of 0.3 standard deviations with a power of 0.80 and a correlation of repeated measures of 0.90. Data were analyzed with IBM SPSS Statistics for Windows Version 22.0. (IBM Corp: Armonk, NY). Means and standard deviations were calculated for all participant characteristics and primary outcome variables at each of the four time points, and distribution statistics were computed to ensure data were normally distributed. Effect sizes (Hedge's g due to small sample size) and independent samples t- tests were utilized to evaluate clinically meaningful differences in outcome variables of interest during Phase 1. Bivariate Pearson correlations were also used to investigate magnitude and direction of relationships among outcome variables of interest during Phase 1.

Paired samples t-tests were conducted to examine statistical differences between SM and CON for data collected in Week 1 testing Phase 2. The main statistical approach used to evaluate data was conducted according to the primary aim, detecting the difference in change in MVPA levels and DQ between SM and CON groups. A per-protocol analysis was used which was carried out on all individuals who provided follow-up data and were compliant to the treatment. Compliance was defined differently per group: 1) for SM, completion of all testing visits at all four time points; participation in Facebook and text messaging for at least 80% of the 12-week timeframe; attending at least 2 of the 3 monthly group meetings; and wearing Jawbone UpMove commercial fitness tracker 80% of the time 2) for CON, completion of all testing visits at all four time points. The data analyses for all main outcome variables proceeded using repeated measures ANCOVAs with treatment group as the between-subjects factor and time as the within-subjects factor, with both elapsed time since summer camp and Week 1 values for that specific outcome as covariates. If the assumption of sphericity was violated for a particular ANCOVA, the Huynh-Feldt correction factor was applied to the degrees of freedom.

3.4 Results

3.4A Participant Demographics

Participants (n = 56) were 11.6 ± 1.0 years old, with 30.3% entering into 6th grade, 39.3% entering into 7th grade and 30.3% entering into 8th grade. The sample was 76.8% white, 17.9% black, 1.8% Asian and 1.8% Hispanic. At baseline, BMI was 22.8 ± 5.7 kg/m^2, and %Fat via bioelectrical impedance was 31.7 ± 9.7%. Approximately half of the sample was in the normal weight-for-age category according to BMI-for-age charts, with the remainder being categorized as overweight (16.1%) or obese (26.8%). The average age of menarche was 11.0 ± 0.9 years with 44.6% of participants having reached menarche at the time of baseline testing. Participants self-reported being at Tanner Stage 2.3 ± 0.6 of pubertal development.

3.4B Participant Adherence

Girls included in Phase 1 analyses attended summer camp 97% of the available camp days, on average ranging from 4.8 to 5 days with 92% of girls attended all 5 days of summer camp, and no girl missed more than 1 full camp day. As shown in Figure 3.1, 4 participants withdrew from the study, due to moving out of state (n = 1) and lack of time to commit to project requirements (n = 3).

Four participants withdrew during Phase 2 of the project (n = 3 for noncompliance and n = 1 for lack of time), as depicted in Figure 3.1. All girls in the SM group attended at least 3 face-to-face meetings, with 100% of girls meeting minimum attendance requirements. On average, SM girls interacted on Facebook 3.5 ± 3.0 times weekly, with only 47.6% of girls meeting the requirements of ~3 interactions each week. Text messaging was used several times weekly to communicate with girls not regularly meeting Facebook requirements, and the study team received responses from girls 87% of the time, on average. Additionally, SM girls wore the JawBone UpMove an average of 5.2 ± 1.8 days each week, with 70.0% of girls meeting requirements to wear the monitor at least 80% of the time. In order to be included in analyses for Phase 2, girls in the SM group were required to have complied with social technology participation as previously described; two participants were asked to withdraw from the study due to noncompliance within the SM group.

3.4C Phase 1 – Baseline to Post Camp Testing Acute Changes

All outcomes of interest were normally distributed when examined using skewness and kurtosis descriptive statistics. One outlier was removed for DQ analyses, as the participant was >2.5 standard deviations above the group mean for total energy intake. As anticipated due to the short time frame, BMI and %Fat, did not differ significantly between baseline and post-camp testing time points (all $p > 0.05$). Waist circumference significantly decreased from baseline to post-camp testing (mean change = -3.9 ± 10.0 cm; $p = 0.01$). There were no significant differences from baseline to post-camp in the following objectively measured PA variables: light intensity PA, moderate intensity PA, vigorous intensity PA, or MVPA (all $p > 0.05$). Total reported energy intake, grams of added sugars, and ounce equivalents of refined grains significantly decreased following summer camp (all $p < 0.05$). Specifically, energy intake decreased by 10.9%, added sugars decreased by 17.1%, and refined grain intake decreased by 16.4%. No other significant differences were evident in AHA Simple 7 diet quality variables of interest (all $p > 0.05$).

Bivariate correlations revealed that age and BMI were significantly related, such that older girls had higher BMI ($r = 0.29$; $p = 0.047$). As expected, total energy intake change was positively related to: 1) change in saturated fat intake, r = 0.60; 2) change in added sugar intake, r = 0.37; 3) change in refined grain intake, r = 0.70; and 4) change in calcium intake, r = 0.42 (all $p < 0.05$). In addition, also expected, change in calcium intake was positively related to change in vitamin D intake (r = 0.54; $p < 0.05$).

Despite the lack of a significant, overall mean change in MVPA min/day (mean change = -3.8 $\pm$ 15.7 minutes/day; $p > 0.05$), variability in change scores existed between individuals (Figure 3.2A). Seventeen participants increased MVPA acutely following camp when compared to baseline, and 32 participants decreased MVPA during the week after summer camp. Figure 3.2B illustrates the strong inverse association between baseline MVPA and Phase 1 change score in MVPA for each participant (r = -0.70, $p < 0.001$) and indicates that girls with higher baseline values had less change in MVPA for Phase 1.

3.4D Phase 2 – Week 1 to Week 12 Longer-Term Changes

After successful completion of Phase 1 and all post-camp testing protocols, eligible participants (n = 52) were cluster-randomized by summer camp week into one of three treatment groups for Phase 2 of the study: SM (n = 24), CON (n = 21), and CON-MOD (n = 7). Independent samples t-tests revealed no significant differences among anthropometric outcomes between groups at Week 1 testing, with the exceptions of BMI and %Fat for CON-MOD being significantly higher than BMI and %Fat for CON (both $p < 0.05$). In addition, paired samples t-tests showed no significant changes in BMI, %Fat, or waist circumference, within groups over the twelve weeks of Phase 2 (all $p > 0.05$).

A 3 x 2 (Group x Time) repeated measures ANCOVA, with MVPA as the outcome variable and Week 1 MVPA as the covariate, revealed no Group x Time interaction or Group effects (both $p > 0.05$), but did show a significant effect for Time ($F(3, 41) = 8.13$, $p = 0.01$), such that all three groups decreased MVPA similarly throughout Phase 2 of the study. Specifically, CON-MOD decreased MVPA by 29.1%, SM decreased 9.8%, and CON stayed almost the same throughout Phase 2 with a small increase of 1.6% in MVPA; all groups remained well below the recommended 60 min/day from Physical Activity Guidelines. Similarly, when added sugars was the main outcome variable, there was no Group x Time interaction or main effect of Group (both $p > 0.05$), but results did indicate a significant effect for Time ($F(1, 42) = 5.84$, $p = 0.02$); all three groups unexpectedly increased added sugar consumption similarly throughout Phase 2 of the study, with CON increasing 6.9%, CON-MOD increasing 14.3%, and SM increasing 34.3%. Additionally, Hedge's g effect sizes were calculated to evaluate the standardized mean differences in both PA and DQ outcome variables from Week 1 to Week 12 within each cluster-randomized group, and most effect sizes were small in magnitude (see Table 3.5).

3.4E – Phases 1 & 2 Overall Patterns

Due to the small sample size in CON-MOD, further analyses on PA and DQ outcomes of interest excluded CON-MOD (Figure 3.4). A 2 x 4 (Group x Time) repeated measures ANCOVA, with MVPA as the outcome variable, revealed no Group X Time interaction or Group effects, but did show a significant effect for Time ($F(3, 35) = 4.29$, $p = 0.04$), such that both groups decreased MVPA similarly throughout the study. Post hoc independent samples t-tests revealed a between group difference in MVPA change from baseline to post camp testing ($p = 0.01$). This analysis was simplified and repeated using only two time-points, baseline and Week 12, and results were similar.

To examine changes in intake of added sugars, a 2 x 4 (Group x Time) repeated measures ANCOVA (covariate was baseline added sugar level) was also completed and, there was no significant Group x Time interaction and no main effects of Time or Group (all $p > 0.05$). This analysis was simplified and repeated using only two time-points, baseline and Week 12, and results were similar.

3.5 Discussion

The overarching goal of this project was to determine the acute and longer-term effects of a healthy behaviors summer camp on MVPA and DQ in middle school girls, while intervening with SM girls in a novel, technology-based manner throughout the longer-term follow up phase in the fall school term. Our results indicate that Project GirlTALK did not have a significant effect on MVPA in the target population of adolescent girls in the community; however, GirlTALK participants did experience positive DQ changes in the short-term after summer camp. Specifically, girls significantly decreased self-reported energy intake, self-reported added sugar intake, and self-reported intake of refined carbohydrates from baseline to post camp testing (all $p < 0.05$).

With regard to the lack of improvements in MVPA and related measures, our findings mimic those reported in the literature aimed at increasing PA in adolescent girls within the community domain. For example, the Active Winners study, which employed a socio-ecological model to deliver a community-based intervention in adolescents including summer camp, found no significant improvements in PA [18]. In addition, a systematic review concluded that summer day camps offered potential for increasing PA among youth, but did not offer quantitative estimates of effect size [17]. A meta-analysis summarizing the effect of PA randomized controlled trials using more of a conventional clinical trial approach, however, does provide evidence that a modest improvement in PA is feasible within this cohort [11], and perhaps stronger study designs (e.g. those including a true control group) and larger doses of intervention and greater behavioral change stimulus (e.g. more face-to-face contact with intervention team) should be explored within the community domain.

Reviews of multi-behavioral interventions with youth have revealed changes in some but not all behaviors, with significant effects more likely for DQ as opposed to PA outcomes [25]. It is promising that researchers performing these multi-behavioral interventions have recently reported decreased added sugar and dietary fat intake in weight management programs [26-28]. Specifically, one study investigated the efficacy of PA + DQ versus PA alone in middle school girls and boys, and found that: A) PA increased minimally in the PA alone group, and B) DQ related changes (increase in fruits and vegetable consumption) were minimal, but not different, across both intervention arms. Adolescents, in general, have very little control over the food available to them at home; thus, many groups of researchers have targeted family units to maximize the potential efficacy of intervention efforts. For example, recent work randomized pairs of children and their parents into an 8-week self-monitoring PA and DQ versus control condition, and found that child-parent pairs in the self-monitoring group had better adherence to protocols than the control condition [20]. Our findings of a healthy behaviors, multi-component, summer camp add to the current literature with favorable decreases in both added sugar and refined carbohydrate intakes across groups.

Two fundamental strengths of using information and communication technologies, such as social media and text messaging, for promoting PA in comparison to traditional methods are 1) technology reduces perceived barriers to interventions and 2) interactivity and social support among participants is pervasive with incorporation of technologies [29]. Despite growing in popularity over the past decade, the area of mobile health intervention research is relatively scarce within the adolescent population. A few studies have employed social media and text messaging to increase PA in middle school girls and have reported very small effect sizes [21, 30-35]; but, no meta-analysis has been published to date to offer an overall mean effect of social technologies on PA in adolescents. Our results of a null effect of social technology on improving PA behaviors, then, are consistent with previous literature. Additional randomized controlled trials in this area are needed to make definitive statements on whether or not incorporation of social technologies into PA programs is a worthwhile endeavor for researchers, clinicians, and public health professionals.

Despite our novel 2-Phase design and contemporary delivery approach, there are several limitations to this cluster-randomized controlled trial. Major concerns that should be addressed for future studies like ours are seasonal and weather-related variations of both PA and DQ in this population; our participants transitioned back into the school year during Phase 2, and then also had Thanksgiving holiday during Phase 2 of the project. Therefore, it was difficult for us to separate intervention-related behavior changes from behavior changes associated with other factors such as weather, school, or holidays. Additionally, as our participants must have 1) had access to social technology (e.g. personal cell phone for text messaging and family computer for internet access), 2) been willing to attend a week-long summer camp, and 3) been involved in a 12-week follow-up program, results may not be representative of the population at large. Furthermore, the study design did not include a true control condition and also employed a multi-component intervention (social media, text messaging, in-person sessions), which limits the ability to draw conclusions about the independent effects of any single component. Finally, there was a lack of standardized time between finishing post-camp testing and starting Phase 2 of GirlTALK due to resource limitations.

This pilot project demonstrates that, although it remains challenging to change behaviors in the adolescent girl population, additional investigations regarding novel community-based interventions for adolescent girls are certainly warranted. Our findings are consistent with existing evidence [25] in that DQ-related behaviors tend to be more responsive to multi-component interventions than PA-related behaviors. Future work in this area should seek to both identify the adequate summer camp stimulus dose to elicit acute improvements in PA behaviors (e.g. longer camp duration) and involve parents/guardians in PA promotion outside of camp hours.

3.6 References

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Table 3.1 *Phase 1 Participant Demographics*

Characteristic	Baseline (n = 56)	Post-Camp (n = 52)
Age (years)	11.6 ± 1.0	---
BMI (kg/m^2)	22.8 ± 5.7	22.4 ± 5.6
Underweight (%)	3.6	0
Normal Weight (%)	53.6	53.6
Overweight (%)	16.1	21.4
Obese (%)	26.8	17.9
Whole Body Adiposity (%)	31.7 ± 9.7	31.3 ± 10.3
*Waist Circumference (cm)	74.2 ± 14.8	69.8 ± 11.0

Data displayed as M ± SD unless otherwise stated; BMI: body mass index.
**Significant time effect evident from paired t-tests ($p < 0.05$).*

Table 3.2 *Phase 1 Physical Activity and Diet Quality Outcomes*

Measurement Tool	Baseline	Post-Camp
Physical Activity (n = 49)		
Light intensity PA (min/day)	208.9 ± 52.6	206.1 ± 45.9
Moderate intensity PA (min/day)	21.7 ± 9.4	20.0 ± 7.5
Vigorous intensity PA (min/day)	8.1 ± 6.1	6.4 ± 4.3
MVPA (min/day)	30.0 ± 13.1	26.2 ± 11.4
Diet Quality (n = 52)		
*Total energy (kcals)	1658.0 ± 376.3	1478.2 ± 339.3
% Intake fat	33.5 ± 5.2	34.1 ± 5.8
% Intake protein	14.6 ± 3.3	15.7 ± 3.2
% Intake carbohydrate	51.9 ± 6.9	50.2 ± 7.6
% Intake saturated fat	11.4 ± 2.2	11.8 ± 2.5
Total fruit intake (cups)	0.7 ± 0.7	0.6 ± 0.6
Total vegetable intake (cups)	0.8 ± 0.5	0.8 ± 0.5
*Added Sugars (grams)	53.6 ± 26.4	44.3 ± 22.9
*Refined grains (ounce equivalents)	6.1 ± 2.2	5.1 ± 1.9
Calcium intake (mg)	806.7 ± 348.9	792.3 ± 285.6
Vitamin D intake (mcg)	5.7 ± 5.4	6.1 ± 5.02

*Data displayed as M ± SD unless otherwise stated; MVPA: moderate to vigorous physical activity. *Significant time effect evident in paired t-tests ($p < 0.05$).*

Table 3.3 *Phase 1 Bivariate Correlations between Age, BMI, and Change Scores*

		2	3	4	5	6	7	8	9	10	11
1.	Age (years)	.29*	-.19	-.01	-.02	-.003	.06	.05	-.07	.10	.27
2.	BMI (kg/m^2)		.06	.07	.14	-.07	-.02	-.23	.16	.03	-.004
3.	MVPA min/day			.004	.13	-.12	-.02	-.11	.29	-.01	-.08
4.	Total energy (kcals)				.64*	.03	.24	.37*	.70*	.42*	.17
5.	Saturated fat (grams)					-.12	-.001	.04	.43*	.57*	.18
6.	Total fruit (cups)						-.08	-.13	-.03	-.19	-.05
7.	Total vegetable (cups)							-.02	.27	-.06	-.02
8.	Added sugars (grams)								.07	.06	.06
9.	Refined grains (ounce)									.13	-.14
10.	Calcium intake (mg)										.54*
11.	Vitamin D intake (IU)										1.0

**Significant Pearson correlation at p <0.05.*

Table 3.4 *Phase 2 Demographic and Anthropometric Characteristics by Group*

Characteristic	**SM (n = 23)**		**CON (n = 19)**		**CON-MOD (n = 6)**	
	Week 1	Week 12	Week 1	Week 12	Week 1	Week 12
Age (years)	11.6 $\pm$ 1.0	---	11.6 $\pm$ 0.9	---	11.4 $\pm$ 0.9	---
BMI (kg/m^2)	22.1 $\pm$ 6.5	22.9 $\pm$ 5.5	20.7 $\pm$ 4.1	20.0 $\pm$ 5.8	26.2 $\pm$ 10.3	23.0 $\pm$ 14.4
% Fat	32.2 $\pm$ 10.3	32.3 $\pm$ 9.9	28.5 $\pm$ 7.9	29.0 $\pm$ 7.5	35.7 $\pm$ 12.2	35.0 $\pm$ 14.5
Waist Cir (cm)	70.2 $\pm$ 11.8	70.1 $\pm$ 11.8	66.6 $\pm$ 8.3	67.6 $\pm$ 10.2	78.3 $\pm$ 21.6	80.3 $\pm$ 20.1

Data displayed as M $\pm$ SD unless otherwise stated; BMI: body mass index; %Fat: total body adiposity; Waist Cir: waist circumference.

[*]Significant time effect from paired samples t-test ($p < 0.05$).

Table 3.5 *Phase 2 Physical Activity and Diet Quality Variables by Group*

	SM (n = 23)			**CON (n = 19)**			**CON-MOD (n = 6)**		
Variable	Week 1	Week 12	*g*	Week 1	Week 12	*g*	Week 1	Week 12	*g*
LPA (min/day)	187.2 + 44.7	174.4 + 42.5	-0.29	194.8 + 49.4	199.6 + 39.9	0.11	186.3 + 38.7	170.3 + 14.9	-0.50
MPA (min/day)	21.7 + 9.1	19.7 + 7.5	-0.23	21.8 + 6.9	21.9 + 10.3	0.01	22.5 + 8.3	16.0 + 4.6	-0.90
VPA (min/day)	7.7 + 5.2	6.8 + 6.3	-0.17	9.9 + 6.7	9.3 + 6.8	-0.10	5.9 + 3.5	4.7 + 3.7	-0.31
MVPA (min/day)	29.4 + 13.3	26.5 + 12.0	-0.23	31.8 + 12.5	32.3 + 14.2	0.04	28.5 + 11.4	20.7 + 7.9	-0.74
Total energy (kcals)	1490.8 + 324.3	1624.2 + 455.6	0.33	1631.8 + 366.2	1654.6 +399.8	0.06	1682.7 + 392.4	1745.3+597.1	28.79
% Intake fat	33.9 + 4.1	35.3 + 4.8	0.30	34.6 + 5.3	33.6 + 5.5	-0.19	34.8 + 2.4	33.6 + 5.6	-0.25
% Intake protein	16.4 + 3.0	15.9 + 3.9	-0.13	15.1 + 4.0	14.5 + 2.3	-0.18	15.9 + 4.2	15.8 + 4.4	-0.02
% Intake carbohydrate	49.7 + 5.5	48.8 + 1.4	-0.23	50.3 + 7.3	51.9 + 6.4	0.23	49.2 + 5.2	50.6 + 9.2	0.17
% Intake saturated fat	11.4 + 2.2	12.0 + 2.5	0.27	11.9 + 3.0	11.4 + 2.5	-0.18	11.6 + 1.5	11.7 + 2.4	0.09
Fruit (cups)	0.8 + 0.6	0.7 + 0.5	-0.13	1.0 + 0.9	0.8 + 0.6	-0.23	1.1 + 1.1	0.7 + 0.8	-0.32
Vegetable (cups)	1.0 + 0.8	1.0 + 0.5	0.06	0.9 + 0.5	1.0 + 0.7	0.25	0.8 + 0.7	1.1 + 0.4	0.40
Added Sugars (grams)	*35.2 + 13.5	47.5 + 30.9	0.51	43.4 + 22.4	46.4 + 23.4	0.12	42.8 + 22. 7	48.4 + 29.0	0.20
Refined grains (oz)	5.3 + 2.3	5.2 + 1.9	0.05	6.3 + 1.9	5.9 + 1.6	-0.18	5.8 + 1.7	6.3 + 3.0	0.19
Calcium (mg)	808.1 + 299.2	868.7 + 384.6	0.17	799.6 + 264.1	907.1 + 325.1	0.36	772.4 + 197.7	772.6 +281.8	0.00
Vitamin D (mcg)	4.7 + 3.6	5.0 + 4.3	0.06	6. 8 + 6.3	8.1 + 7.1	0.20	4.9 + 3.4	4.5 + 2.4	-0.15

*Data are expressed as M + SD as well as Hedge's g effect sizes. *Indicates significant effect of time for paired samples t-test. LPA: light physical activity; MPA: moderate physical activity; VPA: vigorous physical activity; MVPA: moderate to vigorous physical activity.*

Table 3.6 *SM Group Intervention Description*

SM Intervention Component	Participant/Researcher Activities
Face-to-face Group Meetings	*Participant Activities* - Reconnect with friends made during summer camp - Review content from AHA introduced during summer camp - Discuss goal-setting by using the tools provided by study - Engage in physical activities and discuss healthy eating - Play team building games *Researcher Activities* - Encourage the social connections formed among girls - Facilitate discussions regarding physical activity and eating - Expose girls to different modes of physical activity that do not need specialized equipment
Facebook Group Page	*Participant Activities* - Share goals, progress, and setbacks related to being active and eating well - Support other girls by providing encouragement or ideas - Post pictures and videos related to healthy lifestyle - Comment and/or like posts from Researchers *Researcher Activities* - Post discussion prompts and questions based off AHA - Encourage goal-setting with prompts posted to page - Provide role model for participants by posting pictures of daily physical activity and healthy snack/meal choices - Monitor participant use daily, and provide prompts to participants not meeting study expectations
Jawbone Up Move	*Participant Activities* - Self-monitoring by wearing device and engaging on mobile application - Encourage other participants to meet activity goals through mobile application *Researcher Activities* - Monitor participant use daily, and provide prompts to participants not meeting study expectations - Encourage the use of goal setting and time management through interaction with mobile application

AHA: American Heart Association Simple 7 for Kids

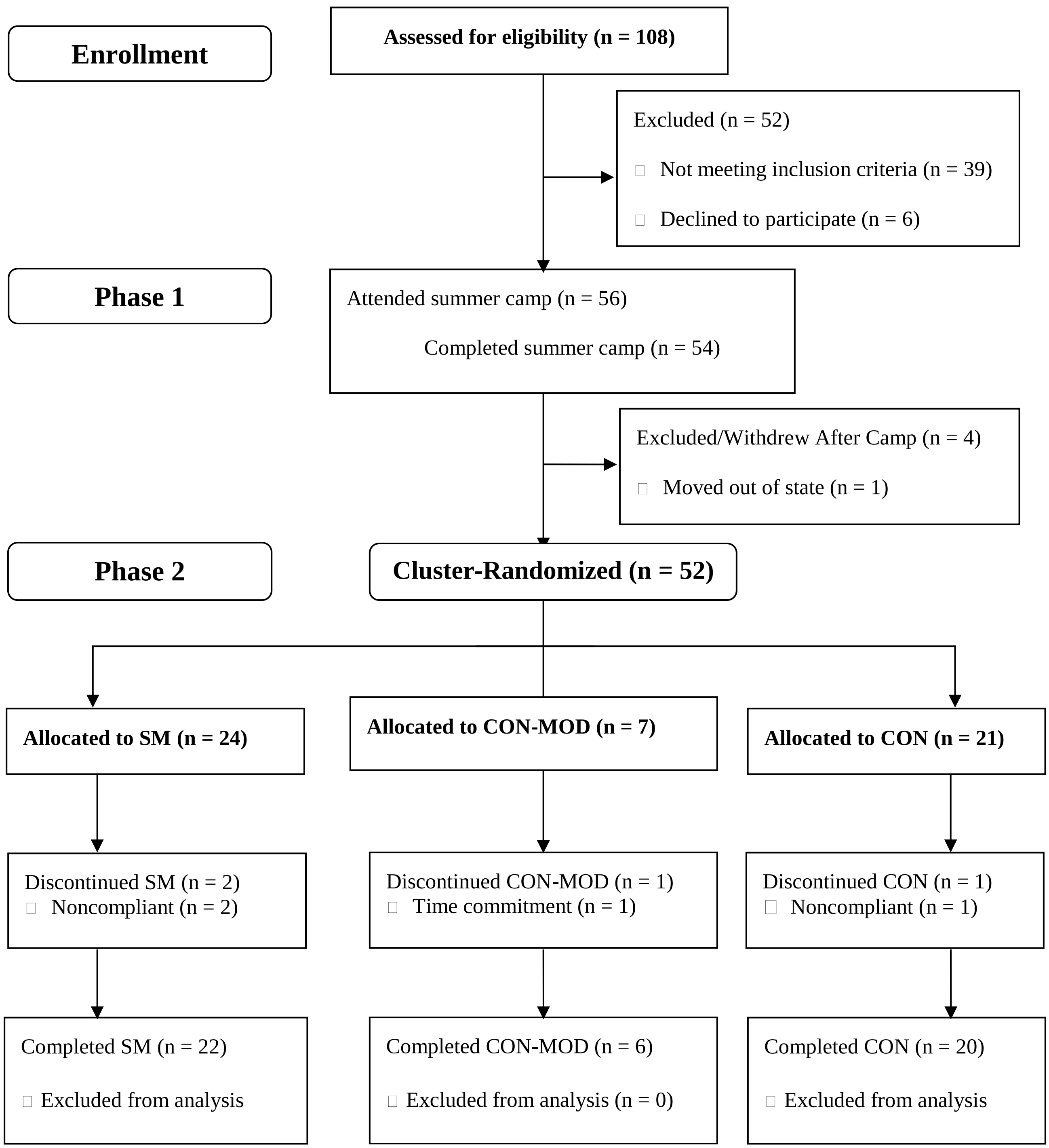
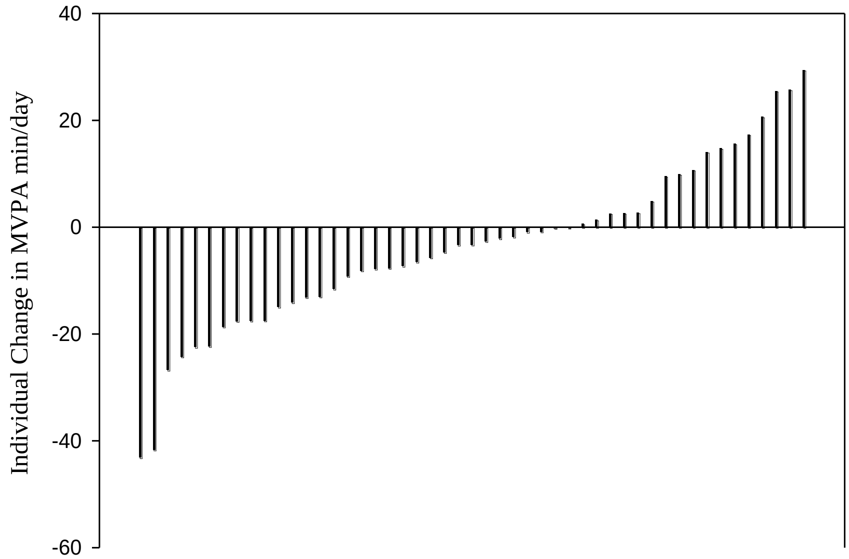


Figure 3.1 Enrollment and Study Completion Consort Diagram
SM: social Media intervention group; CON-MOD: modified control condition; CON: control group

A



B

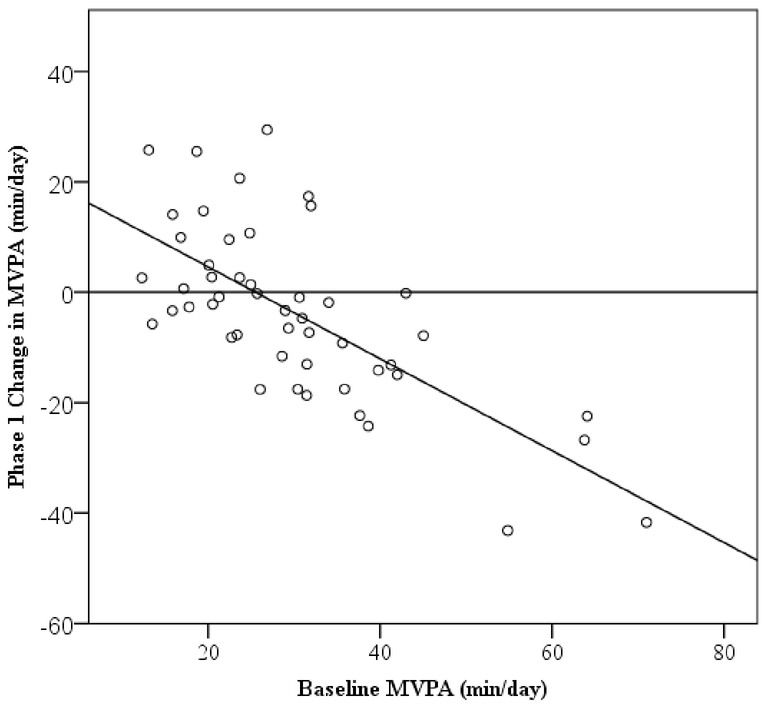


Figure 3.2: **A)** Individual Changes in MVPA from Baseline to Post-Camp Testing, and **B)** Bivariate Correlation between Phase 1 Change in MVPA and Baseline MVPA

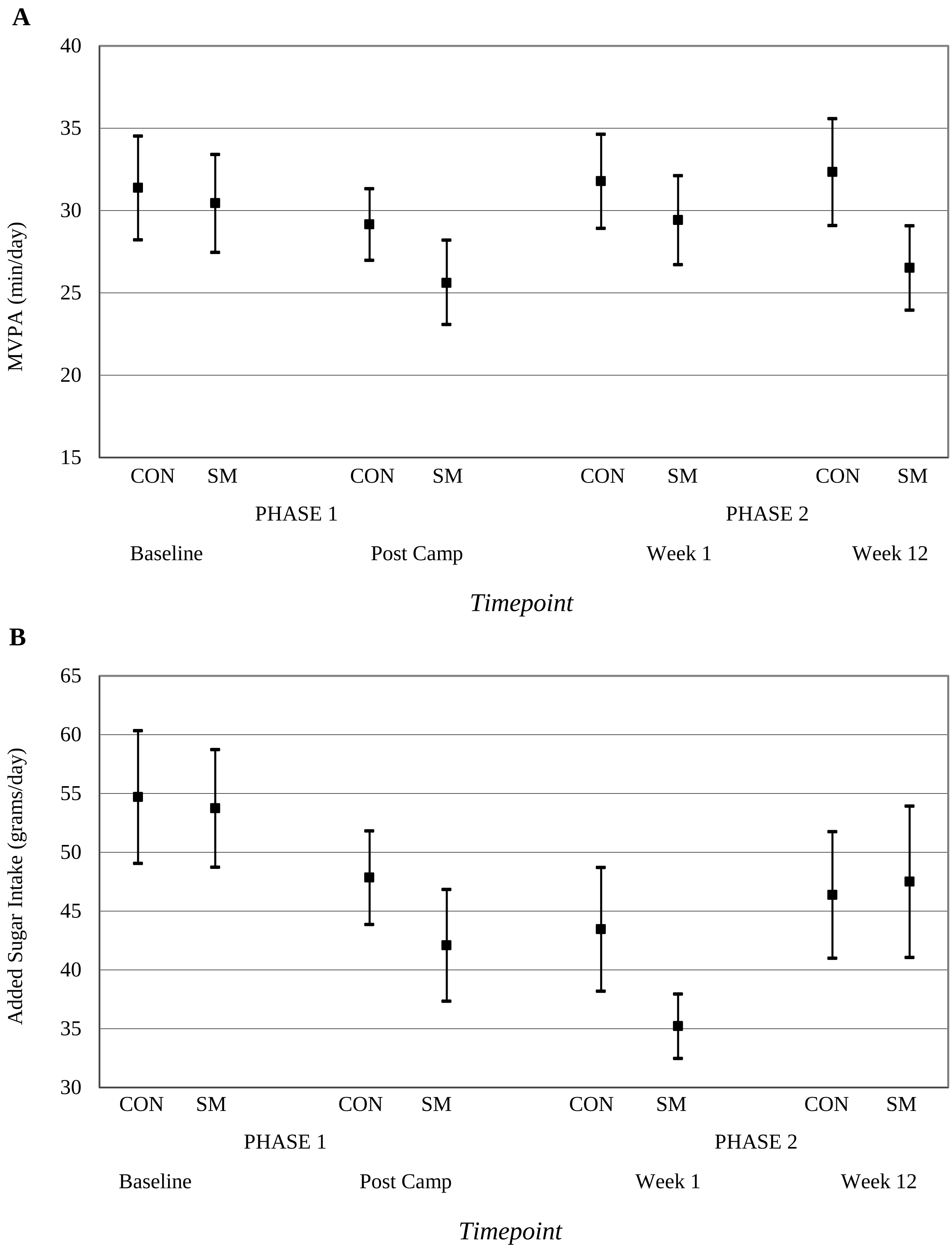


Figure 3.3 A) MVPA for Completers of CON and SM at all 4 Testing Time Points (n = 49), **B)** Added Sugars for Completers of CON and SM at all 4 Time Points (n = 52)
**Bars represent standard error.*

CHAPTER 4

RELATIONSHIPS BETWEEN PHYSICAL ACTIVITY SELF-EFFICACY AND PHYSICAL ACTIVITY BEHAVIORS AFTER A SUMMER CAMP AND FOLLOW-UP INTERVENTION IN GIRLS

Acitelli, Rachelle, Schmidt, M., Lewis, R., Evans, E.M. To be submitted to Journal of Sport and Exercise Psychology.

4.1 Abstract

Background: Given the increasing prevalence of obesity and absence of adequate physical activity (PA) within the adolescent girl population, community-based interventions framed in behavior change theories are warranted. Furthermore, it is recognized that self-efficacy, a primary construct of Social Cognitive Theory (SCT), is strongly associated with and predictive of PA in adolescents. Thus, the purpose of the present study was to explore the relationships between changes in PA self-efficacy and changes in PA, examining related psychosocial constructs (e.g. outcome expectancy, self-management) of PA self-efficacy, in girls participating in a summer camp with a subsequent social technology based follow-up intervention. **Methods:** Girls (n = 52; 11.6 $\pm$ 0.9 years; BMI 22.1 $\pm$ 6.3 kg/m^2) were recruited to attend a 5-day summer camp. Following camp, girls were cluster-randomized into one of 3 treatment groups: 1) Social Media Group (SM) [n = 22]: three face-to-face group meetings, five text message/Facebook contacts per week, JawBone up commercial PA monitor worn daily, completion of testing visits; 2) Control Group (CON) [n = 19]: completion of testing visits only; 3) Modified Control Group (CON-MOD) [n = 6]: JawBone up commercial PA monitor worn daily, completion of testing visits. In addition to conventional anthropometric measures, psychosocial outcomes were assessed using validated questionnaires and PA was measured using accelerometry all being assessed in response to Phase 1 (pre- camp and post-camp) and Phase 2 (pre and post the 12-week intervention which occurred in the Fall school semester). **Results:** During Phase 1, there were no overall changes in PA or PA self-efficacy (both $p > 0.05$). However, change in PA self-efficacy was positively associated with change in PA ($r = 0.27$; $p = 0.06$), such that girls who increased PA self-efficacy may have been more likely to also increase PA behavior. Additionally, girls significantly decreased outcome expectancy-value scores by

22.8% and significantly increased self-management scores by 6% during Phase 1 (both $p < 0.05$). During Phase 2, ANCOVAS revealed no Group by Time interactions, and no main effects of Group; however, a main effect of Time was present $p <0.05$), such that both SM and CON decreased PA and PA self-efficacy over time (both $p < 0.05$). **Conclusions:** Changing both PA self-efficacy and PA behaviors within the middle school girl cohort remains challenging, and future, theory-based research is needed to clarify the intervention dose needed to influence behavior in this population.

4.2 Introduction

Due to the increasing prevalence of adolescent obesity in the United States [1], significant efforts have been devoted to promoting physical activity (PA) behavior change within this cohort over the past decade. Meeting the 2008 Physical Activity Guidelines (PAG) through habitual PA is strongly linked to better physiological health (e.g. enhanced bone status, improved cardiorespiratory fitness, favorable body composition) and is moderately associated with improved psychological health (e.g. lower likelihood of depression and anxiety) in adolescents [2, 3]. Unfortunately, the prevalence of PA behavior remains both stagnant and low in the United States among all age and gender groups [4, 5], with less than 20% of American adolescents meeting PAG [5]. Furthermore, national surveys consistently show that adolescent girls are significantly less active than their male counterparts, and that PA behaviors decline most sharply in girls between the ages of 10 and 14 [6]. Middle school boys not only report participating in different types of PA than girls in this age group, but they also cite competition and winning as their motivators for PA, while girls note weight management and social status as PA motivators [6]. This evidence lends support to the ideas that adolescent girls are especially vulnerable to inadequate PA levels and that, as such, girls may benefit most from PA interventions that are tailored to them.

As middle school girls are at a particularly high risk for physical inactivity, researchers and practitioners have increasingly dedicated resources to developing and implementing novel PA interventions within this cohort. A recent meta-analysis quantified the effect of PA interventions performed in adolescent girls by including both randomized and non-randomized trials comparing an intervention group to a control condition [7]. Results showed a small, yet statistically significant, Hedges' g effect size of 0.35 ($p < 0.05$) in favor of girls in the intervention groups increasing PA levels at post-testing when compared to control conditions [7]. Notably, the majority of studies included in this meta-analysis occurred within the school or laboratory setting; there is a lack of published and successful data within the community domain [3, 7]. The 2012 Mid-Course Report to the PAG recommends that future studies should focus PA intervention efforts targeting adolescents within the community domain and 1) examine ways to convert summer camp experiences into habitual PA and lifestyle changes, 2) include novel designs with longer-term interventions and enhanced follow-up plans, and 3) include diverse samples of adolescents [3].

It is recognized that theory-driven strategies for increasing PA should be utilized when developing and implementing behavior change interventions in adolescents [8]; however, researchers suggest that current meta-analyses in the adolescent population may reveal only modest effects partially because of poor methodology and atheoretical designs [9]. One well-accepted theoretical approach, Social Cognitive Theory (SCT), includes identifiable and modifiable constructs such as self-efficacy, outcome expectations, social support, and goal setting. These SCT constructs can be easily targeted and manipulated using innovative, community-based interventions [8, 10]. Both Healthy People 2010 [11] and Sallis et al. [12] acknowledge that self-efficacy has been strongly associated with and predictive of PA in adolescents. Indeed, self-efficacy theoretically affects health behaviors both directly and indirectly by influencing how adolescents react to their respective environments [13]. To date, few contemporary PA interventions have employed strong theoretical frameworks in the adolescent population. Promisingly, though, recent work found that a text messaging PA intervention rooted in SCT was well-received by college freshman participants, and the publication provides several examples of theory-based messages utilized in that population in an attempt to thoroughly report methodology [14]. Additionally, the Active Winners study [15] employed SCT as the conceptual framework for their community-based PA intervention with middle-schoolers and found evidence of some SCT-related psychosocial outcomes improving in the intervention group compared to the control condition. Additional work within the community domain, designed with behavior change theory as an anchor, may be beneficial for advancing the current PA literature base in the adolescent girl population.

Adolescence has been widely identified as a critical period for developing key health behaviors, including PA, that track both into adulthood and limit prevalence of obesity-related diseases [16]. Current literature reveals a paucity of published data in novel PA intervention approaches backed by behavior change theory within the community domain among middle-school aged girls. Thus, in this context, the primary aim of the present study was to explore the relationships between change in MVPA and changes in PA self-efficacy, examining known covariates and/or mediators (e.g. outcome expectancy, perceived social support, self-management, perceived barriers and enjoyment) of PA self-efficacy, in three groups of adolescent girls participating in a summer camp with a subsequent follow-up, social technology intervention study: A) Social Media Group (SM), B) Control Group (CON), and C) Modified Control Group (CON-MOD). As previous research posits that PA self-efficacy can predict PA behavior change, it was anticipated that girls in the SM group would report greater PA self-efficacy, and thus also experience greater improvements in objectively measured MVPA, than their CON and CON-MOD counterparts.

4.3 Methods

4.3.A Participants

Recruitment targeted rising sixth, seventh and eighth grade girls (n = 56) in the greater Athens, Georgia community. Eligible participants were English-speakers who had access to personal cell phones, were tobacco-free, were permitted to use social media platforms, who planned to live in the community for the duration of the project, and who were willing to be randomized to either the intervention or control conditions. Girls were ineligible if they currently met the 2008 PAG to be active sixty minutes daily, or if they had pre-existing medical conditions that prohibited safe participation in physical activity or adherence to other protocols (e.g. uncontrolled asthma, diagnosed mental illness). The University of Georgia's Institutional Review Board approved all procedures used in this study, and child assent with corresponding parental consent were obtained prior to all data collection.

4.3.B Study Design

Project GirlTALK was a two-phase study. Phase 1 consisted of four cohorts of free, 1-week summer camps (Monday through Friday, 8am-5pm) with content developed from the American Heart Association's Simple 7 for Kids and delivered using a social cognitive theory (SCT) framework [17]. The summer camp aimed to expose girls to a variety of physical activities and healthy eating habits. Parents of participants self-selected the week of summer camp during which their daughter attended, but all camp weeks utilized the same itinerary and staff to minimize differences between weeks. An example summer camp day included: walking scavenger hunts, healthy snack meal mastery lab with a registered dietitian, bone health demonstration with sources of calcium in the diet and dual x-ray absorptiometry with nutrition graduate students, team building physical activity games focused on social support, and healthy blood sugar measuring activity with popular food choices. Participants were required to attend ≥4 full days of summer camp and complete all post-camp testing in order to advance to Phase 2 of the study design.

Following completion of Phase 1, summer camp week groups were cluster-randomized into one of three treatment groups for the 12-week Phase 2 intervention, which aligned with the fall school semester: A) Social Media Group (SM; n = 27), B) Control Group (CON; n = 22), and C) Modified Control Group (CON-MOD; n = 7). Members of SM were required to attend 3 in-person monthly group meetings, to participate in the GirlTALK Facebook group page weekly, to wear the JawBone Up Move commercial activity monitor daily, and to respond to SMS text message conversations with the research staff weekly. Importantly, group meetings, text messaging and Facebook content reinforced behavior change strategies introduced during summer camp. The JawBone Up Move mobile application allowed participants to encourage other group members, and researchers, to be active every day and allowed for participants to self-monitor activity levels and work toward goals. Members of CON-MOD were asked to wear the JawBone Up Move commercial monitor daily but did not have regular contact with the study team, and members of CON had no contact with the study team outside of scheduling testing visits.

Anthropometric, objective PA and psychosocial data were collected at four testing time points for all participants: baseline, post-summer camp, phase 2 week 1, phase 2 week 12. Participants in SM and CON-MOD were rewarded for successful completion of all testing visits by getting to keep the JawBone Up Move they used during the project, and members of CON were given their own JawBone Up Move trackers upon successful completion of final testing.

4.3.C Anthropometric Measures

Height and weight were assessed with participants in bare feet, or while wearing thin socks, after removing heavy clothing and/or accessories. Height was measured to the nearest 0.1 cm via stadiometer (Seca, Model 242), and weight was measured in kg using a calibrated digital scale (Tanita, Model WB-110A). Adiposity (%Fat) was estimated using bioelectrical impedance (Tanita, WB-110A Class III). Body Mass Index (BMI) was calculated as kg/m^2 and plotted on BMI-for-age charts [18] for girls aged 2-20 to determine percentile-based categories.

4.3.D Objectively Measured Physical Activity

Girls wore Actigraph GT3X+ triaxial accelerometers around the waist during waking hours for a 7-10 day period at the four testing time points. Girls were instructed to log the time the monitor was put on each morning, the time it was removed before bedtime, and any time it was removed during waking hours for water-related activities (e.g. swimming, bathing). Based on recent evidence [19], the Evenson cutpoints for children were selected for data processing in ActiLife Version 6.0. A valid day was defined as at least 10 hours of wear, and a minimum of three days (2 weekdays and 1 weekend day) was required for inclusion in analyses. Days with inadequate wear time and/or less than 500 steps accumulated were set to missing values. Total time spent in light intensity PA, moderate intensity PA, vigorous intensity PA, MVPA, and related variables were calculated using a weighted average (week days were given $5/7^{ths}$ of weight, while weekend days were given $2/7^{ths}$ of weight) to generate a value for each participant per time point.

<u>4.3.E Physical Activity Self-Efficacy and Related Constructs</u>

All psychosocial outcomes were assessed using a computer-administered social cognitive questionnaire that was previously developed for middle school girls in the Trial of Activity for Adolescent Girls [20]. Participants completed the questionnaire battery under consistent, ambient laboratory conditions with standardized instructions from the research team. All questionnaire items were rated by participants using a 5-point Likert scale format. Questionnaires were checked for completion by researchers prior to the end of each testing session. Data were downloaded into SPSS Version 22.0 and scored according to their instructions.

Physical Activity Self-Efficacy was assessed using an eight-item survey previously developed for use in the target population [21]. An example item was “I can be physically active during my free time on most days.” The summary score was calculated by averaging the score for each item. *Outcome Expectancy* in PA was measured using nine items that consisted of belief and corresponding value statements adapted from previously developed scales. The belief statements were rated on a five-point scale (1 disagree a lot; 5 agree a lot). The value statements were also rated on a five-point scale (1 very unimportant; 5 very important). The outcome expectancy scores were formed as a product of the belief and corresponding value item scores, and then the item scores were summed to produce a total outcome expectancy score. *Perceived Social Support* from both friends and family were assessed using an eight-item questionnaire. Three items targeted social support from friends, while five items asked participants to rate social support from family. Based on recent factorial validity evidence [20], one item from the family-based section was not included in the overall summary score, as it was a covariate to another question within that section. *Physical Activity Enjoyment* was measured using the Physical Activity Enjoyment Scale [22]. An example item was “When I am physically active, I get something out of it," and participants answered on a five-point scale (1 disagree a lot; 5 agree a lot). Summary scores for each participant were calculated by averaging all items. *Self-Management* was assessed using six questions such as "I set goals to do physical activity," and summary scores were calculated by averaging scores from all six items.

4.3.F Statistical Analyses

All statistical analyses were performed using IBM SPSS Statistics for Windows Version 22.0. (IBM Corp: Armonk, NY). A significance level of alpha <0.05 was set. Data were checked for normality using distribution statistics, and means and standard deviations for each variable of interest were calculated. Paired samples t-tests examined baseline to post camp changes in outcome variables of interest for Phase 1. Bivariate Pearson correlations were employed to provide insight into magnitude and direction of relationships between change scores among outcome variables of interest in Phase 1. ANOVAS were conducted to examine statistical difference between SM, CON-MOD and CON at baseline starting Phase 2 of the study. Group X Time ANCOVAS, controlling for elapsed time since camp (days) and Week 1 scores, were conducted to evaluate changes due to the intervention over time in outcome variables of interest. In addition, effect sizes (Hedge's g) were also calculated to evaluate clinically meaningful differences between groups.

4.4 Results

4.4A Participant Demographics

Participants (n = 52; see Figure 1) were 11.6 $\pm$ 0.9 years of age, with 30.8% of girls entering 6th grade, 38.5% entering 7th grade, and 30.8% entering 8th grade. The sample was predominantly white (76.9%), with 19.2% black, 1.9% Asian, and 1.9% Pacific Islander. At baseline, BMI was 22.1 $\pm$ 6.3 kg/m^2, and %Fat was 31.6 $\pm$ 10.0%. Approximately half of the sample was in the normal weight-for-age category according to BMI-for-age charts, with the remainder being categorized as underweight (1.9%; n = 1) overweight (16.1%; n = 8) or obese (26.8%; n = 14). At the time of baseline testing, 44.6% of girls reported reaching menarche. Girls accrued 29.5 $\pm$ 13.4 minutes of MVPA/day on average at baseline, which is considerably lower than the Physical Activity Guidelines of 60 min/day as expected given inclusion/exclusion criteria.

4.4B Participant Adherence

Attendance to summer camp was, on average, 96.1% time for all completers of Phase 1 with 92% of girls attending all 5 days of summer camp, and no girl missing more than 1 full camp day. To be included in analyses for Phase 1, girls completed all testing visits both before and after summer camp. As shown in Figure 4.1, 4 participants withdrew from the study during Phase 1, due to either moving out of state (n = 1) or lack of time to commit to project requirements (n = 3).

During Phase 2, four participants withdrew (n = 3 for noncompliance and n = 1 for lack of time), as depicted in Figure 4.1. All girls in the SM group attended at least 3 face-to-face meetings, with 100% of girls meeting minimum attendance requirements. On average, SM girls interacted on Facebook 3.5 $\pm$ 3.0 times weekly, with only 47.6% of girls meeting the requirements of ~3 interactions during all 12 weeks of the Fall semester intervention. Text messaging was used several times weekly to communicate with girls not regularly meeting Facebook requirements, and the study team received responses from girls 87% of the time, on average. Additionally, SM girls wore the JawBone UpMove an average of 5.2 $\pm$ 1.8 days each week, with the majority of girls meeting requirements to wear the monitor at least 80% of the time. In order to be included in analyses for Phase 2, girls in the SM group were required to have complied with social technology participation as previously described and were required to complete all testing visits; two participants were asked to withdraw from the study due to noncompliance within the SM group. Girls in both CON-MOD and CON were required to complete all testing visits to be included in analyses.

4.4C Phase 1 Results for Baseline to Post Camp

As shown in Table 4.1, no overall mean changes in PA self-efficacy, social support, enjoyment, or perceived barriers from baseline to post camp were evident (all $p > 0.05$). Additionally, there was no mean change in MVPA over time ($p = 0.10$); but, variability was apparent in that 17 girls increased MVPA from baseline to post-camp, and 32 girls decreased MVPA from baseline to post-camp. On average, outcome expectancy-values of PA significantly decreased by 22.8% (Hedge's $g = -0.30$; $p = 0.03$; Figure 4.2A), and self-management scores significantly increased by 6% (Hedge's $g = 0.22$; $p = 0.02$; Figure 4.2B). Bivariate correlations in Table 4.2 revealed no significant associations among outcome variables of interest (all $p > 0.05$); however, it is relevant to note that change in PA self-efficacy was positively, though not significantly, related to change in MVPA, such that girls who increased PA self-efficacy also increased MVPA ($r = 0.27$; $p = 0.06$; Figure 4.3). Importantly, too, change in MVPA was positively, though not significantly, related to change in self-management, such that those who increased self-management may have increased MVPA acutely ($r = 0.18$; $p = 0.12$).

4.4D Phase 2 Results for Week 1 to Week 12

For Phase 2, one-way ANOVAS were performed to investigate between group differences at Week 1 for key outcomes of interest. Importantly, cluster randomization groups did not differ in BMI, %Fat, waist circumference, MVPA, PA self-efficacy, outcome expectancy, social support from friends, social support from family, PA enjoyment or PA self-management at Week 1 of Phase 2 (all $p > 0.05$). Unexpectedly, cluster randomization groups did differ significantly in reported perceived barriers to PA ($F(2, 47) = 3.66$, $p = 0.03$) at Week 1. Post hoc analyses revealed that girls in both CON ($p = 0.02$) and SM ($p = 0.01$) reported significantly lower scores than girls in CON-MOD at Week 1.

As shown in Table 4.3, analyses revealed no Group by Time interaction effects or main effects of Group or Time for BMI, adiposity, waist circumference, social support from friends, PA enjoyment, or perceived barriers to PA (all $p > 0.05$). For the primary outcome variable of MVPA, no Group by Time or Group effects were apparent (both $p > 0.05$) but there was a main effect of Time ($F(1, 41) = 8.134$, $p = 0.01$) indicating a reduction in MVPA over the 12 weeks. With regard to PA self-efficacy and outcome expectancy-values, similar findings were evident with no Group by Time or Group main effects evident (all $p > 0.05$) but significant Time effects indicating a reduction in both PA self-efficacy (F (1, 44 = 5.44, $p = 0.02$) and outcome expectancy (F (1, 44 = 5.40, $p < 0.001$) over the 12 week Fall school term.

For social support from family, no Group by Time or Group main effects were evident (all $p > 0.05$), but a significant main effect of Time ($F(1, 44) = 8.90$, $p = 0.005$) indicated a reduction in family social support. Finally, self-management exhibited the same pattern as outcomes reported above with no significant Group by Time or Group effects being present with a significant main effect of Time ($F(1, 45) = 10.3$, $p = 0.002$) indicating reductions in self-management over the 12 week intervention.

4.4E Overall Trends for Phases 1 and 2

Analyses investigating differences from baseline testing to post-intervention focused on comparisons between only CON and SM groups, given the larger sample sizes within those groups. Thus, 2 x 4 (Group x Time) ANCOVAS were conducted, including baseline scores as the covariate, for our primary outcome variables of both MVPA and PA self-efficacy as shown in Figures 4.3 and 4.4. In the ANCOVA with MVPA as the dependent variable, there was neither a Group x Time interaction effect nor a main effect of Group (both $p > 0.05$); however, the analysis revealed a main effect of Time ($F(1, 36) = 7.83$. $p < 0.001$), such that both groups decreased MVPA similarly throughout the entire study period (i.e. Baseline to Post-12 week). Specifically, CON reported an overall decrease of 8.4% in MVPA, with SM decreasing 13.1%.

Similarly, when PA self-efficacy was examined as the dependent variable, there was no significant Group by Time or main effect of Group (both $p > 0.05$), but a significant main effect of Time ($F(2.8, 39) = 7.37$, $p < 0.01$) indicated that both SM and CON reported decreased PA self-efficacy throughout the study (2.7% and 8.1%, respectively). Notably, the correlation between baseline PA self-efficacy score and change in PA self-efficacy score throughout the entire project (Baseline to Post-12 week) was moderate and significant ($r = -0.48$, $p = 0.03$), suggesting that girls with lower baseline PA self-efficacy may have been more likely to increase PA self-efficacy throughout the study.

4.5 Discussion and Conclusion

The primary purpose of the present study was to explore relationships between changes in PA self-efficacy and changes in MVPA, considering related psychological constructs such as self-management and outcome expectancy-values, in middle school girls throughout a contemporary, 2-Phase PA and DQ intervention. Despite the existing evidence that adolescent girls typically have a low to moderate response to PA interventions [7], our results suggest that neither PA Self-Efficacy or MVPA nor changed significantly in response to this particular intervention approach. Accelerometer data demonstrated that girls in our sample did not meet current PA guidelines for 60 minutes of MVPA each day at either baseline or post testing; however, it is favorable that we saw no significant decrease in MVPA through summer months in our sample either, as summer months have been identified as a vulnerable season for reductions in PA behaviors [3].

Notably, baseline PA self-efficacy scores in this sample appeared slightly higher than PA self-efficacy in previously published adolescent girl samples [20]. However, our data do align with previous findings such that change in PA self-efficacy and change in MVPA were positively correlated during Phase 1 of the study ($r = 0.27$, $p = 0.06$) [20, 23]. Also during Phase 1, outcome expectancy-values for PA significantly decreased over time (Hedge's $g = -0.30$; $p = 0.03$), which is an unanticipated finding. Indeed, outcome expectancy-values is a key component of self-efficacy based theories and can be defined as a person's estimate that a given behavior will lead to certain outcomes [24]. After exposure to the summer camp stimulus, girls made less positive judgments about the likelihood of outcomes that flow from engaging in PA behavior. A possible explanation of this is that, due to recruiting girls who were currently in the "low active" category and had little experience with organized sport participation, girls may have had an unrealistically positive view of being active prior to the exposure provided during summer camp. During camp, girls were exposed to several modes of both PA and structured exercise that they may have not previously experienced, including spin cycle classes, Zumba, agility games, and yoga; perhaps this new exposure altered their views in the unanticipated direction.

Also during Phase 1 of the present study, self-management scores for PA increased significantly from baseline to post-camp (Hedge's g = 0.22; p = 0.02). Given that summer camp curriculum did highlight the importance of thoughts, goals, plans and actions regarding PA behaviors, this result is both anticipated and confirmatory of recent literature. Specifically, a correlational study of 6th and 8th grade girls found that self-management strategies may help to explain relationships between PA self-efficacy and PA in this sample [25]. Importantly, this study suggested that future interventions targeting increased habitual PA among adolescent girls by increasing PA self-efficacy should target self-management strategies [25].

After cluster randomization during Phase 2, there was no evidence of between group differences for any major outcomes of interest. Unfortunately, our intervention did not have the intended effects of improving PA self-efficacy and MVPA more in the SM group when compared to both CON and CON-MOD, even when both controlling for baseline scores and examining related psychosocial measures as mediators. A plausible explanation for lack of significant differences between groups during Phase 2 may be that our methods for delivery of SM group content via JawBone UPMOVE, Facebook, and text messaging were of an insufficient dose or stimulus. Our results mimic those of the Active Winners study, which found no between group differences in PA between control and intervention groups with a camp design and innovative follow-up approach [15]. However, few published studies exist like the present one, and this lack of evidence base makes our results more difficult to interpret. Future researchers interested in this type of approach should generate better pilot data to investigate efficacy of different doses of hands-off, technology based approaches with this age group. Additionally, it's important to recognize the clear barriers to PA associated with the adolescent age group, in that they have only partial control over their behaviors outside of the school day, cannot drive themselves to and from activities, are not old enough to join exercise facilities, etc. Perhaps future work should involve parents or employ a socio-ecological framework to better eliminate some barriers.

The current study adds to the body of knowledge on theory-based PA interventions in middle school girls and has multiple strengths to note. Specifically, the current literature base reveals a paucity of data in novel, technology-based PA intervention approaches framed by behavior change theory within the community domain among middle-school aged girls. Our approach attempted to intervene in a 2-Phase design, with Phase 1 being more traditional and hands-on, and Phase 2 being more translational and hands-off with use of social technology to keep girls engaged. Secondly, the study utilized both objectively measured PA via accelerometry and psychological instruments designed for and validated in the middle school girl population.

Our novel, 2-phase study design is not without limitations. Importantly, inclusion criteria required girls to 1) have access to social technology (e.g. personal cell phone for text messaging and family computer for internet access), 2) attend a week-long summer camp, and 3) be involved in a 12-week follow-up program; thus, our results may not be representative of the adolescent girl population at large. Additionally, the study design did not include a true control condition and also employed a multi-component intervention (social media, text messaging, in-person sessions), which limits the ability to draw conclusions about the independent effects of any single component. Finally, due to measurement instrumentation constraints, there was a lack of standardized time between finishing post-camp testing and starting Phase 2 of the study; thus, the research team is unaware of the time course of any longer-term effects of camp on influencing both MVPA and PA self-efficacy.

In conclusion, the results of our pilot study confirm that changing PA behaviors within the middle school girl cohort remains challenging, and that future, theory-based work is needed to clarify the mediators of behavior change in this population. Researchers should aim to better assess known SCT-based mediators of behavior change during PA interventions with both longer doses of camp-based stimuli and more diverse populations to better understand relationships between PA self-efficacy and changes in PA behaviors.

4.6 References

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Table 4.1 Phase 1 Participant Characteristics (n = 52)

Characteristic	Baseline	Post-Camp	p value
Age (years)	11.6 ± 0.9	---	---
BMI (kg/m^2)	22.1 ± 6.3	21.9 ± 6.7	0.79
% Total Body Adiposity	31.6 ± 10.0	31.3 ± 10.3	0.90
Waist Circumference (cm)	73.9 ± 14.9	69.8 ± 11.0	0.01*
MVPA (min/day) (n = 51)	29.5 ± 13.4	26.4 ± 11.4	0.10
PA Self-Efficacy	4.1 ± 0.6	4.1 ± 0.6	0.73
Outcome Expectancy-Value	175.7 ± 37.8	162.6 ± 47.6	0.03*
Social Support Friends	2.8 ± 1.1	2.8 ± 1.1	0.85
Social Support Family	3.4 ± 0.8	3.4 ± 0.8	0.68
PA Enjoyment	3.1 ± 0.2	3.1 ± 0.2	0.59
Perceived Barriers to PA	1.9 ± 0.6	1.9 ± 0.5	0.47
Self-Management	3.3 ± 0.9	3.5 ± 0.9	0.02*

Data displayed as M ± SD unless otherwise stated; BMI: body mass index.
**Significant difference over time evident from paired t-tests ($p < 0.05$).*

Table 4.2 Phase 1 Bivariate Correlations among Change Scores in Main Outcomes

	Characteristic	**1**	**2**	**3**	**4**	**5**
1	Age	1.0				
2	Baseline BMI	0.10 (0.47)	1.0			
3	Change in MVPA	0.01 (0.93)	0.09 (0.53)	1.0		
4	Change in OEV	-0.20 (0.15)	-0.17 (0.50)	-0.12 (0.41)	1.0	
5	Change in Self-M	-0.18 (0.20)	0.08 (0.57)	0.18 (0.21)	-0.02 (0.63)	1.0
6	Change in PA SE	-0.04 (0.78)	0.09 (0.50)	0.27 (0.06)	0.09 (0.55)	.22 (0.12)

Data displayed as correlation (p value). BMI: body mass index, in kg/m^2*; MVPA: moderate to vigorous physical activity, in min/day; OEV: Outcome Expectancy Value; Self-M: Self-Management; PA: physical activity; SE: Self-Efficacy.*

Table 4.3 Phase 2 Outcome Variables by Cluster Randomization Group

	SM (n = 22)		CON (n = 19)		CON-MOD (n = 6)		Main Effect of Time
Variable	Week 1	Week 12	Week 1	Week 12	Week 1	Week 12	**p value**
*MVPA (min/day)	29.4 ± 13.2	26.5 ± 12.0	31.8 ± 12.5	32.3 ± 14.2	28.4 ± 11.4	21.4 ± 8.5	*0.01*
*PA Self-Efficacy	4.2 ± 0.5	4.0 ± 0.7	4.1± 0.6	3.9 ± 0.6	3.6 ± 0.7	3.5 ± 0.5	*0.02*
*Outcome Expectancy	147.0 ± 43.6	160.5 ± 33.8	158.9 ± 46.4	161.1± 50.5	164.3 ± 23.0	173.2 ± 13.3	*<0.001*
Social Support Friends	2.9 ± 1.0	2.9 ± 1.1	2.9 ± 0.9	2.8± 1.0	2.1 ± 1.2	1.9 ± 1.1	*0.12*
*Social Support Family	3.5 ± 0.8	3.3 ± 0.8	3.5 ± 0.7	3.3± 0.3	2.8 ± 1.4	2.5 ± 0.8	*0.01*
PA Enjoyment	3.1 ± 0.3	3.1 ± 0.3	3.1 ± 0.3	3.1± 0.2	3.0 ± 0.1	3.0 ± 0.1	*0.23*
Perceived Barriers to PA	1.7 ± 0.1	1.9 ± 0.1	1.8 ± 0.5	2.0± 0.5	2.3 ± 0.4	2.0 ± 0.2	*0.20*
*Self-Management	3.5 ± 0.2	3.5 ± 0.2	3.5 ± 0.8	3.3± 0.9	3.4 ± 0.9	3.1 ± 0.6	*0.002*

Data shown as M ± SD. BMI: body mass index; MVPA: moderate to vigorous physical activity; PA: physical activity.
ANCOVAS controlled for baseline values of outcome measures and elapsed time since summer camp.
**Significant main effect of Time, p < 0.05.*

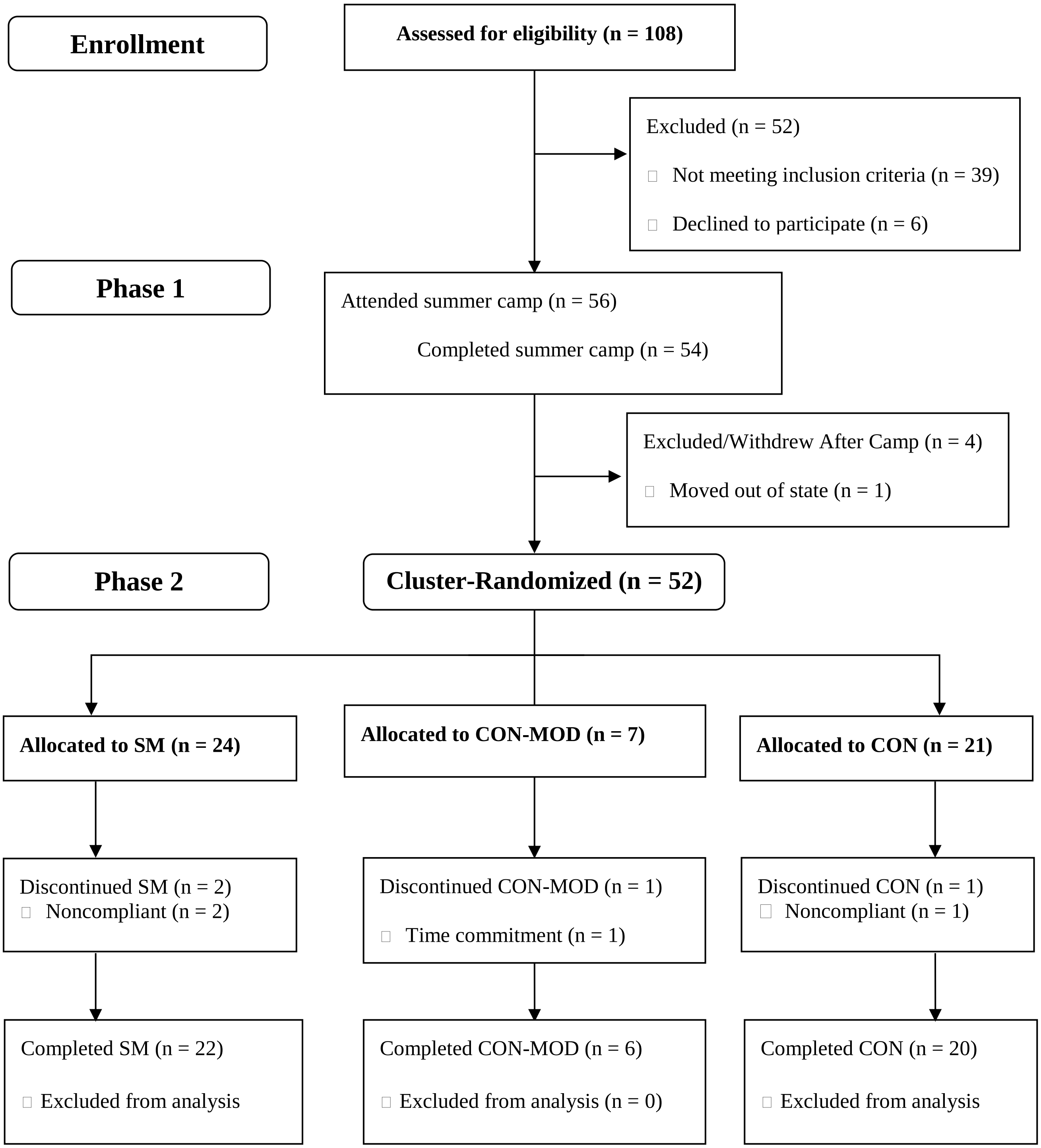
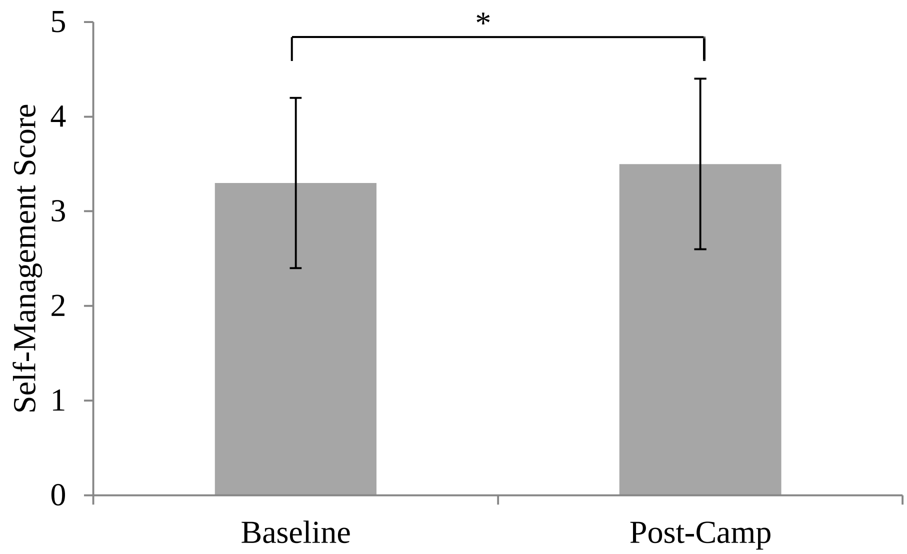


Figure 4.1 Enrollment and Study Completion Consort Diagram
SM: social Media intervention group; CON-MOD: modified control condition; CON: control group

A



B

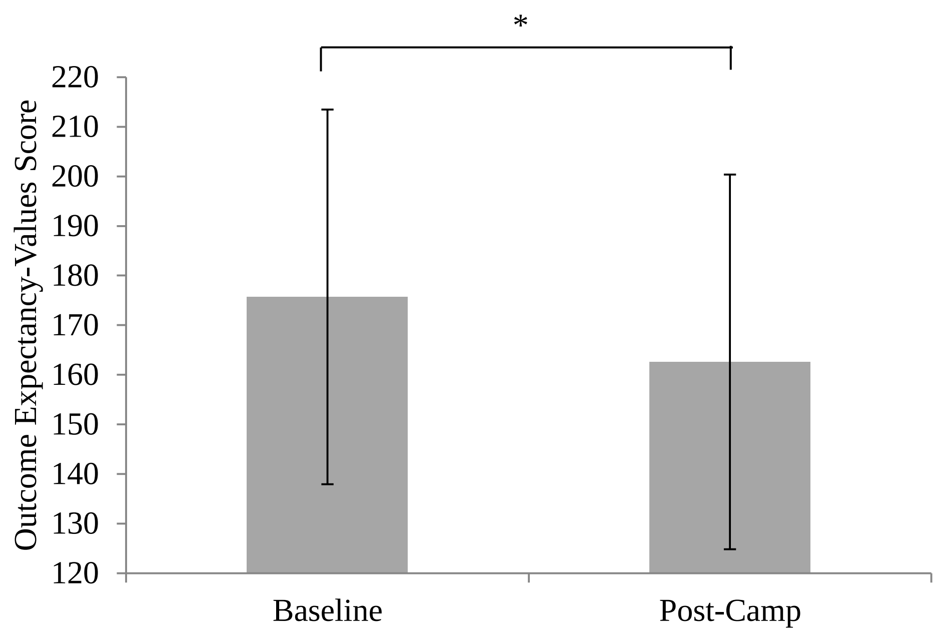


Figure 4.2 A) Phase 1 self-management scores **B)** Phase 1 outcome expectancy-values scores
**Significant change over time as evident by t-test; p < 0.05.*

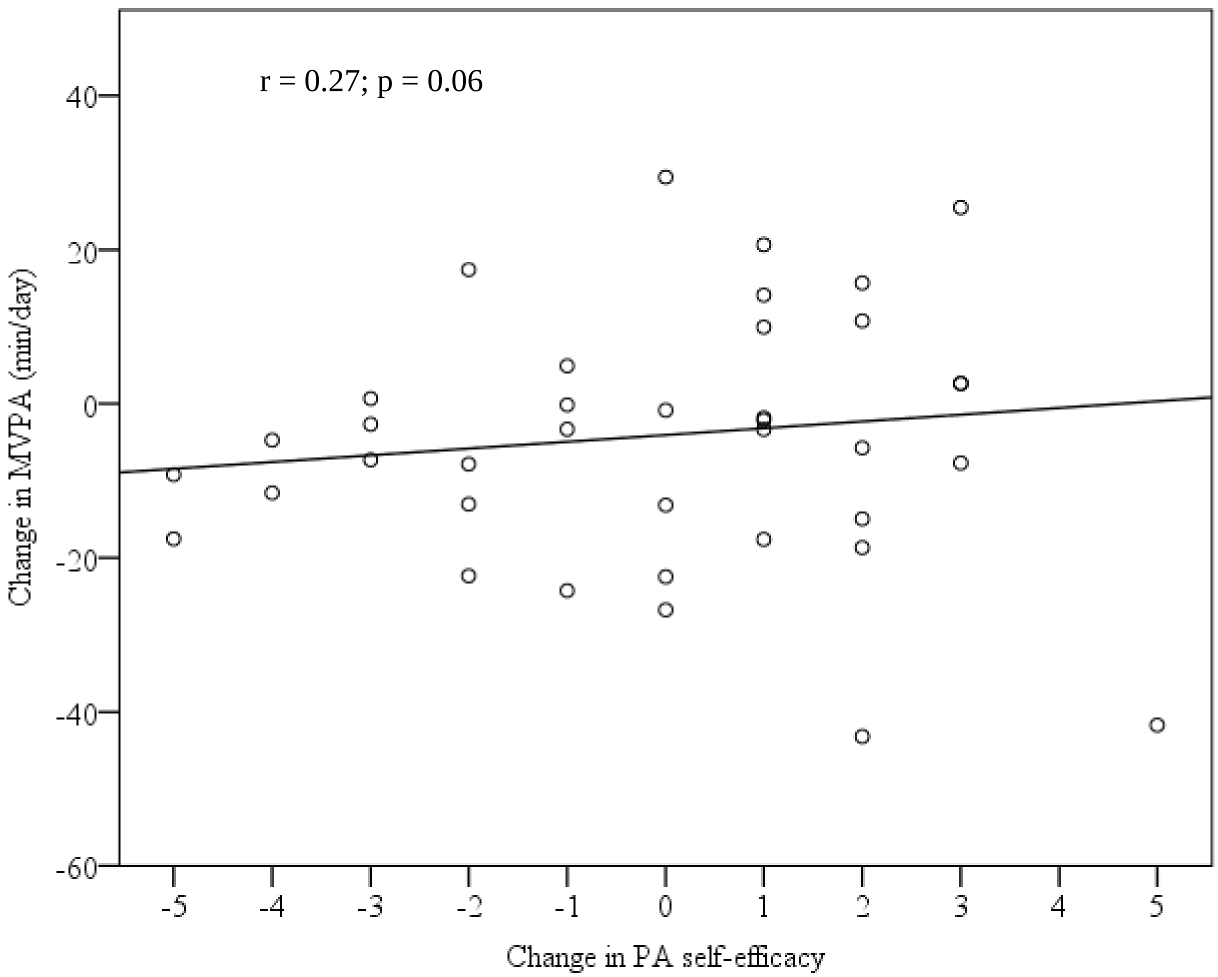
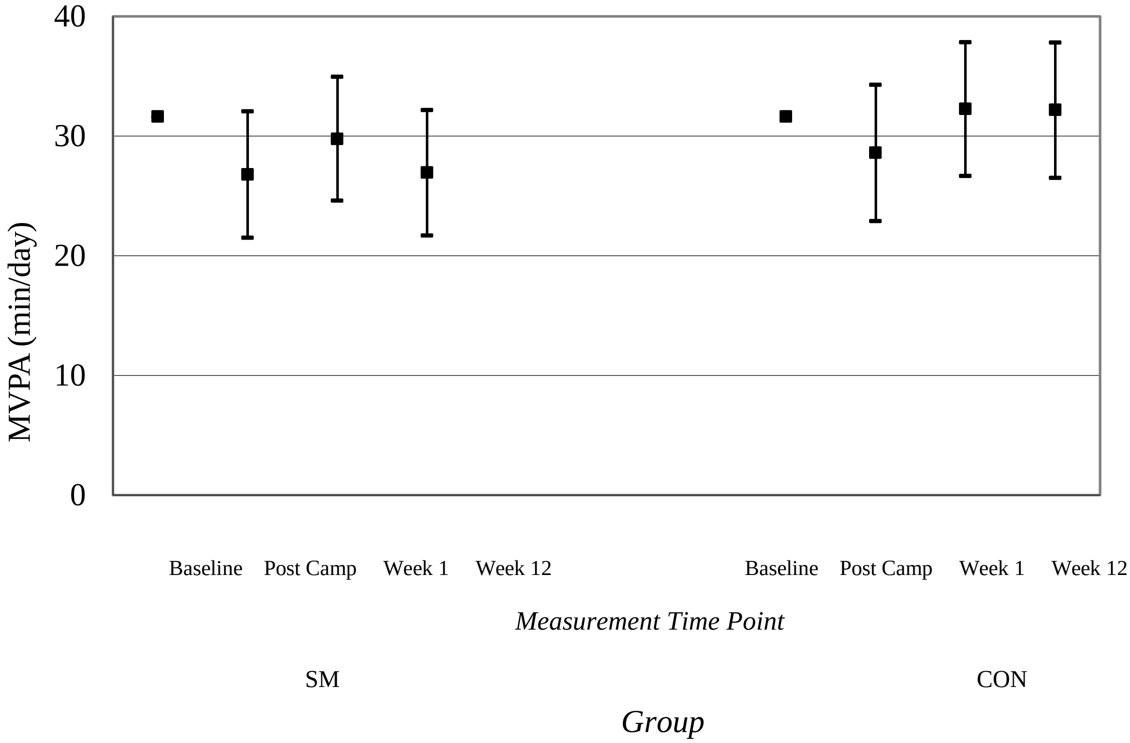


Figure 4.3 Phase 1 Bivariate Correlation between Change in PA Self-Efficacy and change in MVPA

A



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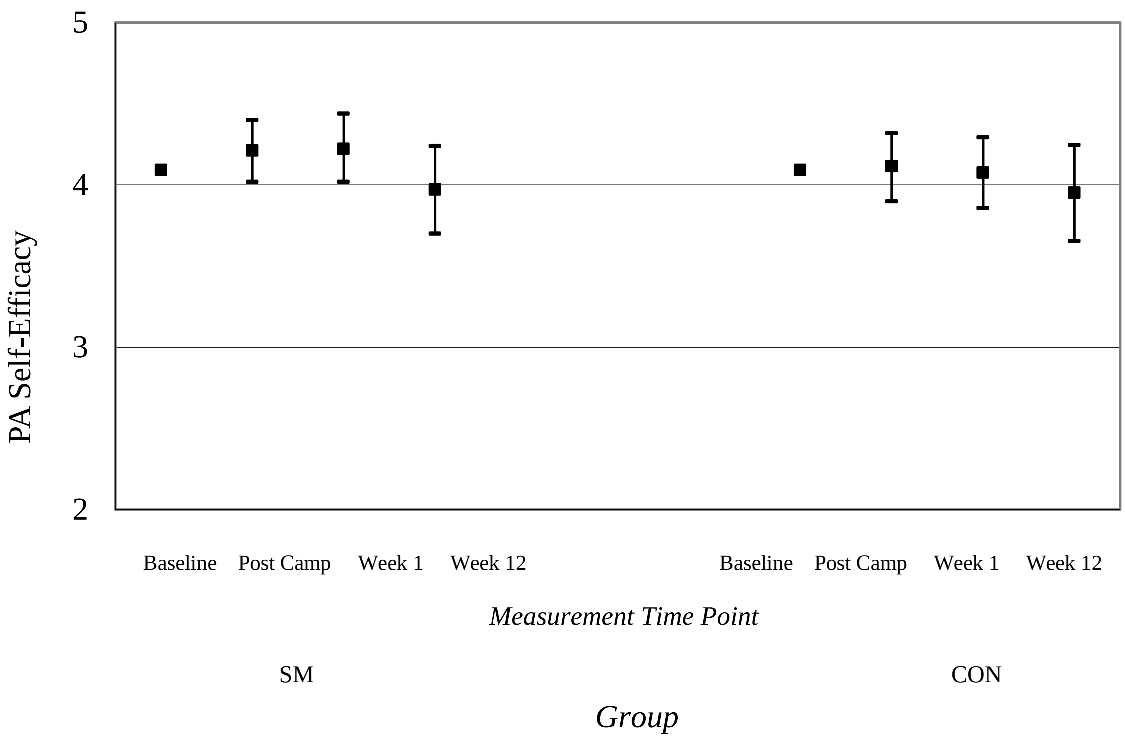

Figure 4.4: A) ANCOVA for MVPA (min/day) for SM and CON across all Time Points, **B)** ANCOVA for PA Self-Efficacy for SM and CON across all Time Points.
Bars represent 95% CI. Model controlled for baseline values; no bars for baseline time point.

CHAPTER 5

SUMMARY AND CONCLUSIONS

Results from the present study add to the growing body of literature examining contemporary, social technology, community-based PA and DQ interventions within the adolescent girl cohort. Specifically, this study employed a novel, 2-phase approach: 1) a 5-day summer camp framed with Social Cognitive Theory (SCT) and developed around AHA Simple 7 for kids and 2) a 12-week follow up intervention in the fall school term where girls in the intervention group received frequent contacts and prompts via social technology, to elicit behavior changes by increasing habitual PA and improving overall DQ. The study was timely due to a recent call for researchers to focus intervention efforts on adolescent girls within the community domain. Additional strengths of the study include our use of objectively measured PA, use of social technologies like Facebook and the JawBone UpMove activity monitor, and a strong SCT framework and delivery of intervention content.

Our findings from study 1 indicate that middle school girls, on average, did not increase MVPA in response to a week-long summer camp; however, it is promising that MVPA also did not decrease during the summer months. Additionally, our findings reiterate that responses in MVPA following summer camp are highly variable; girls who started with lower levels of baseline MVPA were more likely to increase MVPA after summer camp than girls with higher levels of baseline MVPA. In Phase 2 of our study, there were no treatment group differences in response to MVPA; but, all girls decreased slightly over time, suggesting that our longer-term portion of the intervention was not effective in changing MVPA behaviors.

In regard to DQ-related outcomes, our findings from study 1 are consistent with existing evidence in that DQ-related behaviors tend to be more responsive to multi-component interventions than PA-related behaviors. Participants in our study, on average, self-reported decreases in daily caloric intake, added sugar intake, and refined carbohydrate intake following summer camp. In Phase 2 of the study design, the SM group significantly increased consumption of added sugar, which was an unfavorable change; there appeared to be no additional main effects of Group in the additional DQ outcomes during Phase 2.

Additionally, our findings from study 2 for psychosocial outcomes related specifically to PA behaviors suggest that girls' PA self-efficacy did not change in response to summer camp; however, there was a positive association between PA self-efficacy and PA, such that girls who increased PA self-efficacy may have been more likely to also increase PA behavior. Self-management, a known covariate of PA self-efficacy, did show favorable changes in response to summer camp. Outcome expectancy-values for PA also increased following summer camp, which was a change in the unanticipated direction. During Phase 2 of the study, there appeared to be no Group by Time or Group main effects in PA self-efficacy or related psychosocial constructs; however, there was evidence of main effects for Time, indicating reduction in many psychosocial outcomes throughout Phase 2, including PA self-efficacy, self-management, and outcome expectancy.

Our findings highlight the fact that, although challenging, multi-component interventions targeting PA and DQ within the adolescent girl population are warranted. Future work in this area should seek to both identify the adequate summer camp stimulus dose to elicit acute improvements in PA behaviors (e.g. longer camp duration) and to involve parents/guardians in PA promotion outside of camp exposure. In light of the current adolescent obesity epidemic, researchers should also continue to strive to improve DQ-related outcomes in this population, perhaps further exploring contemporary social technologies and community-based interventions.