GIRLS' PERCEPTIONS OF TAILORED MESSAGES
IN A PHYSICAL ACTIVITY INTERVENTION: ASSOCIATIONS WITH
PSYCHOLOGICAL CHARACTERISTICS AND PHYSICAL ACTIVITY

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ABSTRACT

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Physical activity (PA) declines dramatically with age, especially in adolescent girls. Many different types of interventions have been employed to determine the best way to increase adolescent girls' PA behaviors. The overall purpose of this study was to examine the relationship between perceptions of tailoring and physical activity behavior in the Girls on the Move (GOTM) PA intervention. Adolescent girls (n=510) between the ages of 10-15 years, from two subsequent cohorts, completed 17 weeks of an intervention and were included in the study's analysis. Girls completed the Perceptions of Tailoring Survey (with two subscales, PA Evaluation and Computer Program) at the mid-point of the intervention (~9 weeks) where they received tailored messages based on their individual answers to questions regarding psychosocial characteristics related to physical activity, including benefits of PA, barriers to PA, self-efficacy, and social support. Multiple linear regression analyses indicated that benefits (p<.001), self-efficacy (p<.001), and barriers (p=.035) significantly predicted answers to the PA Evaluation subscale when controlling for SES (p=.008). The PA Evaluation subscale (p=0.005) significantly predicted post-intervention MPA when controlling for ethnicity (p=0.01). Perceptions of tailoring mediated the relationship between perceived barriers of PA and post-intervention MPA. Since girls who had fewer barriers to PA had more positive perceptions of the tailored messages and higher levels of post-intervention MPA, the web-based tailored message component may have moderately influenced change in girls' PA behaviors.

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CHAPTER 1: INTRODUCTION

There continues to be a high prevalence of overweight and obese individuals in today's society, but the rates have started to level off in both adults and youth (75). Overweight and obesity contribute to a number of health conditions such as cardiovascular disease and diabetes (75). The most recent estimates indicated that 69% of today's adults were classified as either overweight or obese, with more men (71.6%) than women (66.5%) classified as overweight or obese in 2011-2012 (75). Specifically regarding youth, obesity rates in 2- to 19- year-olds leveled off from 2003-2004 to 2011-2012 with 17.1 and 16.9% of 2- to 19-year-olds classified as obese, respectively (75). Even though overall youth obesity rates have started to level off, 31.8% of all youth were still classified as either overweight or obese in 2011-2012 (75). Therefore, it is important to continue investigating overweight and obesity and examine possible ways to lower the high prevalence, especially in children and adolescents.

Regular engagement in physical activity is an important lifestyle behavior that helps lower prevalence of obesity, mortality risk (6), and risk of developing cardiovascular disease risk factors (71). Even though the benefits of physical activity are established, physical activity declines dramatically with age, especially through adolescence (106,120). For example, less than half of youth between the ages of 6 to 11 years met the national recommendations for physical activity (106), which is engaging in at least 60 minutes of physical activity on a daily basis. Fakhouri et al (2014) found that 24.8% of 12- to 15- year olds engaged in at least 60 minutes of moderate-to-vigorous physical activity (MVPA) in 2012 (31). Specifically, physical activity rates decline tremendously for adolescent girls (76,120). As girls progress from 6th grade to 8th grade, there is a decline in MVPA by 4% per year (76). Similarly, Webber et al (2008) found that 6th grade participants engaged in higher total minutes of physical activity

compared to 8th grade participants, where 6th graders engaged in a total of 366.4 minutes of physical activity per day and 8th graders engaged in only 317.7 minutes of physical activity per day (120). This exemplifies the rate of decline in adolescent girls, specifically during middle school, illustrating that it is important to target this population to help promote physical activity during a critical stage of development.

The decline in physical activity during adolescence is related to the increase in sedentary behavior and increase in overweight and obesity rates, particularly in girls, especially during the middle school years (47,48,78). For example, 6th graders had an average of 456.5 minutes of sedentary behavior per week compared with 510.5 minutes of sedentary behavior in 8th graders (120). Therefore, it is important to not only emphasize increasing physical activity but to emphasize decreasing sedentary behavior as well.

Since physical activity declines tremendously throughout adolescence, especially in girls (76,120), it is advisable to increase physical activity participation before girls reach the high school years (90). A physical activity intervention program is a commonly used method to help increase rates of physical activity participation among individuals, with the hope of developing a healthier lifestyle after completion of the program. Physical activity interventions have been utilized in a variety of settings such as schools (33,34,36,88,90,91,120), communities (19,20,37-39,42,46,49,51,56,66-70,99-101,111-113,128), worksites (7,15,21,126,127) and clinical settings (14,20,77-79,114,116,124).

Based on recent data, by the ninth grade, 15.5% of girls did not participate in at least 60 minutes of physical activity on at least one day of the week, and 17.9% and 10.2% of girls were already overweight and obese, respectively, by the ninth grade (17). An estimated 49% and 61% of overweight and obese of 12- to 19- year- old adolescents, respectively, were found to have at

least one cardiovascular disease risk factor on top of their weight status (71). In addition, 37% of normal-weight adolescents had at least one cardiovascular disease risk factor (71). Therefore, adolescents in any weight category would benefit from a physical activity intervention program designed to increase physical activity (91).

One type of physical activity intervention program that has been increasing in popularity is a tailored intervention program. This type of program utilizes tailored communication for which the learning experience for each individual is specifically tailored to him/her (2). This method is a powerful way of delivering physical activity interventions that meet the specific needs of each individual based on that person's demographic and behavioral characteristics (2). Tailored messaging is a way to start communicating in an individualized manner where individuals provide personal information regarding variety of behaviors (53). Different levels of tailored messaging include personalizing, targeted communication and tailoring. Personalizing is when the message uses the name of the participant to strike his/her attention. Targeted communication is when the message is geared toward a specific group or subgroup. Tailoring is based on personal characteristics of the desired outcome of interest, which is the highest level of message tailoring (2).

The difference between targeted communication and tailoring based on personal characteristics is that targeted communication is intended to reach a subgroup of a population based on characteristics shared among group members, while tailored communication is intended to reach one specific individual based on the individual's own characteristics provided through a formal assessment (53). Despite the distinction between the two types of communication, both approaches have a similar rationale for their use in research- the more information gathered about the intended recipients of a message, the more likely the message will be relevant to them

(53). Although there is little evidence to show which communication method is more effective,

Kreuter & Wray (2003) suggested that tailored messages have an advantage over targeted

messages when there is significant variability within the target audience regarding the intended

outcome (physical activity, for example) (53). Therefore, several researchers have utilized

tailored messaging in their intervention programs in order to reach each participant based on his

or her own personal characteristics within each variable of interest.

Compared with traditional health communication, tailored interventions have many

potential benefits including: improved opportunity to tailor information to the specific needs of

individuals or groups of users; improved capability of combining a variety of media to address

the particular purposes of the intervention or the learning styles of users; increased possibility for

users to remain anonymous while seeking information and support from peers or experts about a

sensitive health issue; increased access to information and support on demand; and enhanced

ability to update and maintain current scientific knowledge (2). In addition, tailored messages

have a better chance of being read and remembered (10,15), which allows for individualized

feedback because these messages demand greater attention, contain less redundant information,

are processed more intensely by the reader, and are received more positively by the reader (10).

These benefits exemplify the advantages that tailored communication has over other forms of

communication and why tailored messages would possibly yield better results in intervention

studies.

The several different types of tailored intervention programs include print-based

(11,12,15,24,66-70,78,100,109-113,118,123), computer-based (21,33,34,36,114,116), internet-

based (57,67,68,70,88,91,101,126,127), short message service (SMS) (5,19,41,99), online videos

(117,118), and email messages (126-128). When tailored interventions first became known in

research the majority were print-based interventions (10). A print-based tailored intervention delivers messages via letters, pamphlets, booklets, and/or similar media forms to the participants after the participants answer demographic and behavioral information through written questionnaires (10). Print-based interventions have several limitations, such as the cost of printing and delivering the feedback to the individuals and most importantly the time between the survey responses and the tailored feedback delivered to the individuals (or the lack of immediate feedback) (10). The lack of immediate feedback decreases the personal relevance of that feedback and lowers the effectiveness of the tailored information for the individual (10). Due to these limitations, print-based interventions have become less frequently used in recent research. When print-based interventions started to decrease in popularity, the establishment of computer-based interventions increased (117).

Computer-based interventions involve participants answering demographic and behavioral questions through a computerized program or on-screen questionnaire, which then provides participants tailored feedback almost immediately right on the screen through an automated system (10). In contrast to print-based interventions, computer-based interventions are less expensive, allow for more interaction, and provide feedback almost immediately to the participants (10).

Three ways to deliver computer-based tailored messages include online tailored e-mail messages (126-128) online tailored video messages (117,118), and web-based tailored interventions (57,67,68,70,91). These methods of tailored interventions are similar because they provide tailored feedback messages to the participants, but differ in their delivery mechanisms to appeal to different groups of individuals. Individuals who receive tailored e-mails or video messages after researchers examine responses to survey questions experience a slight delay in

the feedback. However, web-based interventions have the means to deliver messages instantly to the individuals while they are taking the surveys.

Web-based interventions utilize a web-site into which participants register and log-in. Once they are logged in, participants can engage in various types of activities. They can follow various modules (58), take surveys (58,70,91), have access to various motivational and educational resources (67), play interactive games (68), take quizzes (68,70), use downloadable charts to plan daily activities (68), watch interactive demonstrations of different activities (68), and set goals (67,70). The websites used in previous research have differed in activities provided to the participants, but all served a similar purpose in obtaining personal and behavioral information to produce tailored feedback (almost immediately) to the participant. These types of interventions reach large populations, are fairly cheap to conduct, and provide several resources of information (10). However, these interventions have some issues of concern with regard to the validity of the information provided as resources, the opportunities to browse the web, and the adherence of individuals logging on the website when directed (10). Even with these concerns, web-based tailored interventions are increasing in popularity due to widespread internet usage, advancement of technology, and an increase in participant interest in using new, advanced technology (2).

Another type of a tailored intervention is SMS messages or text-based messaging. SMS messages are brief texts transmitted at different times through the mobile network (19). Similar to internet/website-based interventions, this method continues to grow in popularity because the new wave of communication in today's society is via text messages. Bauer et al (2010) pointed out the following advantages of using SMS: SMS is accessible at almost any time and anywhere; it is a fast and interactive medium; it can be used with little effort; and communication via SMS

is inexpensive (5). Sending tailored feedback to the participants is easy and likely to be readily available for the participant to view and read immediately upon receiving the message. However, even though SMS messages are growing in popularity, text-based interventions have focused on other health behaviors such as weight loss (5), vitamin intake (19), and smoking cessation (41) with limited research evaluating the promotion of physical activity through SMS messages (41).

Many, if not all, tailored interventions are based on one or more theoretical models and constructs. Social-psychological as well as communication and persuasion theories and models are the theoretical basis from which tailored communication is derived (16). Examples of theoretical models and theories utilized in tailored communication include the stages-of-change transtheoretical model (TTM) of Prochaska and DiClemente (16,37,64,66,88,100,113,114,123, 125,128), self-determination theory (SDT) (91,112,113), I-CHANGE Model (24,100,113), decisional balance model (7,65), social cognitive theory (42,66,123), Health Promotion Model (HPM) (88,90,91), practice change model (92), Health Action Process Approach (113), Precaution Adoption Process Model (113), Self-regulation theory (112,113), self-efficacy (7,42,65,66,68,88,90,91,123), and theory of planned behavior (114). One of the most common models utilized in tailored communication interventions is the stages-of-change TTM (16). However, this model generally uses the targeted messaging form of tailored communication rather than tailored messaging. A common construct in tailored interventions is self-efficacy, which is a main construct from the Social Cognitive Theory, and it refers to the amount of confidence an individual has in his/her self to perform certain behaviors successfully (5). Another model that focuses on the individual in tailored communication is the HPM. This model focuses on three areas including individual characteristics and experiences, behavior-specific

cognitions and affect, and behavioral outcomes with the belief that each individual has his/her own unique characteristics and experiences that affect future actions (81). The HPM focuses on achieving higher levels of well-being and self-actualization with the idea that individuals need to meet basic needs before they can aim to reach those higher levels (81). This model is sometimes combined with the SDT, which is a broad framework to explain human motivation and the importance of meeting three basic needs of autonomy, competence, and relatedness in order to reach higher levels of healthy development and functioning (93). These models and constructs help build the foundation of tailored interventions and drive the mechanisms behind the outcome measures and methods. Although these constructs play a role in tailored interventions, it is unclear how these models impact the effectiveness of tailored messages. Additionally, it is not clear how well they relate to individuals' perceptions of the messages. Therefore, it is important to examine individuals' perceptions of the tailored messages and whether the messages are effective at addressing the specific needs of the individuals.

Compared to generic communication or non-tailored messages, participants viewed tailored messages more positively than general messages, and individuals found the messages more relevant, relatable, and interesting to read (12,15,24). Similarly, participants were more likely to read the tailored messages compared to the non-tailored messages, which indicates that participants found tailored messages more enjoyable and fun to read (10). Therefore, if participants found tailored messaging more interesting and personally relevant and actually read more tailored messages than non-tailored it would seem evident that tailored interventions would yield greater benefits and health behavior changes among participants compared to non-tailored interventions.

Girls on the Move (GOTM) is a 5-year, school-based intervention program targeted to increase MVPA in girls in grades 5-8. Each year girls in the intervention schools participated in a 17-week after-school physical activity program and answered demographic and behavioral survey questions via an iPad at pre-, mid-point, and post-intervention. Specifically at the mid-point of the intervention, girls answered survey questions where web-based tailored messages were delivered to provide individualized, tailored feedback based on survey responses. The tailored messages were based on theoretical constructs from the HPM and SDT. According to the HPM, non-modifiable personal factors, including age, race or ethnicity, and academic grade, and a variety of prior behaviors are associated with MVPA.. However, cognitive and affective mediating variables such as perceived benefits of physical activity (32), perceived barriers to physical activity (13,32,72), social support (32,60,72,95), and self-efficacy (13,31,95) all can be influenced by the personal and prior behaviors but unlike the non-modifiable personal factors, these variables are modifiable (32). Therefore, the GOTM web-based tailored messaging focused on these mediating variables to influence the girls' physical activity behaviors.

Research has shown that tailored intervention programs influence each of the above mediating variables. For example, one previous study found a significant difference in social support between the tailored intervention group and the control group (88). On the other hand, some studies have shown no significant differences between the tailoring and control groups for self-efficacy (7,66,88) and perceived benefits and barriers (7,66,88). Although there is slightly more evidence suggesting that there is not a significant effect of tailored messages on these variables, it is evident that the variables are related to physical activity (25,95) and so researchers should continue to investigate the relationship between tailored interventions and perceived

benefits of physical activity, perceived barriers to physical activity, self-efficacy, and social support.

Due to the complexity of physical activity behavior, several variables could contribute to the success of tailored messaging interventions. For example, research has shown that participation in tailored interventions results in an increased number of participants who meet the physical activity guidelines (115). The finding means that low active individuals who did not meet recommendations prior to the intervention were able to increase their physical activity levels more after the intervention compared to individuals who did not receive the tailored intervention. There is less evidence regarding the effects of tailored interventions on body mass index (BMI). This variable tends to be unchanged from the pre- to post- intervention (7,66), but these interventions simply delivered tailored messages to participants without providing a means to become physically active like the GOTM physical activity intervention program. Similar to BMI, there is limited research on the effects of tailored intervention programs on physical fitness but tailored interventions have helped increase physical activity levels among participants. The low but positive relationship between physical activity and physical fitness is established, which might indicate that tailored intervention programs will elicit similar benefits on physical fitness. However, more research needs to be conducted to examine this relationship. Therefore, it is important to not only continue examining perceived benefits, perceived barriers, self-efficacy, and social support but also the other variables that have not been analyzed as much in previous research, such as BMI and physical fitness.

The overall purpose of the current study was to examine the relationship between perceptions of tailoring and physical activity behavior in the GOTM intervention program. The examination occurred in three ways: 1) through identifying predictors of responses to a survey

asking participants their perceptions regarding the tailored messages; 2) through examining if the perceptions regarding tailored messages were related to physical activity behavior and 3) through determining if perceptions of tailoring mediated the relationship between psychosocial perceptions related to physical activity and post-intervention physical activity. Specific research questions and hypotheses follow.

Research Questions and Hypotheses

Research Question 1: Do psychosocial perceptions related to physical activity influence girls' perceptions of tailored messages at the midpoint of the intervention?

Hypothesis 1: Girls with more positive psychosocial perceptions related to PA will have a higher score on the Perceptions of Tailoring scale at the midpoint of the intervention compared to girls with less positive psychosocial perceptions related to physical activity.

Research Question 2: Are perceptions of tailoring at the midpoint of the intervention related to level of PA measured at post-intervention?

Hypothesis 2: Girls with higher scores on the Perceptions of Tailoring scale at the midpoint of the intervention will have greater PA post-intervention than those with lower perceptions of tailoring scores.

Research Question 3: Do perceptions of the tailored messages mediate the effect of the psychosocial perceptions related to PA on the level of PA measured at post-intervention?

Hypothesis 3: The perceptions of the tailored messages will mediate the effect of psychosocial perceptions related to PA on the level of PA measured at post-intervention.

Study's Significance

This study adds several key aspects to current research including the innovative use of web-based tailored messages delivered via iPads, the combination of including two theoretical frameworks (HPM and SDT) upon which to base the tailored intervention program, and focus on cognitive mediating variables of physical activity such as perceived benefits of physical activity, perceived barriers to physical activity, self-efficacy, and social support. Additionally, because research is limited regarding effects of tailoring interventions in early adolescent girls, this study will provide valuable information regarding the effectiveness of this approach.

Definition of Key Terms

Computer-based Tailored Intervention: A tailored intervention method that delivers tailored messages to participants via online e-mails, online videos, or web-based programs.

HPM: Health Promotion Model. A theoretical framework which posits that each individual has his/her own unique characteristics and experiences that affect future actions. It focuses on three areas including individual characteristics and experiences, behavior-specific cognitions and affect, and behavioral outcomes.

MPA: Moderate Physical Activity. Physical activity measured by an ActiGraph accelerometer using 15-s cutoff values between 574-1002 counts.

MVPA: Moderate-to-Vigorous Physical Activity. Physical activity measured by an ActiGraph accelerometer using 15-s cutoff values $\geq$ 574 counts.

Personalized Communication: A form of health communication intended to strike the attention of individuals by putting the individuals' names on the top of the message.

Print-based Tailored Intervention: A tailored intervention method that delivers tailored messages to participants via letters, pamphlets, booklets, or similar forms of media.

SMS Tailored Intervention: A tailored intervention method that delivers tailored messages to participants via text messages through a mobile network.

SDT: Self Determination Theory. A theoretical framework that explains how humans need to meet three basic needs of autonomy, competence, and relatedness in order to reach higher levels of healthy development and functioning and experience intrinsic motivation for a particular activity.

Tailored Communication: A form of health communication intended to reach one specific individual that is based on personal characteristics of the individual derived from an individual assessment.

Targeted Communication: A form of health communication intended to reach a subgroup of individuals from the general population based on similar and shared demographic characteristics.

VPA: Vigorous Physical Activity. Physical activity measured by an ActiGraph accelerometer using 15-s cutoff values of ≥ 1003 counts.

Delimitations:

This study includes the first two years of the 5-year GOTM intervention and includes only participants who completed pre- and post- intervention as well as the 9-month follow-up measurements and those who fully answered the mid-point tailored survey. This study also only included urban girls

Limitations:

Inability to separate the effects of the tailoring portion of the intervention from other components due to overlapping variables and combinations of messages.

Assumptions: It is assumed that the girls voluntarily participated in data collection days. It is also assumed that girls understood survey questions unless they specifically asked for clarification from the data collection staff.

CHAPTER 2: LITERATURE REVIEW

Introductory Comments

Participating in physical activity on a regular basis is advantageous, as it is an important lifestyle behavior to help lower the risk of developing cardiovascular disease risk factors (71) and decrease the risk of mortality (6). Regular participation in physical activity can also help lower the prevalence of obesity (6). Even though overweight and obesity rates have started to level off, the prevalence of obesity among today's youth remains high (75). Although the benefits of physical activity have been established, many of today's youth are inactive and do not meet physical activity guidelines (31,106) of engaging in at least 60 minutes of mostly moderate-to-vigorous physical activity (MVPA) (83). According to the *Youth Risk Behavior Surveillance* survey (17), only 27.1% of high school students engaged in at least 60 minutes of any form of physical activity every day of the week, and 15.2% of students did not engage in any form of physical activity on at least one day of the week. Physical activity starts to decline significantly during adolescence, especially for adolescent girls (106,120). Due to the high prevalence of overweight and obesity and the low physical activity levels in today's youth, and the associated benefits of regular engagement in physical activity to improve individuals' lifestyle, it is important to examine possible ways to increase physical activity levels in today's youth.

One way to increase physical activity levels is through a physical activity intervention program where researchers or practitioners provide an avenue for participants to engage in physical activity with the goal of increasing adherence to the behavior following the intervention. Physical activity interventions have been utilized in a variety of settings. A community-based setting (19,20,37-39,42,46,49,51,56,66-70,99-101,111-113,128) is one of the most common settings but other settings such as schools (33,34,36,88,90,91,120), worksites (7,15,21,126,127)

and clinical settings (14,20,77-79,114,116,124) have been popular in the research as well. A tailored intervention program is a type of physical activity intervention that has been growing in popularity.

This chapter explores several research studies on tailored interventions, specifically examining the overall effectiveness of tailored messaging on influencing various outcome variables such as physical activity, perceived benefits of physical activity, perceived barriers to physical activity, social support, and self-efficacy. Tailored messaging is an attractive method utilized to influence individuals' behaviors and promote positive changes in one's lifestyle.

What is Tailoring?

Tailored intervention programs utilize tailored communication where the learning experience for each individual is specifically tailored to him/her (2). This method is a powerful way of delivering physical activity interventions that meet the specific needs of each individual based on the individual's demographic and behavioral characteristics (2). There are different levels of tailored messaging including personalizing, targeted communication and tailoring. Personalizing is when the message uses the name of the participant to strike his/her attention. Targeted communication is when the message is geared toward a specific group or subgroup, and tailoring is based on personal characteristics of the desired outcome of interest, which is the highest level of message tailoring (2). Kreuter et al (1999) displayed the varying levels of communication relative to the amount of individualized content and individual-based assessment in the different types of communication (Figure 1) (52). The authors explained that as the level of assessment increases to more a more individualized form so does the amount of individualized content that is possible to communicate (52). Therefore, tailored communication contains very

individualized content that is delivered to participants, and it seems evident that tailored

interventions could be more effective compared to non-tailored interventions or interventions

that use generic communication.

Figure 1: Classification of five approaches to health communication by level of assessment and nature of content (Kreuter et al., 1999).
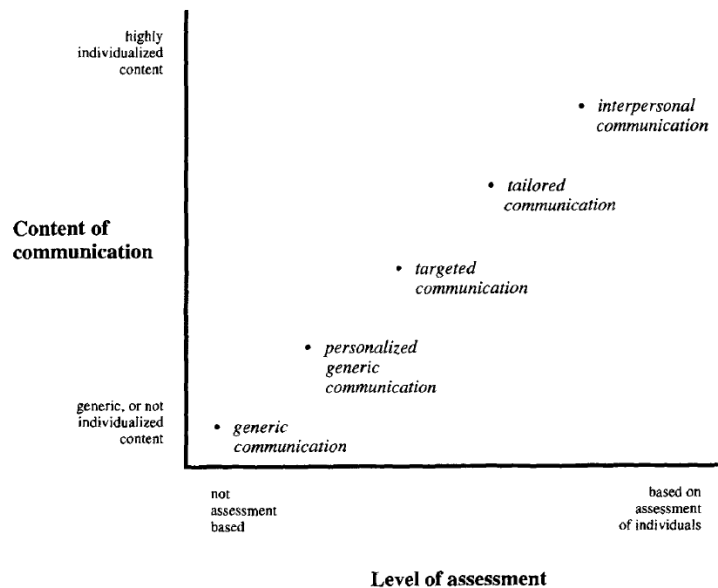
Types of Tailored Interventions and Theoretical Frameworks

As previously explained, there are several different types of tailored intervention

programs including print-based 11,12,15,24,66-70,77,100,109-113,118,123), computer-based

(21,33,34,114,116,117), internet-based (58,67,68,70,88,91,101,126,127), short message service

(SMS) (5,19,41,99), online videos (117,118), and email messages (126-128). These programs

vary in their delivery mechanism but are similar in their purpose of distributing content that is

tailored to each participant in hopes of increasing the relevance of the information in order to

promote a change in the particular health outcome. The majority of tailored intervention

programs incorporate theoretical frameworks that build the foundation of tailored messages (16) such as the Transtheoretical Model of Change (TTM), Self-Determination Theory (SDT), Health Promotion Model (HPM), and self-efficacy. These theoretical frameworks were used to determine the main outcome variables in studies as well as help guide measurement procedures. A meta-analysis found that studies in which researchers utilized at least one theoretical framework had larger effect sizes compared to studies where researchers did not utilize any theoretical frameworks (73). In addition, this same meta-analysis found significant difference among studies where researchers tailored based on 4-5 theoretical framework(s) compared to studies where researchers tailored based on only 0-3 theoretical frameworks (73). Therefore, it seems evident to utilize theoretical frameworks in tailored intervention programs in order to elicit the greatest benefits.

Theoretical Frameworks and Psychosocial and Behavioral Variables

Generally, the theoretical constructs that studies utilized as the basis for tailored interventions determined the different outcome variables in the studies. Variables examined in tailored intervention studies related to physical activity were self-efficacy (7,42,65,67,68,88,90, 91,123), social support (88,90,91), perceived barriers to PA (7,11,51,56,88,90,91), benefits of PA (7,11,51,56,88,90,91) and PA enjoyment (88,90,91). Research has suggested that interventions that aim to increase physical activity should address these psychological and behavioral constructs (7). Self-efficacy is associated with a variety of theoretical constructs (122) and is the main component of the SCT (42), and research has shown positive correlations between physical activity and self-efficacy (42,66). Perceived benefits of PA and perceived barriers to PA are associated with the Decisional Balance Model and HPM, and social support

and PA enjoyment are associated with HPM. The Decisional Balance Model involves the idea that individuals are more likely to engage in physical activity when they perceive the benefits of engaging in physical activity outweigh its costs (65). The HPM has seven underlying assumptions and 14 theoretical statements or propositions, and it categorizes several factors that influence various health behaviors. Some of these modifying factors include behavioral and situational factors, interpersonal influences, and biological and demographic characteristics (81).

Another theoretical construct commonly used in tailored communication is the TTM. The TTM implements other behavior change models' concepts and processes, and combines them together to suggest that behavior change happens in stages (37). The model is utilized to help determine individuals' relative readiness to change and provide stage-matched feedback to the individuals (16). Individuals move through five stages as they adopt new behaviors moving through precontemplation, contemplation, preparation, action, and maintenance (65). Precontemplation means that individuals do not intend to make changes; contemplation means that individuals are considering to make changes; preparation means that individuals are prepared to make small changes; action means that individuals are engaged in the new behavior; and maintenance means that individuals sustain the behavior change over time (65). Generally, messages are targeted for each group at a certain stage, meaning the messages are written for a group in each stage rather than for each individual in the group at that particular stage.

Tailored Interventions and General Health Behaviors

Tailored interventions have been successful at changing a variety of health behaviors including increasing smoking cessation (102-104,119), increasing fruit and vegetable intake (8,15,55), decreasing alcohol consumption (18,98,107), increasing weight loss (108), increasing

safe-sex practices (130), increasing safe-work practices (61), and decreasing incidence of diabetes (80).   In an internet-based multicomponent intervention looking at the effects of tailored messages versus non-tailored content on smoking cessation, the authors found that the 7-day abstinence rate for the tailored group and the control group at one month was 15.2 and 9.0% and at three months was 13.5 and 9.0%, respectively (119). Similarly, in another smoking cessation study, participants who received multiple tailored materials had higher abstinence rates compared to participants who received a single set of tailored materials or non-tailored materials (103). In a web-based tailored intervention smoking cessation study, Strecher et al (2005) found that the tailored message group had higher continuous abstinence rates compared to the non-tailored group at both 6-week (29% versus 23.9%) and 12-week (22.8% versus 18.1%) follow-ups (104). Many smoking cessation tailored intervention studies conducted found the intervention to be successful at changing the health behavior.

In addition to smoking cessation, other studies found that tailored interventions were effective at influencing someone's diet such as reducing fat intake and increasing fruit and vegetable intake (8,15,55). For example, Brug et al (1998) found that the multiple-tailored group and the single tailored group had significantly reduced fat intake and significantly increased vegetable intake compared to the control (non-tailored) group from pre- to post-intervention (~8 weeks) (8). Participants in the multiple-tailored group reduced their average fat points by 2.7 points per day and increased their servings of vegetables from 1.06 servings at baseline to 1.20 servings per day at the second post-test (~8 weeks)(8). However, the participants in the control group only reduced their average fat intake by 0.7 points and increased their vegetable intake from 1.02 servings per day to 1.08 servings per day (8). Similarly, Kypri & McAnally (2005) compared participants who received web-based tailored assessment and tailored feedback,

participants who only received a tailored assessment, and participants who did not receive

anything (control group) on the effects of fruit and vegetable intake, PA, and alcohol

consumption (55). Specifically regarding fruit and vegetable intake, the results indicated that

participants who received the tailored assessment and feedback had significantly higher

compliance to the fruit and vegetable consumption guidelines compared to the control group

(55). Therefore, both of these studies show that tailored interventions were effective at

influencing individuals' behavior regarding their diet.

Other effects of tailored interventions on various health behaviors include increase the

use of hearing protection among factory workers (61) and reducing alcohol consumption

(18,98,107). Lusk et al (2003) conducted a tailored intervention in a factory workplace to

examine if the intervention influenced factory workers behavior to wear hearing protection

devices (61). The authors compared a tailored group to two other groups (a non-tailored group a

control group) and found that only the tailored group significantly increased their use of hearing

protection devices from pre- to post- intervention (between 6 and 18 months) (61). Therefore,

due to the overall effectiveness and success of various tailored interventions on multiple health

behaviors, it is reasonable to assume that tailored interventions would have a similar impact on

influencing individuals' physical activity behaviors. Physical activity varies tremendously from

person to person and across different demographic groups, so it is important to continue to

investigate other possible influences that might impact physical activity such as tailored

interventions. The effects of various tailored interventions on physical activity behaviors are

examined and analyzed in the following paragraphs.

Print-Based Interventions and Total Minutes of Physical Activity

The effectiveness of tailored intervention programs examining physical activity, self-efficacy, social support, and other health measures such as benefits of physical activity, barriers to becoming physically active, and stage of change improvement using the TTM has been inconsistent throughout recent history. The results were dependent on the type of tailored intervention program, the characteristics of participants, procedures conducted, outcome measures, and the theoretical construct(s) used. Print-based tailored interventions have shown positive trends in influencing total minutes of physical activity. De Vries et al (2008) showed that the tailored print group who received three tailored letters throughout the course of the intervention had significantly more improvements in physical activity after nine months (24). Another study showed a significant difference in total minutes of physical activity per week at a 2-month follow-up between the tailored and control groups. The tailored group increased total minutes of physical activity per week by 78 minutes but the control group had an increase of only 12 minutes (69). Similarly, Marcus et al (1998) found significant differences between the intervention group (tailored report manuals) and the standard group (non-tailored report manuals) where the intervention group increased total minutes of physical activity by 145.9 minutes per week and the standard group increased physical activity by only 77.6 minutes (66). These studies demonstrate the effectiveness that print-based tailored intervention programs can have at influencing physical activity behaviors.

However, there were studies that did not report a significant difference between a tailored print group and a standard or control group in examining total minutes of physical activity. Bull et al (1999) did not find any significant differences between the tailored print group and the standard group at influencing physical activity, but the tailored group participants reported doing

more physical activity at each follow-up compared to the standard group (12). A similar study did not find any significant differences between the tailored and personalized group (TAP) and both general groups-general and personalized (GAP) and general and not personalized (GNP). All three groups showed an increase in the total number of physical activity sessions or number of days of participating in at least 30 minutes of physical activity (11). Even though all of the above studies utilized a print-based tailored intervention program, there were varying results in the overall effectiveness of these types of interventions when the outcome was total minutes of physical activity.

Components of a Computer-Based Tailored Intervention

Brug et al (2003) stated "the process of computer tailoring attempts to mimic the process of personal counseling: people are surveyed or interviewed, and the results are used to develop individualized feedback and advice," and explained that "the tailoring expert system analyzes these data (results) and links them with a feedback and advice source (message library or archive) that contains appropriate feedback and advice for each survey response" (10). Therefore, there are four key components to a computer-based intervention: 1) appropriate theoretical constructs used to assess participants' characteristics; 2) a screening instrument such as a questionnaire to obtain personal and behavioral characteristics of participants, and a data source file to store the information; 3) a message library that contains all the possible tailored messages created from coded algorithms (tailored computer program) that match each person's characteristics; and 4) a mode of delivery to provide the tailored messages to the participants (9).

Web-Based Interventions and Total Minutes of Physical Activity

Computer-based tailored interventions conducted via an on-screen computer program or an online website had mixed results regarding total minutes of physical activity, which was similar to the print-based interventions. Haerens et al (2009) showed a 38-minute mean increase of MVPA per week from baseline to the 1-month follow-up in the intervention group compared to a 24-minute mean increase of MVPA per week in the control group (36). Similarly, Spittaels et al (2007) found that both intervention groups increased physical activity levels from baseline to a 6-month follow-up compared to the control group (101). Participants in the first intervention group increased total minutes of MVPA per week by 77 minutes, the second group increased by 37 minutes, and the control group increased by 25 minutes (101). Other measures of physical activity such as transportation PA and leisure-time PA resulted in a significant difference between both intervention groups and the control group (101). These results indicate that on-screen computer-based intervention programs are an effective way to deliver tailored messages to participants in order to increase the total amount of physical activity participants engage in on a weekly basis.

There were studies that did not find any significant differences between a computer-based tailored intervention group compared to a control group. For example, Haerens et al (2007) found that the intervention group had a mean increase from pre-to post- intervention of 5.3 minutes of physical activity per day and the control group had a pre- to post- intervention mean increase of 6.3 minutes of physical activity (34). Similarly, Robbins et al (2006) did not find any significant differences between a tailored group and a control group in total minutes of moderate physical activity (MPA) and total minutes of MVPA for four days (88). The intervention group had a mean increase from week 1 to week 12 of 73.05 and 112.62 minutes of MPA and MVPA,

respectively, for four days, respectively, and the control group had a mean increase of 57.88 and 74.35 minutes of MPA and MVPA for four days from week 1 to week 12 (88). Even though Robbins et al (2006) did not find significant differences between the two groups, these findings show that this type of intervention can be an effective method to influence the physical activity behaviors of individuals.

E-Mail-Based Interventions and Total Minutes of Physical Activity

In addition to an on-screen computer program or an online website, another method of a computer-based tailored intervention is tailored e-mail messages. Two studies utilized this technique (126,127), but only one of these studies examined the effects on total minutes of physical activity (127). Results of this study showed that mean number of steps per day (measure of total physical activity) in the tailored group was significantly higher than the mean number of steps per day in the control group with a 300 mean steps per day difference between the two groups (127). More studies that use tailored e-mail messages are needed in order to determine if there is an effect on total minutes of physical activity because only the Yapp et al. (126,127) studies examined this relationship.

Print-Based versus Web-Based Interventions and Total Minutes of Physical Activity

Besides comparing a tailored intervention group to a non-tailored group (control), a few studies compared different types of tailored intervention techniques (67,68,70). Two studies compared a print-based to a web-based tailored intervention (68,70), and the other compared a tailored print group and a tailored internet group to a standard internet group (67). Marks et al (2006) and Marshall et al (2003) found similar results comparing a print-based tailored group

and a web-based tailored group (68,70). The former study found that both groups increased total

physical activity but only the print-based group had significant within group differences (68),

and the latter study found that both groups showed positive trends in total PA but only the print-

based group showed a trend for significance (70). The other study that compared three different

types of tailored interventions did not find any significant differences among the three groups at

a 6-month follow-up as well as at a 12-month follow-up (67). The median total minutes of

physical activity per week at six months and 12 months for the three groups (tailored print,

tailored internet, standard internet) were 112.5, 120.0, and 90.0 minutes per week at 6-month

follow-up and 90.0, 90.0, and 80.0 minutes per week at 12-month follow-up, respectively (67).

All three of these studies indicated that a print-based tailored intervention could yield greater

benefits for increasing total minutes of physical activity per week but the evidence was

inconclusive; therefore, more studies need to be conducted to compare various types of tailored

interventions such as web-based interventions.

Print-Based Interventions and Physical Activity Guidelines

Similar to looking at the effects of tailored interventions on total minutes of physical

activity, studies utilized tailored interventions to examine the effects of participants reaching

physical activity guidelines. According to the United States Department of Health and Human

Services, the physical activity guidelines recommend that adults engage in at least 150 minutes

per week of moderate physical activity, and that youth engage in at least 60 minutes of MVPA

on a daily basis (83). Print-based interventions had a significant effect at influencing participants

reaching the physical activity guidelines by the end of the intervention. For example, in a study

comparing a tailored letter to a general letter, the participants who received the tailored letter

were more likely to meet the guidelines than the individuals who received the general letter (24).

In Marshall et al (2003), researchers mailed a tailored letter and booklet to the intervention group and a general letter and booklet to the control group (69). Results of this study showed that at 2-months following the intervention there was a significantly greater number of participants classified as active (reaching physical activity guidelines) in the intervention group compared to participants in the control group with 45% and 33% of participants, respectively (69). Similarly, van Keulen et al (2010) found that 27% of participants in the tailored print communication group met the physical activity guidelines at the 6-month follow-up, compared to 23% in control group (110). Researchers from another study found a significantly greater number of subjects who attained physical activity guidelines in the intervention group compared to the control group by the end of the treatment (43.6%) and at a 3-month follow-up (18.1%) (68). Similarly, van Stralen et al (2010) showed that intervention participants were 1.6 times and 2.5 times more likely to comply with physical activity guidelines than control participants at the 3-month and 6-month follow-up, respectively (113). All of these studies utilized a print-based tailored intervention and examined the effects on physical activity guidelines and found consistent results, which shows the effectiveness that these types of interventions can have on influencing the activity behavior of individuals.

Computer-Based Interventions and Physical Activity Guidelines

Unlike print-based interventions, computer-based tailored interventions showed mixed results regarding the number of participants reaching physical activity guidelines. Researchers found a significant increase in the total number of participants who met physical activity guidelines at a 6-month follow-up in the first intervention group (tailored message + feedback)

compared to the second intervention group (tailored message only) and a control group where the first group had a 10% increase in the number of participants who met PA guidelines compared to only a 5% increase in the second group and a 4% increase in the control group (101). However, this same study showed that all three groups were effective in helping participants who were insufficiently active at baseline meet guidelines at the 6-month follow-up (101). For example, 23% and 25% of participants in the first and second intervention groups, respectively, and 20% of participants in the control group were insufficiently active at baseline but met the PA guidelines at the 6-month follow-up (101). In another study, there was a 14% increase in the number of participants who met PA recommendations in both intervention groups compared to a 7.4% increase in the control group (114). Researchers from another study found that for participants who did not meet PA recommendations, the generic intervention was more effective than the tailored intervention, with a 46-minute mean increase in physical activity minutes per week in the generic intervention compared to a 17-minute increase in the tailored intervention. The effectiveness of computer-based intervention programs on increasing the number of participants who meet the physical activity measurements is unclear but the results generally show a positive relationship, and so more research is needed to investigate this relationship further.

Print-Based versus Computer-Based Interventions and Physical Activity Guidelines

In addition, the studies that compared a print-based intervention to a web-based intervention found similar results where there was not a significant difference meeting physical activity guidelines between the two groups. Both the print-based and web-based groups showed a significant increase in the number of participants who were inactive at baseline but met PA

guidelines at follow-up (68). Researchers in Marshall et al (2003) found that 11% of the print-based and 10% of the web-based groups became sufficiently active between baseline measurements and 10-week measurements (70). Marcus et al (2007) compared a tailored print group and tailored internet group to a standard internet group and found 37.2%, 44.4%, and 36.6% of participants, respectively, met PA guidelines at the 6-month follow-up and 32.6%, 39.5%, and 30.5% of participants, respectively, met PA guidelines at the 12-month follow-up (67). These results were not statistically significant, but the trends showed that both tailored groups were successful at helping participants meet PA guidelines. However, there needs to be more research conducted on the effects that computer-based tailored interventions have on increasing the number of individuals who meet PA guidelines.

Print-Based Interventions and Stages of Change from the TTM

Another main outcome variable that tailored intervention studies examined was the stage of change using the TTM, and print-based intervention studies showed inconsistent results. The majority of studies did not find any significant differences between print-tailored groups and control groups. For example, Marshall et al (2003) did not find any significant differences between the intervention and control groups regarding stage progression of moving from stage-to-stage in the TTM (69). Similarly, Bull et al (1999) found that 31% and 44% of the standard and tailored groups, respectively, progressed one or more stages from baseline to one month but 41% and 40% of the standard and tailored groups, respectively, progressed one or more stages from baseline to six months post intervention (12). These results explain that the intervention was not significantly more effective at progressing participants through stages of change throughout the intervention and into follow-ups.

However, one study found significant differences between groups at the 3-month and 6-month follow-up where significantly more intervention participants achieved the 'Action' stage compared to control participants at three months (31.2% v 16.7%) and six months (42.3% v 18.8%) (66). Furthermore, 43.1% of baseline precontemplators and contemplators in the intervention group reached the 'Action' stage by the end of the treatment compared to only 20% of precontemplators and contemplators in the control group (66). In addition, 43.1% of baseline intervention precontemplators and contemplators reached physical activity guidelines by the end of the treatment compared to 19.3% of control precontemplators and contemplators (66). This study demonstrated the success that a print-based tailored intervention had in progressing participants who were not even considering or were only considering being active to actually becoming active, which is beneficial for individuals who want to start living a healthier lifestyle.

Computer-Based Interventions and Stages of Change from the TTM

Similar to print-based interventions, computer-based tailored interventions did not find many significant differences between intervention groups and control groups but computer-based interventions were successful in progressing individuals through stages of change in the TTM. Lau et al (2012) showed that the intervention group had a higher percentage of stage progression compared to the control group with a 39.5% stage progression versus a 22.5% stage progression, respectively, but these differences were not significant (58). This study found that 18.4% and 11.1% advanced to the preparation stage or beyond, 50% versus 60% of participants stayed in the same stage, and 10.5% versus 17.5% of participants regressed to earlier stages in the intervention and control groups respectively but these results were not statistically significant between the two groups (58). One of the e-mail tailored intervention studies found that

significantly more tailored group participants progressed to a higher stage compared to a control

group with 38% and 27% of participants progressing stages, respectively (127). The other email-

tailored intervention examined forward movement for participants in an intervention group and a

control group and did not find any significant differences between the two groups regarding

forward movement or progressing to a higher stage (126). However, this study examined

forward movement specifically for participants who were contemplators and found that there was

a significant difference between the intervention and control groups with 53.3% of the

intervention contemplators and only 19.2% of control contemplators progressing to a higher

stage (126). One of the two comparison studies examining the effectiveness of a print-based

intervention and a web-based intervention found that there were 53% of participants in both

intervention groups in the pre-contemplation, contemplation, and preparation stages at baseline

but at the 10-week follow-up 9% of web-based participants had moved into the action or

maintenance stages whereas the percentage of print-based participants remained unchanged.

Therefore, computer-based tailored interventions are effective at helping individuals progress to

higher stages of change and become more physically active.

Tailored Interventions and Psychosocial Variables

Several tailored intervention studies examined psychosocial variables of self-efficacy,

perceived benefits of physical activity, perceived barriers to physical activity, social support, and

PA enjoyment (7,42,51,66,68,88,123) The majority of the studies examining these psychosocial

variables utilized the previously described theoretical constructs. The majority of studies

examining self-efficacy found a positive relationship with physical activity, and found similar

results regarding whether a tailored intervention was more effective than other methods such as

non-tailored intervention (7,42,65,66,68,88,123) or motivational interviewing (90). Robbins et al (2006) found a significant relationship between physical activity and self-efficacy but did not find any significant differences between the computer-based tailored intervention group and the control group (88). Similarly, Marcus et al (1998) found that both the intervention and standard control group significantly increased self-efficacy for physical activity between baseline measures and six months post baseline but these results were not statistically significant between the two groups (66). Another study found a significant relationship between physical activity and self-efficacy but no significant interactions between the tailored intervention group and the control group (7). For example, Bock et al (2001) found a significant difference in self-efficacy between participants who did and did not meet the minimum criteria for PA at the 12-month follow-up with a 2.9 mean self-efficacy score compared to a 2.2 mean self-efficacy score in the intervention and control groups, respectively (7). The results from these studies indicate that self-efficacy is a mediating variable to individuals' physical activity but a tailored intervention group does not influence self-efficacy more than a control group.

Similar trends were found for the other psychosocial variables and the effectiveness of tailored interventions. One study found that participants in both the tailored intervention and control groups significantly increased perceived benefits of physical activity over a six month period but perceived barriers to physical activity remained unchanged during that time (66). Bock et al (2001) did not find any significant differences between the intervention group and the control group regarding perceived benefits and barriers of physical activity (7). However, one study showed a significant interaction between social support and group indicating that the intervention group had significantly greater social support from baseline to post-intervention where there was an increase in social support for intervention group participants and an actual

decrease in social support for control group participants (88). Even though the majority of these studies did not see any interactions between the groups and the psychosocial variables, there are indications that these variables are related to physical activity and should be examined further in tailored intervention research in order to determine the effectiveness that tailored messaging has on improving these variables and ultimately increasing physical activity among participants.

Process Evaluation of Tailored Interventions

One way to determine the effectiveness of the tailored interventions is through process evaluation via questionnaires. According to Abrams et al (1999) questionnaires should evaluate the fidelity and integrity of the intervention program, ask questions regarding the amount of knowledge and information the individuals gained, and note how much of the material was read and recalled, along with the individual's personal opinions and satisfaction of the program (1). Process evaluation questions can be implemented straight into the internet program, computer-based questionnaire, or a print-based questionnaire. Another way to utilize process evaluation questions is to send out a follow-up questionnaire or direct participants to log back into the website/internet program and answer a follow-up questionnaire after the intervention program was completed. However, this method delays the response of the immediate feedback from participants and the possibility of not getting responses sent back increases with this method. The majority of the studies that used the latter method found similar results regarding information recall and participant readership where most individuals in tailored intervention groups recalled receiving the information as well reported reading the information. In these studies, researchers generally sent out the tailored intervention either via the web/website (68,70) or via print-based materials (11,12,15,24,69,70,77,112). For example, two-thirds of intervention

participants in a print-based study recalled receiving the tailored material and 72% reported reading 'all' or 'most' of the tailored material (11). De Vries et al (2006) found the intervention group read more of the information in the tailored letter compared to the generic letter read by control participants with a mean score of 3.89 and 3.65, respectively (24). Researchers in another study found that 98% of participants in the tailored group read the tailored letters (112). These results indicate that participants were more likely to read and remember the tailored messages delivered to them, regardless of delivery mechanism, compared to control groups, which means that tailored messages potentially will yield greater benefits and results for the participants compared to generic messages.

Besides information regarding whether or not participants recalled receiving the tailored messages/material, studies examined factors such as personal relevance, amount of interest, and preferred method of receiving information (12,15,24,68,69,77,79,121). One study found that 93% of intervention group participants found the tailored material interesting to read (12) and another study reported that intervention group had higher recall and readership of the tailored materials and greater personal relevance (15). De Vries et al (2008) compared a print-based tailored letter to a print-based generic letter and found that final tailored letter received at the end of the intervention was rated as more interesting, personally relevant, and personalized compared with the final generic letter (24). This study found a personal relevance mean score of .60 and .04, an individualizing mean score of .56 and .19, and an interesting mean score of .74 and .32 in the tailored and generic groups respectively (24). These results show that tailored messages and materials are more interesting and personally relevant to the participants compared to non-tailored information, which helps participants adhere to the intervention and believe in the information or advice that is provided to them.

Specifically regarding the preferred mode of delivery, studies found mixed results. One study found that 53% of a print-based and 59% of a web-based tailored intervention group would prefer to receive tailored health information via website or via an e-mail, indicating that even participants in the print-based group would prefer to receive information via a computer-based method of tailored interventions (70). Similarly, another study found that participants rated the computer-based tailored program as the most helpful regarding behavioral changes and mailed material the least helpful regarding behavioral changes. However, in contrast, Patrick et al (2008) found that 43% of participants would prefer to receive information via a print-based method such as information being mailed to a home or office whereas only 33% preferred to receive information via a web-site or via an e-mail (79). This study was a print-based study, which could help explain the higher preference towards a print-based method compared to a computer-based method.

Other studies directly implemented the process evaluation questions into the computer-based questionnaire (34,88,91). These studies generally delivered tailored messages immediately on the screen as the participant took a questionnaire (34,88,91) rather than waiting to send the tailored feedback afterwards such as a web-site, email, or in print. For example, Robbins et al (2013) integrated process evaluation questions into the internet computer program delivered via iPads where the girls answered questions regarding the items in the survey to questions and the design of the computer program using a 4-pt Likert Scale from 'disagree a lot' to 'agree a lot' (91). Researchers from a similar study found that 95% of the girls would use the program again and would also recommend the program to a friend (88). In addition, Haerens et al 2007 included five items to evaluate the computer-based tailored intervention program as a diagnostic tool, nine items to evaluate the physical activity advice, and four items to evaluate the

mode of delivery (computer) for receiving physical activity advice (34). Participants answered

questions on a 5-pt Likert Scale from 'totally disagree' to 'totally agree' and discovered that 64%

of participants found the questions were easy to understand and 63.4% found the answering

options to be clear. Also, 55.5% of participants found the physical activity advice was easy to

understand, 50.3% found the advice interesting, and 39% of the participants found the advice

personally relevant. Specifically regarding the program, 73.9% indicated that the program was

easy to use, 89.5% found the colors and design of the program appropriate, and 91.1% preferred

using a computer-based questionnaire compared to a print-based or written questionnaire (34).

These results help exemplify the participants' perceptions of the tailored messages, which helps

explain the overall effectiveness tailored messages has at influencing individuals' behaviors.

Perceptions of Tailoring

As previously explained above, tailored messages are more likely to be read and

remembered (10,15) viewed more positively, more relevant, relatable, and interesting to read

(12,15,24). However, few studies examined how these aspects impact the effectiveness of a

tailored intervention, specifically perceived message relevance. A few studies looked at the

possible effect that perceived message relevance, the degree to which individuals view some

form of communication or communicative stimuli as applicable or being related to a person

and/or situation (45), has on tailored communication or what role it plays in tailored

interventions (45,50,105). Strecher et al (2006) examined possible moderating and mediating

factors of the effectiveness of a web-based smoking cessation tailored intervention (105).

Perceived message relevance was found to mediate the relationship between tailoring and

smoking cessation, and the authors concluded that perceived message relevance may be a

possible explanatory mechanism for effective program tailoring (105). Similarly, Ko et al (2010) looked at possible mechanisms that might help explain the effectiveness of tailored communication, specifically in a fruit and vegetable consumption intervention (50). Results indicated that information processes (perceived message relevance) mediated the effect of tailoring on fruit and vegetable consumption (50). Even though perceived message relevance or perceptions of tailoring might be a possible underlying mechanism of effective tailoring and is a suggested factor to investigate in determining the overall effectiveness of tailored communication, it is important to continue analyzing the effects of perceived message relevance in tailored interventions in order to determine how perceptions of tailoring influence other variables or factors.

Limitations in Tailored Intervention Research

The majority of these tailored intervention studies regarding physical activity and psychosocial variables related to physical activity behaviors examined the effects of the intervention on adults (7,24,67,69,70,100,101,109-111,114,116,117,123) rather than on children and adolescents (33,34,36,44,58,68,77,88,90,91,99,124). Additionally, the majority of the adult intervention programs were conducted in clinical (14,20,77-79,114,116,124), community-based (19,20,37-39,42,46,49,51,56,66-70,99-101,111-113,128), or worksite settings (7,15,21,126,127) whereas the interventions examining youth were conducted in a school setting (33,34,36,88, 90,91,120). Regular intervention programs to help increase physical activity in both adults and youth might result in similar effects but tailored interventions are different. Tailored interventions need to ensure that the study's population is treated differently based on individual characteristics rather than on an entire group of individuals (tailored versus targeted

communication). For example, to help increase middle school girls' physical activity, they should not be treated as a homogeneous group because each girl has a unique response to an experience or situation (90).

Future Research

Implications for future research involve examining effects on youth and adolescents, implementing interventions in school-based settings, utilizing handheld devices to deliver the questionnaires and provide feedback immediately, and integrating tailored feedback messages right into the questionnaire to not only give immediate feedback to the participant but also get immediate feedback in return (process evaluation). Other implications for future research include analyzing the effectiveness of tailored interventions on an individual level; in other words, future research should determine how effective the tailored message is for influencing an individual's behavioral change rather analyzing a groups' behavioral change. Similarly, effectiveness of the tailored messages at giving relevant and helpful advice based on the individual's answers and personal characteristics should be examined.

Filling the Holes- Significance of the GOTM Intervention

The Girls on the Move intervention program included several significant contributions that have not been done before. The program focused on increasing physical activity in 5th-8th grade girls through several mechanisms, which were an after-school physical activity club, motivational interviewing, and tailored messages delivered via iPads. The tailored messages were coded and specifically written for each individual participant so that each girl received messages that would be most relevant and meaningful to her. In addition, the study integrated a

combination of the HPM and SDT as well as self-efficacy theoretical constructs to build the foundation of the tailored messages. This type of tailored intervention program is unique and adds several pieces to the literature that can be implemented in the future to promote healthy behaviors in adolescent females.

CHAPTER 3: METHODS

Recruitment and Participants

Members of the research team received approval from the Michigan State University Biomedical Institutional Review Board to conduct the intervention study, and respective school officials and administrators provided approval to conduct the study in their school districts. The participants were recruited through school assemblies focusing on girls in 5th-8th grades, where the purpose and general procedures of the study were explained. The research team members invited the girls to participate in the study and informed the girls of the different opportunities to receive incentives for study participation. A two-minute recruitment video was played to attract the girls' attention and help with recruitment by providing several reasons to participate in the study while demonstrating a variety of girls having fun in different phases of the study.

Inclusion criteria for the study included: Girls in 5th – 8th grades (ages 10-15); willing and available to attend the PA club 3 days/week for 17 weeks; available for post- and follow-up data collection (9 months post intervention); agreement to study's procedures; and able to read, speak, and understand English (91). Exclusion criteria for the study included: current involvement or planned involvement in school/community organized PA groups or sports that required after-school participation for more than 3 days/week and involved MVPA; and a current health condition(s) preventing safe participation in the PA club and engaging in MVPA (91).

Study Design

The Girls on the Move (GOTM) is an ongoing, group-randomized design of 24 urban, racially diverse schools in the mid-Michigan region of the United States. The 5-year study (2011-2016) involves the randomization of eight schools/year, four of which receive the PA intervention (called Girls Only Activity for Life, GOAL), which includes a PA club,

motivational interviewing with a nurse, and individualized tailoring, and four of which serve as

the control condition during years 2, 3, and 4 of the study. Schools in an urban community with

at least a 50% minority student body as well as a relatively equal percentage of the student body

enrolled in the free and reduced lunch program were included. Schools also needed to have at

least 100 girls enrolled in each of the eligible grade levels (91). Schools were excluded from the

study if the administrators did not have any interest in the study, did not agree to the school's

random assignment, or did not want to commit to the 9-month follow-up (91).

Each data collection staff member was trained using standardized protocols. After

successful demonstration of specific procedures, staff members were certified to conduct data

collection. The project's measurement coordinator supervised and oversaw all training and

certification sessions to ensure reliability of the measurement protocol. Data collection sessions

at the schools included pre-intervention, mid-intervention (specifically for tailoring), post-

intervention (immediately after 17 weeks), and 9-month post-intervention follow-up. The girls

received different incentives for completing data collection such as a Girls on the Move t-shirt or

backpack for survey completion, $20.00 gift-card for proper wear of accelerometer, and for those

who needed to re-wear accelerometer due to non-compliance, an opportunity to receive a $10.00

gift card (instead of the $20.00 card) if they correctly followed wearing instructions for a second

week.

Intervention

Theoretical Bases
The Girls on the Move intervention study integrated both the HPM and SDT theoretical

constructs. Both of these constructs were the foundation of the study's design, procedures,

outcome and covariate variables, and tailored messages. Specific descriptions of these theoretical constructs were described previously.

Components

Girls within schools were randomly assigned to control or intervention conditions (i.e., school was the unit of randomization). The intervention group received two face-to-face individually, tailored motivational interviews/counseling sessions, an internet-based interactive session including individually tailored messages via iPad, and an after-school PA Club. The girls participated in two face-to-face motivational interviews administered by a school nurse that took about 20 minutes to complete. The school nurse utilized a one-page printout that contained each girl's specific responses from the baseline survey (initial session) and from the baseline and mid-point surveys (final session). These handouts helped the nurse guide the conversation and tailor the topics based on the individual response from the girls. The PA club was 90 minutes long and took place immediately following school hours. The club provided organized and fun activities to help the girls see the benefits of physical activity, improve their physical activity skills, and receive support from their peers and from the club instructors. The PA club was set up to provide healthy snacks before and after club, allow time to warm-up for the activities, provide a 60-minute window of opportunity to engage in MVPA, and allow time to cool down after the activities. The instructors encouraged physical activity behaviors outside of the club and promoted improvement in physical activity skills. The girls participated in the PA club on 3 days of the week for 17 weeks.

Slightly past the mid-point of the intervention (~11 weeks), girls completed an abbreviated survey (tailored intervention survey) similar to the survey completed at pre-intervention/baseline. At the beginning of the baseline survey, each girl chose one out of four racially and physically diverse female avatars (called "femtors", a derivation of "female

mentor") that would take the girls through each survey throughout the entire intervention. The girls had the option of reading the questions or clicking a play button that would activate the femtor to read both the questions and tailored messages to the girls. Individually tailored messages were delivered to each girl via the iPad throughout completion of the survey. These messages were constructed based on each girl's personal responses to the survey questions, taking into account the changes since baseline. The survey also provided tailored, open-ended questions for which each girl could type her response immediately on the iPad. Each girl received the individually, tailored messages based on the perceived benefits of PA, perceived barriers to PA, social support, and self-efficacy scale item responses.

The responses to the questions were sent to a message library containing hundreds of possible messages depending on the response for each girl. These messages were coded based on specific logic, and girls would receive one individually, tailored message specific to the answers on each scale's items including perceived benefits of PA, perceived barriers to PA, social support, and self-efficacy (4 individually, tailored messages total). Figure 2 shows the flow of how questions in the survey and tailored messages were administered. Details regarding each specific component within the tailored intervention survey and the process of how messages were created and delivered to each girl are described in the following text.

Figure 2: The mid-point tailored survey flow of questions and order of tailored messages

General survey questions 1 → Perceived benefits questions 2 → Received perceived benefits tailored message 3 → Filled out MI open-ended questions 4

Perceived barriers questions 5 → Self-efficacy questions 6 → Received self-efficacy and perceived barriers message 7 → Filled out MI open-ended questions 8

Social support questions 9 → Received 2 social support messages 10 → Filled out MI open-ended questions 11 → Program feedback questions 12

Tailored Message Delivery

  Perceived Benefits

  Each item had a response code between 0 and 3 (see following Measures section for further detail regarding response choices). Based on the code of each response, the top three benefits were picked for each girl. If a girl had more than three '3's' the computer algorithm system would randomly choose three to represent the top three benefits. If a girl had one '3' and six '2's' the system would select the '3' as the top benefit and randomly choose two of the '2's' for the second and third top benefit.

  Each girl received one tailored message based on her responses and the corresponding logic. For example, if a girl had at least one benefit and her top benefit was hanging out with friends (*BenFriend)* then this would provide the following tailored message:

  "Great thinking! You can do two important things at the same time- be with friends and

  take care of your body. Besides, it's boring sitting around all day! Here are some fun

  ways I like to exercise with my friends:

    take an exercise or dance class together

    join a sports team

    walk or jog together

    do chores, like raking leaves or shoveling snow

    turn on music and dance around!"

After the tailored message, each girl was prompted with three MI questions that were based on her responses to the questions.   For example, using same situation above, the logic for hanging out with friends as a top benefit would produce this MI question:

  "What kinds of exercise do you like to do with your friends?"

If the girls did not fit three logic conditions, then they would be prompted with default questions. If a girl only fit one logic condition, then she would receive that specific MI question and then two default questions. For example:

"How do people in your family feel about the exercise you or they are getting?"

Each tailored message and open-ended MI question had different logic and codes associated with them that determined how the message was delivered and who would receive the message based on the responses to the questions. The specific definitions of perceived benefits logic can be found in Appendix A.

Perceived Barriers

Each item had a response code between 0 and 3 (see following Measures section for further detail regarding response choices). Based on the code of each response, the top three barriers were picked for each girl. If a girl had more than three '3's' the computer algorithm system would randomly choose three to represent the top three barriers. If a girl had one '3' and six '2's' the system would select the '3' as the top barrier and randomly choose two of the '2's' for the second and third top barrier.

Each girl received one tailored message based on her responses and the corresponding logic. For example, if a girl's top barrier was that she felt embarrassed (*BarEmbarr*), then the logic would provide this tailored message:

"You said you feel embarrassed about exercising. Yes, it can feel strange at times. Especially if it's a new kind of exercise. It's ok- a lot of girls our age feel the same way. Here are some tips that might help you feel less embarrassed:

-Try things that don't embarrass you. Maybe write a list of things you already like to do. These might be things you're used to doing or know how to do - like walking or riding a bike.

-Think of places you're not embarrassed. Maybe there are some private places where you feel more comfortable – like somewhere at home, where fewer people might see you.

-Think of what else might help. What if you exercise with friends? Would it help to get different exercise clothes? Try to think about some things that might help you feel less embarrassed.

-Remember it'll get better over time. Other girls have told me that they stop feeling embarrassed after a while. They get used to it, and even get better at it. So after a while, it starts to feel normal. And remember, the only person you have to impress is yourself!

-Try to think in a different way. I hope you're proud of yourself when you exercise. You're working hard to stay healthy. You're taking care of your body – this means you're toning your muscles and keeping your weight healthy! Over time, you may feel better about yourself and the way you look.

After the tailored message, each girl was prompted three MI questions that were based on her responses to the questions. If the girls did not fit three logic conditions, then they would be prompted with default questions. If a girl only fit one logic condition, then she would receive that specific MI question and then two default questions. For example:

"What are some other ideas you have for getting past the things that are in your way?"

Each tailored message and open-ended MI question had different logic and codes associated with them that determined how the message was delivered and who would receive the message based on the responses to the item questions. The specific definitions of perceived barriers logic can be found in Appendix A.

Social Support

The sum of the eight social support responses was calculated to determine whether each girl had high social support (sum $\geq$ 12) or low social support (sum < 12; see following Measures section for further detail regarding response choices). The logic for the social support survey had several conditions that determined which messages each girl received. If a girl had a *SSCount* = 1 then she would see the message corresponding with her response she selected as 'sometimes' or 'often', but if she had an *SSCount* $\geq$ 1 then she would see a list of each response she selected as 'sometimes' or 'often' along with a written message. For example, if a girl had a *SSCount* = 4 and chose 'sometimes' or 'often' for certain questions (e.g., transportation (*SSTake*), participation partner *(SSPlaysW*), financial assistance for activities (*SSPay*), and financial assistance for equipment (*SSBuy*)) she would see the following message:

"*You told me you have people who:*

-drive you around

-exercise with you

-pay for your activities

-buy the stuff you need for your activities

That's great! The fact that they'll do all these things tells me that they know how important being active is to you. It also tells me it's important to THEM!

If a girl had a *SSCount* $\geq$ 1 she would see a message and then a list of ways to ask for help based on the responses she chose as 'rarely' or 'never'. For example, if she chose 'rarely' or 'never' for certain questions (e.g., encouragement (*SSEnc*), attendance (*SSWatch*), and organize activities (*SSPlan*)) she would see the following message:

> *"How might you get even more support for being active? Here are some ways you might ask for new kinds of help:*
>
> *-Ask someone to cheer you on. Maybe people don't know how important your activities are to you. Talking to them about it might help them understand. Sometimes people don't know how to help you. Telling friends and family what you want or need might help.*
>
> *-Ask people to come to your events. Some people might not think you want them there. Once I asked my best friend to watch me, when my parents couldn't come. It was nice to have her there.*
>
> *-Earn money or choose free activities. Maybe no one will pay for you. There might be ways you can earn money by doing chores to help pay for your own classes or sports gear. On the other hand, you might also choose activities that are free – walking, jogging, and dancing are all great exercise.*

After the tailored message, the girls were prompted with 2 MI questions depending on whether they had 'support = high' (*SupportMI2)* or 'support = low' (*SupportMI3)*. For example, if a girl had 'high social support' and selected her mom, dad, and sister as her sources of support (*SSWho)* then she would receive the following two MI questions:

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- *"What types of support do you need to be active every day? What kinds of things would you like people to help you with?*

- *You said you get support from:*

  -your mom

  -your dad

  -your sister

  How can each person help you be active?

Each tailored message and open-ended motivational interview (MI) question had different logic and codes associated with them that determined how the message was delivered and who would receive the message based on the responses to the questions. The specific definitions of social support logic can be found in Appendix A.

Self-Efficacy

Girls had high self-efficacy and low self-efficacy if their mean score was > 2.5 or < 2.5, respectively (see following Measures section for further detail regarding response choices). The girls would see the following messages depending on their high or low self-efficacy score:

- *What gets in your way: Great news – it looks like you feel like you can be active every day. That kind of confidence will really help you. Once in a while, things still get in my way. Let's talk about how to get past some of things that get in your way.*

- *What gets in your way: It looks like you're not too sure you can be active every day. I understand – a lot of girls our age feel this way. We all have trouble sometimes. The good news is that I am here to help. Let's talk about how to get past some of the things that get in your way.*

Following these messages, the girls would see the perceived barriers to PA messages that were described previously because the two pieces of the survey are related.

Each tailored message and open-ended MI question had different logic and codes associated with them that determined how the message was delivered and who would receive the message based on the responses to the items. The specific definitions of self-efficacy logic can be found in Appendix A.

Measures

Participants self-reported demographic variables via a screening survey including age, race or ethnicity, and academic grade. Socioeconomic status (SES) was measured by whether the girls qualified for the free and reduced lunch provided at the schools, which was indicated by the parent/guardian's answer on the consent form that was sent home.

As previously noted, the tailored survey was conducted using an iPad tablet. The first questions on the tailored survey consisted of personal factor questions such as how many hours of TV or movies girls watched on a typical school day and on the weekends, and how many hours spent talking on the phone or sending text messages on a typical school day and on the weekends. After the personal factor questions, the tailored survey continued to ask questions about enjoyment, perceived benefits of physical activity, perceived barriers to physical activity, self-efficacy, and social support (Figure 2). At the end of the tailored survey, there were feedback/evaluation questions that the girls answered in order to examine the overall effectiveness of the tailoring intervention.

Perceptions of Tailoring Assessment

The girls were asked to answer feedback questions regarding the overall tailoring program using the Perceptions of Tailoring Survey. They were given instructions to 'Please tell us how much you agree or disagree with these statements about the GOAL computer program.' The girls answered the questions on a 4-pt scale from 'disagree a lot' (coded= 0) to 'agree a lot' (coded= 3).

There were seven questions that were related to the software program, 6 questions related to physical activity, and 4 miscellaneous questions for a total of 17 questions. For 16 of the 17 questions, higher scores indicated a positive response and lower scores indicated a negative response. However, one question (question #7) was negatively-worded and therefore resulted in opposite responses (higher scores= negative responses; lower scores= positive responses). Therefore, question #7 was statistically reverse-coded to allow for consistency throughout the scale of questions. Research has shown that using all positively worded questions has higher reliability compared to using all negatively worded questions or mixed- both positive and negative worded- questions (97). The list of the 17 questions is shown below:

Software questions (Not related to physical activity)

1) I like the pictures

2) I like the colors

3) The questions were easy to understand

4) It is good for girls my age

5) It was easy to use

6) It was fun to do

7) It had too many questions

Physical Activity/ Effectiveness of the Tailoring

8) It made me want to get more physically active

9) It made me feel that I can choose the activities I want to do

10) It helped me see a lot of reasons for doing physical activity

11) It helped me solve problems that stop me from being active

12) It helped me see that I can be active

13) It helped me see that physical activity can be fun

Femtor Questions

14) I could relate to the female Femtor

15) The support the Femtor gave me was helpful

Not related to physical activity

16) I was ok with leaving class to do this program

17) My teacher was okay with me leaving class to do this program

There was a specific order of questions in the survey and then following each section of questions the girls received the corresponding category of a tailored message. For example, after the girls answered questions regarding perceived benefits of physical activity, they received their personal and individual tailored message. The specific order of questions and tailored message delivery are displayed in figure 2.

Physical Activity

Minutes of MVPA were measured using a small, lightweight accelerometer, the ActiGraph GT3X+ , which is a reliable and valid device to assess MVPA. Each girl wore the accelerometer on her right hip and for the specified amount of time- from when she woke up to when she went to bed for seven consecutive days (except during water activities). The accelerometer recorded acceleration counts based on the girls' movement throughout the seven days, and the minutes of MVPA were estimated based on these acceleration counts. Data were collected in raw mode and reintegrated to 15-second epochs so that count thresholds could be applied to determine the intensity of the activity. The following count thresholds determined activity intensities: 574-1002 counts/15 seconds (moderate PA) and $\geq$ 1003 counts/15 seconds (vigorous PA) (30). In order to be included in analyses, participants needed to provide at least four days of data (three weekdays and one weekend day) with at least eight hours of wear time.

Height and weight for assessing body mass index (BMI) and body fat percentage (BF %) were measured behind a privacy screen following proper measurement guidelines and procedures. Height was measured with a portable stadiometer (Shorr Board Productions, Olney, MD) to the nearest 0.1 cm with the participants barefoot or without shoes. Weight and BF % were assessed on a foot-to-foot bioelectric impedance scale (Tanita Corporation, Tokyo, Japan). Weight was measured to the nearest 0.1 kg and BF % was measured to the nearest 0.1%. Two measures of each were taken and averaged for use in data analyses. BMI was calculated using the BMI equation: weight in kilograms / height in meters squared, and BMI z-scores were estimated using CDC growth charts on the *Centers for Disease Control* website (17).

Psychosocial Variables

Perceived benefits of PA was assessed with 12 items using a 4-pt Likert scale with response choices ranging from 'Not at all True' (code= 0) to 'Very True' (code= 3). This scale had good reliability with Cronbach's alpha value of .83 in the current study. There were 12 different items that girls answered based on the following statement on the survey: "For me, a major reason that I would be physically active is," and examples of the items were 'To spend time with friends or others my age' or 'To be healthier' or 'To be the weight I want to be.'

There was a 17-item scale that was associated with the perceived barriers to PA that each girl answered using a 4-pt Likert scale ranging from 'Not at all True' (code= 0) to 'Very True' (code= 3). The Cronbach's alpha was .90 for this scale in the current study. There were 17 different items that girls answered based on the following statement on the survey: "Think about things that may stop you from being active or doing sports- How true is each sentence about you?", and examples of the items were 'I feel embarrassed about the way I look whenever I exercise' or 'I feel too lazy to exercise.'

To assess self-efficacy for PA, a 6-item scale was used. It provided a 4-pt Likert scale ranging from 'Disagree a lot' (code=0) to 'Agree a lot' (code=3). This scale had good reliability with Cronbach's alpha value of .81 in the current study. The mean score of the responses was calculated to determine the self-efficacy of each girl.

There was an 8-item Social Support Scale that the girls answered using a 4-pt Likert scale ranging from 'Never' (code=0) to 'Often' (code= 3). This scale had good reliability and validity (Cronbach's alpha .87 in the current study). There were 8 different items based on the following statement on the survey: "Think about how much people in your life help you to exercise, be active, or do sports by doing things for or with you," and a few examples of the survey items

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were 'Someone takes me to play sports or exercise" or 'Someone exercises or plays active games or sports with me.' Higher scores represented greater social support and lower scores represented lower social support. In addition, the girls could choose up to three people whom they felt supported them or helped them do exercise or sports, and this was summed to a total between 0 and 3.

Data Analysis

Data were analyzed using IBM SPSS Statistics 22.0. Summary descriptive statistics (including means, standard deviations, frequencies, and percentages) were performed to describe the participants in the Girls on the Move (GOTM) Intervention. The power analysis for the main study followed the calculation steps established in the GOTM methods paper (91). To achieve a power of .80 and an alpha of 0.05, the goal was to recruit 62 girls per school each year in order to account for 20% attrition rate or to retain at least 50 girls per school each year. Bivariate analyses included independent-samples t-test, one-way analysis of variance (ANOVA), and Pearson product-moment correlation analysis, which was calculated to determine if there were significant relationships between the appropriate independent and dependent variables. Multiple linear regressions were performed to examine the relationship between a group of independent variables and one dependent variable in order to develop a model that accurately predicted the dependent variable. The independent variables in research question one were the psychosocial perceptions related to physical activity (PA) (perceived benefits of PA, perceived barriers to PA, self-efficacy, and social support) and the dependent variable was perceptions of tailoring. In research question 2 the independent variable was perceptions of tailoring and the dependent variable was post-intervention PA (sedentary behavior, light PA, moderate PA, vigorous PA, and

moderate- to vigorous- PA). The *coefficient of determination (R^2)* of each model was analyzed to assess the variance explained by the model. The significance of the *regression coefficients* were tested and analyzed to examine which predictor variable(s) were significant contributors to each model.

Mediation analysis was conducted to look at how possible mediating variable(s) might describe the process by which one variable affects another.   In mediation analysis, it is hypothesized that the mediating variable is influenced by the independent variable, which then influences the dependent variable. Therefore, the mediating variable helps clarify the relationship between the independent and dependent variables. The single-mediator model as explained by Mackinnon (63) was utilized in this study's analysis. The Baron and Kenny approach for establishing mediation involves four detailed steps, which uses the three regression equations explained by Mackinnon. The first step (equation 1) was to test the relationship between the dependent variable (post-intervention PA) and the independent variable (psychosocial perceptions related to PA) for significance. The next step (equation 3) was to test the relationship between the independent variable (psychosocial perceptions related to PA) and the potential mediating variable (perceptions of tailoring) for significance. The third step (equation 2) was to examine if the mediating variable (perceptions of tailoring) was significantly related to the dependent variable (post-intervention PA) when both the independent (psychosocial perceptions related to PA) and the mediating (perceptions of tailoring) variables predict the dependent variable (post-intervention PA). Finally, the last step was to determine if the absolute value of coefficient (labeled c) in equation 1 is larger than the coefficient (labeled c') in equation 2. Figure 3 shows the mediation model proposed by Baron and Kenny (4).

For the purpose of parsimony and to uncover possible underlying data concepts and structures, an Exploratory Factor Analysis (EFA) was conducted on the data from the Perceptions of Tailoring Survey. The criteria used in EFA analysis were 1) minimum eigenvalue greater than 1.0; 2) Principal Component analysis extraction; and 3) Varimax rotation with Kaiser Normalization.

Figure 3: Baron and Kenny's Mediation Model from Baron & Kenny (1986).
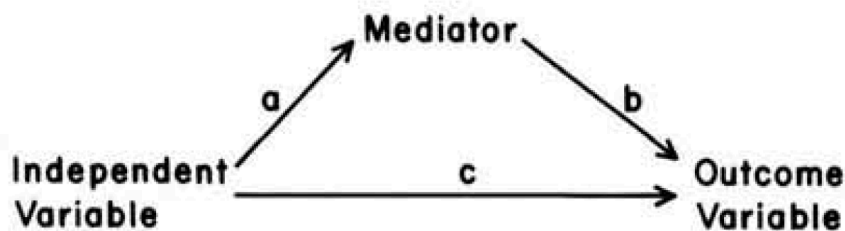
Research Questions, Hypotheses and Analytical Approaches:

Specific aims, hypotheses, and analytical approaches follow.

Research Question 1: Do psychosocial perceptions related to physical activity influence girls' perceptions of tailored messages at the midpoint of the intervention?

Hypothesis 1: Girls with more positive psychosocial perceptions related to PA would have a higher score on the Perceptions of Tailoring scale at the midpoint of the intervention compared to girls with less positive psychosocial perceptions related to PA.

Analytical approach:

Multiple linear regression with a mean score of the Perceptions of Tailoring scale as the dependent variable and variables assessed at the time of the tailoring survey (benefits of

PA, barriers to PA, self-efficacy, social support) as independent variables, controlling for baseline age, school, race/ethnicity, and socioeconomic status (SES) as measured by whether the girls qualified for the free and reduced lunch program provided at the schools.

Research Question 2: Do perceptions of tailored messages at the midpoint of the intervention influence level of PA measured at post-intervention?

Hypothesis 2: Girls with higher scores on the Perceptions of Tailoring scale at the midpoint of the intervention would have greater PA post-intervention than those with lower perceptions of tailoring scores.

Analytical approach: Multiple linear regression with post-intervention physical activity as the dependent variable and the mean score of the Perceptions of Tailoring scale as the independent variable. Separate regression models were conducted for each level of physical activity (sedentary behavior, LPA, MPA, VPA, MVPA) while controlling for the corresponding baseline value. Other control variables include age, school, race/ethnicity, and socioeconomic status (SES) as measured by whether the girls qualified for the free and reduced lunch program provided at the schools.

Research Question 3: Do perceptions of the tailored messages mediate the effect of the psychosocial perceptions related to PA on the level of PA measured at post intervention?

Hypothesis 3: The perceptions of the tailored messages would mediate the effect of psychosocial perceptions related to PA on the level of PA measured at post-intervention.

Analytical Approach: The Baron and Kenny approach to mediation analysis including

three regression equations and four detailed steps. The three regression equations

included:

1 - PA = i1 + c Psychosocial + e1

2 - PA = i2 + c' Psychosocial + b PA perceptions of tailoring + e2

3 - Perceptions of tailoring = i3 + a Psychosocial + e3

Where i1 and i2 and i3 were intercepts, PA was the dependent variable, the psychosocial

scales were independent variables, Perceptions of tailoring was the mediator, c was the

coefficient relating the psychosocial scales and PA , c′ was the coefficient relating the

psychosocial scales to PA adjusted for perceptions of tailoring, b was the coefficient

relating perceptions of tailoring to PA adjusted for the psychosocial scales, a was the

coefficient relating the psychosocial scales to perceptions of tailoring, and e1, e2, and e3

were residuals.

CHAPTER 4: RESULTS

Exploratory Factor Analysis

The Perceptions of Tailoring Survey used in this study had 17 original questions. Three

questions were eliminated either due to the univariate analysis of each item in the survey or the

EFA results. Question #7 ("It had too many questions") was eliminated prior to the factor

analysis based on the univariate characteristics of each item in the survey. Unlike all other

questions, this item was only answered by three-fourths (n=390) of the girls, while the others

were consistently answered by 94% (n=480) of the girls. The EFA was run on the 16 remaining

questions and following the results two items were deleted. Questions 16 ("I was ok with

leaving class to do this program") and 17 ("My teacher was ok with me leaving class to do this

program") were subsequently eliminated when it was shown that these two items 'fell' into a

factor by themselves in the EFA and did not reveal an underlying concept. The 16-item Rotated

Component Matrix is displayed in Table 1. Therefore, the Perceptions of Tailoring Survey is a

14-item scale with two resulting factors established from the EFA results and used in this study's

analysis: a Physical Activity (PA) Evaluation sub-scale (8 questions) and a Computer Program

(CP) Evaluation sub-scale (6 questions).

Table 1: Rotated component matrix with factor loadings from the exploratory factor analysis

ITEM	COMPONENT		
	1	**2**	**3**
I like the pictures	.380	.666	
I like the colors		.763	

Table 1 (cont'd)

The questions were easy to understand		.671	
It is good for girls my age		.675	
It was easy to use		.743	
It was fun to do	.438	.534	
It made me want to get more physically active	.688		
It made me feel that I can choose the activities I want to do	.718		
It helped me see a lot of reasons for doing physical activity	.746		
It helped me solve problems that stop me from being active	.737		
It helped me see that I can be active	.750		
It helped me see that I physical activity can be fun	.706		
I could relate to the female Femtor	.680		
The support the Femtor gave me was helpful	.715		
I was ok with leaving class to do this program			.730
My teacher was ok with me leaving class to do this program			.787

Notes: Extraction Method: Principal Component Analysis; Rotation Method: Varimax with Kaiser Normalization; Rotation converged in 4 iterations

Reliability

For the Perceptions of Tailoring scale completed by 480 girls (30 missing), Cronbach's alpha was .91. The Cronbach's alpha for the PA evaluation sub-scale was .90 and the Cronbach's alpha for the CP evaluation sub-scale was .83. Line-item analyses for the Perceptions of Tailoring scale, the CP Evaluation sub-scale, and the PA Evaluation sub-scale are displayed in Tables 2, 3, and 4, respectively.

Table 2: Line-item analysis for the perceptions of tailoring scale.

ITEM	M	SD	Item-Total Correlation	Cronbach's Alpha if deleted
I like the pictures	2.13	.858	.595	.906
I like the colors	2.34	.801	.526	.909
The questions were easy to understand	2.31	.796	.516	.909
It is good for girls my age	2.59	.653	.547	.908
It was easy to use	2.57	.668	.540	.908
It was fun to do	2.32	.885	.633	.905
It made me want to get more physically active	2.06	.882	.628	.905
It made me feel that I can choose the activities I want to do	2.23	.833	.666	.903
It helped me see a lot of reasons for doing physical activity	2.26	.819	.690	.903

Table 2 (cont'd)

It helped me solve problems that stop me from being active	1.91	1.000	.589	.907
It helped me see that I can be active	2.34	.799	.729	.901
It helped me see that I physical activity can be fun	2.35	.829	.722	.901
I could relate to the female Femtor	1.91	.903	.611	.906
The support the Femtor gave me was helpful	2.17	.887	.708	.902

NOTES: Cronbach's Alpha= .91

Table 3: Line-item analysis for the computer program evaluation subscale.

ITEM	M	SD	Item-Total Correlation	Cronbach's Alpha if deleted
I like the pictures	2.13	.858	.612	.793
I like the colors	2.34	.801	.617	.791
The questions were easy to understand	2.31	.796	.558	.804
It is good for girls my age	2.59	.653	.603	.797
It was easy to use	2.57	.668	.627	.792
It was fun to do	2.32	.885	.573	.803

NOTES: Cronbach's Alpha= .90

Table 4: Line-item analysis for the physical activity evaluation subscale.

ITEM	M	SD	Item-Total Correlation	Cronbach's Alpha if deleted
It made me want to get more physically active	2.06	.882	.649	.890
It made me feel that I can choose the activities I want to do	2.23	.833	.692	.886
It helped me see a lot of reasons for doing physical activity	2.26	.819	.729	.883
It helped me solve problems that stop me from being active	1.91	1.000	.631	.893
It helped me see that I can be active	2.34	.799	.753	.881
It helped me see that I physical activity can be fun	2.35	.829	.727	.883
I could relate to the female Femtor	1.91	.903	.616	.893
The support the Femtor gave me was helpful	2.17	.887	.715	.884

NOTES: Cronbach's Alpha= .83

Univariate Analysis

A total of 510 adolescent girls between the ages of 10-15 participated in the first two years of the intervention. The mean age was 12.2 years (SD= .95) and the majority of the girls were enrolled in the school's free or reduced lunch program (n= 392; 83.9%). Ethnic/racial distribution was: 12.7% of the girls were Hispanic (n= 61), almost half (48.2%) of the girls were black (n= 246), 27.3% were white (n= 139), and 24.5% (n= 125) identified as mixed-race or other. The mean score from the PA Evaluation sub-scale was 2.16 (SD= .67) and the mean score from the CP Evaluation sub-scale was 2.38 (SD= .57). Means and standard deviations for baseline age and for psychosocial variables at the time of the Perceptions of Tailoring Survey are displayed in Table 5. Table 6 shows means and standard deviations for baseline PA and post-intervention PA.

Table 5: Means and standard deviations for baseline age and psychosocial variables and scales at time of the tailoring.

	n	Mean (SD)
Age (years)	510	12.21 (.953)
Benefits	480	2.32 (.48)
Barriers	480	1.15 (.62)
Self-Efficacy	480	2.08 (.62)
Social Support	480	1.86 (.74)
PA Evaluation sub-scale	480	2.16 (.67)
CP Evaluation sub-scale	480	2.38 (.57)

Table 6: Means and standard deviations for baseline and post-intervention PA.

	Baseline		Post-Intervention	
	n	Mean (SD)	n	Mean (SD)
Sedentary Behavior (min/hr)	472	39.25 (4.29)	373	39.67 (4.34)
LPA (min/hr)	472	17.83 (3.44)	373	17.44 (3.56)
MPA (min/hr)	472	2.16 (.86)	373	2.16 (.82)
VPA (min/hr)	472	.76 (.60)	373	.74 (.57)
MVPA (min/hr)	472	2.92 (1.32)	373	2.89 (1.29)

Bivariate Analysis: Psychosocial Variables and Evaluation Subscales

Independent sample t-tests and one-way analysis of variance (ANOVA) tests were conducted to determine if there were significant relationships between the CP Evaluation and the PA Evaluation sub-scales and the control variables (Socioeconomic Status (SES) ethnicity, race, and school). There were no significant relationships found between the CP Evaluation subscale and any of the control variables. A significant difference was found for the PA Evaluation subscale and SES, $t(437)= -2.289$, $p= .023$, and for the PA Evaluation sub-scale and race, $F(2, 477)= 3.413$, $p= .034$. Lower SES girls had higher mean scores ($2.18 \pm .64$) on the PA Evaluation subscale compared to higher SES girls ($1.98 \pm .76$), and black girls had higher scores ($2.23 \pm .69$) on the PA Evaluation subscale compared to white girls ($2.04 \pm .73$). No significant relationships were found between the PA Evaluation scale and ethnicity and school.

Pearson Product Moment Bivariate Correlations were conducted to determine if there were significant relationships between the CP Evaluation and PA Evaluation sub-scales and the

four psychosocial scales. Significant relationships were found between the CP Evaluation sub-scale and all four psychosocial variables: Benefits $r(478)= .325$, $p< .01$; Barriers $r(478)= -.090$, $p< .05$; Self-Efficacy $r(478)= .390$, $p< .01$; Social Support $r(478)= .222$, $p< .01$. Significant relationships were found between the PA Evaluation sub-scale and all four psychosocial scales: Benefits $r(478)= .447$, $p< .01$; Barriers $r(478)= -.149$, $p< .01$; Self-Efficacy $r(478)= .412$, $p< .01$; Social Support $r(478)= .285$, $p< .01$.

Bivariate Analysis: Evaluation Subscales and Post-Intervention Physical Activity

Independent sample t-tests and one-way analysis of variance (ANOVA) tests were conducted to determine if there were significant differences between the control variables for post-intervention PA. A significant difference was found for ethnicity and post-intervention sedentary behavior, $t(346)= -2.128$, $p= .034$, post-intervention MPA, $t(346)= 2.516$, $p= .012$, and post-intervention MVPA, $t(346)= 2.196$, $p= .029$. Hispanic girls had higher levels of post-intervention sedentary behavior (40.96 ± 3.38), lower levels of MPA ($1.87 \pm .63$), and lower levels of MVPA ($2.50 \pm .98$) compared to non-Hispanic girls (Sedentary behavior$= 39.47 \pm 4.42$; MPA$= 1.87 \pm .63$; MVPA$= 2.50 \pm .98$). No significant differences were found for ethnicity and post-intervention LPA and VPA. A significant difference was found for school and post-intervention sedentary behavior, $F(7, 365)= 2.339$, $p= .024$, post-intervention LPA, $F(7, 365)= 3.268$, $p= .002$, and post-intervention and MPA, $F(7, 365)= 2.305$, $p= .026$. No significant differences were found for school and post-intervention VPA and MVPA. No significant relationships were found between SES and any post-intervention PA variables or between race and any post-intervention PA variables.

Pearson Product Moment Bivariate Correlations were conducted to determine if there were significant relationships between the CP Evaluation and PA Evaluation sub-scales and post-intervention PA. No significant relationships were found between the CP Evaluation sub-scale and any post-intervention PA. A significant relationship was found between the PA Evaluation sub-scale and post-intervention MPA, $r(366)= .139$, p= .008, and post-intervention MVPA, $r(366)= .124$, p< .017.

Multivariate Analysis: Psychosocial Variables and Evaluation Subscales

Multivariate linear regressions were conducted to see if any of the control variables (SES, ethnicity, race, school) or any of the psychosocial variables (benefits, barriers, self-efficacy, social support) predicted the scores in the CP Evaluation and PA Evaluation sub-scales. Only significant variables from the bivariate analysis were entered into the multiple regressions and used for analysis. The multiple regression showed that benefits significantly predicted, $t(475)= 4.59$, p<.001, the variations in the CP Evaluation sub-scale when controlling for the significant inverse effect of the interaction of social support and self-efficacy, $t(475)= -2.20$, p=.028. The model accounted for approximately 20% of the variance in the CP Evaluation sub-scale and the predictors for the CP Evaluation sub-scale are displayed in Table 7. The multiple regression found that benefits, $t(434)=8.63$, p<.001, self-efficacy, $t(434)=5.68$, p<.001, and barriers, $t(434)=-2.12$, p<.0035, significantly predicted the variations in the PA Evaluation sub-scale when controlling for the significant effect of SES, $t(434)=2.65$, p=0.008. The model accounted for approximately 30% of the variance in the PA Evaluation sub-scale and the predictors for the PA Evaluation sub-scale are shown in Table 8.

Table 7: Multiple regression: predictors of the computer program evaluation subscale.

Independent Variable	β (Unadjusted)	β (SE)	β Adjusted	Significance of β (t Test)
Constant	.828	.198		.000
Benefits	.243	.053	.204	.000
Social Support	.242	.102	.316	.018
Self-Efficacy	.458	.093	.495	.000
Social Support & Self-Efficacy Interaction	-.103	.047	-.404	.028
f-test for the whole model		30.082		
Significance level (overall)		P< .000		
R^2		.202		
Adjusted R^2		.195		

Table 8: Multiple regression: predictors of the physical activity evaluation subscale.

Independent Variable	β (Unadjusted)	β (SE)	β Adjusted	Significance of β (t Test)
Constant	.321	.163		.05
Benefits	.524	.061	.373	.000
Self-Efficacy	.275	.048	.255	.000
SES	.189	.071	.107	.008
Barriers	-.095	.045	-.090	.035
f-test for the whole model		46.459		

Table 8 (cont'd)

Significance level (overall)	P<.000
R^2	.30
Adjusted R^2	.29

Multivariate Analysis: Evaluation Subscales and Post-Intervention Physical Activity

A multivariate linear regression was also calculated to examine if any of the control variables (SES, ethnicity, race, school) or any of the scores on the CP and PA Evaluation sub-scales predicted post-intervention PA. Only significant variables from the bivariate analysis were entered into the multiple regressions and used for analysis. The multiple regression revealed that the PA Evaluation sub-scale, $t(340)=2.82$, $p=0.005$, significantly predicted the variation of post-intervention MPA when controlling for the significant inverse effect of ethnicity, $t(340)=-2.61$, $p=0.01$. The model accounted for approximately 4% of the variance in post-intervention levels of MPA and the predictors of post-intervention MPA are displayed in Table 9. The multiple regression revealed that the PA Evaluation sub-scale, $t(366)=2.39$, $p=0.017$, significantly predicted the variation of post-intervention MVPA. The model accounted for approximately 2% of the variance in post-intervention levels of MVPA, and the predictors for post-intervention MVPA are shown in Table 10.

Table 9: Multiple regression: predictors of post-intervention MPA.

Independent Variable	β (Unadjusted)	β (SE)	β Adjusted	Significance of β (t Test)

Table 9 (cont'd)

Constant	1.767	.161		.000
PA Evaluation sub-scale	.199	.071	.150	.005
Ethnicity	-.345	.132	-.139	.010
f-test for the whole model		4.947		
Significance level (overall)		P=.001		
R^2		.04		
Adjusted R^2		.035		

Table 10: Multiple regression: predictors of post-intervention MVPA.

Independent Variable	β (Unadjusted)	β (SE)	β Adjusted	Significance of β (t Test)
Constant	2.310	.255		.000
PA Evaluation sub-scale	.266	.111	.124	.017
f-test for the whole model		5.728		
Significance level (overall)		P=.017		
R^2		.02		
Adjusted R^2		.013		

Mediation Analysis

The purpose of mediation analysis is to examine how the mediating variable influences the relationship between the independent and dependent variables. Mediation analysis was conducted to determine if perceptions of the tailored messages mediated the effect of

psychosocial perceptions related to PA on the level of PA measured at post-intervention. The

four steps utilized in the single-mediator model, described previously, was performed in this

study's analysis and the three regression equations (including the current study's variables) are

shown below:

1) $PA = i_1 + c$ Psychosocial Scales$+ e_1$

2) $PA = i_2 + c'$ Psychosocial Scales $+ b$ PA Evaluation sub-scale $+ e_2$

3) PA Evaluation sub-scale $= i_3 + a$ Psychosocial Scales$+ e_3$

The first step (equation 1) was to ensure that there was a significant relationship between

psychosocial perceptions related to PA and post-intervention PA. The regression results showed

that self-efficacy $t(365)=-2.111$, $p=0.035$ and barriers $t(365)=2.440$, $p=0.015$ significantly

determined post-intervention sedentary behavior. Barriers $t(366)=-2.652$, $p=0.008$ significantly

determined post-intervention LPA. Self-efficacy $t(365)=3.263$, $p=0.001$ and barriers $t(365)=-$

1.990, $p=0.047$ significantly determined post-intervention MPA. Barriers $t(366)=-2.573$, $p=0.01$

significantly determined post-intervention VPA, and self-efficacy $t(365)=2.855$ $p=0.005$ and

barriers $t(340)=-2.169$, $p=0.031$ significantly determined post-intervention MVPA. The second

step (equation 3) was to ensure that there was a significant relationship between the PA

Evaluation sub-scale and psychosocial perceptions related to PA. The regression results show

that benefits $t(478)=10.912$, $p<0.01$, barriers $t(478)=-3.286$, $p=0.001$, self-efficacy $t(478)=9.891$,

$p=<0.01$, and social support $t(478)=6.510$, $p<0.01$ significantly determined the PA Evaluation

sub-scale.

The third step (equation 2) was to determine if the PA Evaluation sub-scale was significantly related to post-intervention PA when both psychosocial perceptions related to PA and the PA Evaluation sub-scale predict post-intervention PA. The regression results showed that barriers $t(365)=-2.530$, $p=0.012$ and the PA Evaluation sub-scale significantly explained the variation in post-intervention MPA. The fourth and final step was to examine if the coefficient in equation 1 (labeled c) was larger in absolute value than the coefficient in equation 2 (labeled c'). The regression results show that the coefficient (c= -0.199) relating barriers to post-intervention MPA (equation 1) was larger in absolute value than the coefficient (c'= -0.176) relating barriers to post-intervention MPA in the regression model with both barriers and the PA Evaluation sub-scale predicting post-intervention MPA (equation 2). Therefore, the final mediation model determined by the single-mediator model steps as followed in this analysis is shown in Figure 4.

Figure 4: Mediation Model
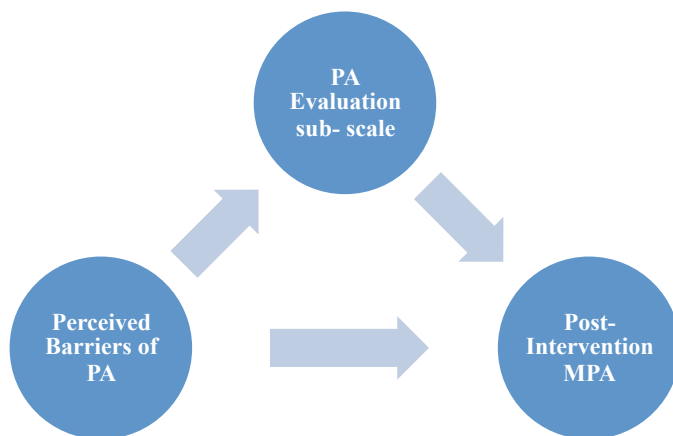
CHAPTER 5: DISCUSSION

The overall purpose of this study was to examine the relationship between perceptions of tailoring and physical activity behavior in the GOTM intervention program. This was examined through 1) identifying predictors of perceptions of tailored messages; 2) examining if the perceptions of the tailored messages were related to PA behavior following the intervention; and 3) determining if perceptions related to the tailored messages mediated the effect of psychosocial characteristics related to PA on post-intervention PA.

Prior to statistically testing the study hypotheses, the team needed to confirm the factor structure of the survey used to assess perceptions of the tailored messages. An Exploratory Factor Analysis (EFA) was conducted to assess the factor structure of a 16-item survey. Two subscales were established from the EFA results that were used in the study's statistical analysis. The first subscale was an 8-item scale that included questions from the survey that were related to PA (e.g., "It made me want to get more physically active"), and the second subscale was a 6-item scale that included questions regarding the computer program through which the survey was delivered (e.g., "I like the pictures"). Two items were eliminated following the EFA because these questions did not fit with the other questions, which was confirmed when they fell into a separate factor by themselves. Therefore, the two subscales utilized consisted of the 14 remaining questions. These two subscales followed the logic behind how the survey questions were developed. Specifically, the questions related to PA and the femtor fell into a separate factor than the questions related to the computer program, and therefore, it was logical how the two subscales were established from the EFA. Additionally, the subscales provided high reliability. Even though there is not a comparable survey or questionnaire in the literature, the

EFA demonstrated the strength of the tailoring survey used in the GOTM PA Intervention and the ability to use it as both an independent and dependent variable in analyses.

The relationship between psychosocial variables related to PA, such as perceived benefits of PA, perceived barriers to PA, self-efficacy, and social support, and PA behavior has been examined throughout the literature. However, the relationship between these psychosocial variables and perceptions of tailoring has not been well established in tailored message intervention programs. In order to evaluate if tailored messages were associated with the psychosocial variables, the current study examined the relationship between perceived benefits of PA, perceived barriers to PA, self-efficacy, and social support and mean scores on the PA Evaluation subscale. Girls who had higher benefits of PA, lower barriers to PA, higher self-efficacy, and higher social support had higher mean scores on the PA Evaluation subscale and therefore had more positive perceptions of the tailored messages compared to girls who had lower benefits of PA, higher barriers to PA, lower self-efficacy, and lower social support. This association between tailored messages and psychosocial perceptions related to PA has been not examined in previous literature.

Prior studies analyzed how the psychosocial variables changed from pre- to post-interventions following a tailored program (7,66,88) and found positive relationships between the psychosocial variables and PA behavior, but there were not any differences between groups who received tailored messages and those who did not receive messages. For example, three studies found (7,66,88) a positive relationship between self-efficacy and PA but that the changes in PA were not significantly different between the tailored group and the control group. The relationship between perceived benefits of PA and perceived barriers to PA and PA behavior were inconclusive (7, 66), and one study found a significant difference between the intervention

group and the control group regarding the relationship between social support and PA behavior (88). However, the intervention in the later study (88) used a PA self-report measurement (Child and Adolescent Activity Log) and the tailored messages were not specific to social support. In addition, the intervention was a multicomponent intervention and the components were analyzed together (the tailored message component was not separated out from the other two components) versus a control group, and this could be a possible explanation for the change in social support from pre- to post- intervention.

The current study looked at the association between perceptions of tailoring and psychosocial perceptions related to PA, which is unique and unlike previous studies. The finding that girls who had positive psychosocial perceptions related to PA also had higher mean scores on the PA Evaluation subscale and those girls had higher levels of post-intervention MPA and MVPA is a significant contribution to the literature. Psychosocial variables related to PA can vary greatly among individuals and can be difficult to change or influence depending on each individual. However, the current study showed that girls who had more positive psychosocial perceptions related to physical activity had more favorable perceptions of the tailored messages. Therefore, tailored messages are a feasible and effective method to positively influence those individuals who see the benefits of physical activity, have few barriers to become physically active, believe in their abilities to engage in physical activity, and have good social support to continue staying physically active and engaging in an active lifestyle.

Previous web-based tailored interventions have been effective at changing or influencing a particular health behavior whether it is smoking cessation (102-105,119), reducing alcohol consumption (18,98,107), increasing fruit and vegetable intake (8,15,55), weight loss (108), or increasing PA (36,67,68,70,88,101). The majority of these previous studies were single-

component interventions, and it was feasible to evaluate the effectiveness of the tailored messages alone. Single-component tailored interventions in previous studies compared the difference between groups such as an intervention group (received tailored message materials) versus a control group (received generic communication materials) to analyze the effectiveness of the tailored program. These studies, in general, found that the tailored communication was more effective than generic communication at influencing change in the particular behavior. Studies that examined the effects on PA found inconclusive results, which is why more studies were needed to look at the effects of tailored messages on PA. In contrast to these single-component interventions, the web-based tailored message intervention in the current study was one of three components of the GOTM PA intervention program. Therefore, it was not feasible to single out one component of the intervention in order to evaluate the effectiveness of the entire program, and the current study took a unique approach by assessing girls' perceptions of the tailored messages utilized in the intervention.

Researchers have previously had difficulty when attempting to assess the effectiveness of one component in multi-component interventions because of how intervention components are inherently related. For example, de Souza et al (2014) examined the development and implementation of a peer helper intervention, which was one component in a multicomponent obesity prevention program, and concluded that the individual effects of the peer helper program cannot be singled out from the entire intervention program (23). The authors of this study also contended that research has not yet reached a point in implementing methodologies that would allow examining the effects of one individual component separately from the entire multicomponent program (23).

Similarly, the HEALTHY Intervention included four components aimed at improving prevalence of the metabolic syndrome and physical activity, and did not find any differences between the control conditions and the intervention conditions (43). This can partially be explained by the inability to single out one component of the intervention to determine the effectiveness of the entire program. Furthermore, Rydell et al (2005) examined the effectiveness of a web-based component that was a part of a multicomponent nutrition and PA behavioral intervention, and concluded that a web-site intervention may not be effective at achieving behavior change individually but rather more effective as one piece of a larger multicomponent intervention (94). Therefore, it is important to look at the effectiveness of the entire intervention program (all components) compared to each component separately, as each individual component contributes to the overall success of the program, meaning it might not be just one component that affected change or influenced individuals' behavior.

Even though the current study found that perceptions of tailored messages influenced MPA behavior post-intervention, one cannot quantify how much the tailored message component of the multicomponent intervention impacted the entire program as a whole. However, this does not mean multi-component interventions are ineffective at changing behavior. For example, two review studies conducted on PA interventions in a school-based setting concluded that multicomponent PA interventions were more effective at impacting PA behavior in children and adolescents compared to individual component interventions (54,96). Furthermore, one of those reviews (96) also concluded that interventions in school-based settings that involved tailored communication were an effective strategy at impacting behavior. Therefore, the GOTM PA Intervention program, which is a school-based, multicomponent intervention, has the potential to be an impactful and meaningful intervention program at influencing behavior change.

Although the current study differed in its use of the evaluation of tailored messages, it showed similar results to previous research finding that receiving tailored messages can be an effective method to help influence a change in behavior. We found that perceptions of tailoring were only significantly related to levels of post-intervention MPA and MVPA, but not other PA intensity levels. Additionally, the amount of variance in MPA and MVPA explained by perceptions of tailored messages was low. PA behaviors can be difficult to change because PA is influenced by several different variables, and reasons why individuals choose to engage in PA or not varies from person to person. Also, other intervention components could have independently influenced PA. Therefore, post-intervention sedentary behavior, LPA, and VPA levels could be influenced by other factors and health behaviors that the current study did not examine.

In addition to examining the relationship between tailored messages and PA behaviors, a few researchers throughout the tailoring research have suggested that it is important to identify and validate mediators that could potentially help explain the relationship (86). Previous tailored intervention studies have found that tailored messages are affected by a mediator variable, but there is limited research on tailored messages themselves as the mediating variable. Similar to the current study, Jensen et al (2012) examined if perceived message relevance (a component of tailored message perceptions) mediated the effects of a tailored intervention (45). However, unlike the current study, the authors analyzed the effects of tailored illustrative pamphlets on breast cancer screening in women over the age of 40 (45). The authors found that perceived message relevance mediated the effects of tailored illustrative pamphlets on breast cancer screening (45). Even though the current study and the Jensen et al. study examined different health behaviors, these are two of the few studies that examined perceptions of tailoring as a

mediating variable, and they both found mediation existed. Although there has been an increase

in use of tailoring in research, and tailored communication has been shown to be more effective

than generic communication, the "exact mechanism responsible for this tailoring effect is not

known" (40). Therefore, it is important for future researchers to further examine perceptions of

tailoring as a mediating variable in order to determine if they (perceptions of tailoring) yield the

effects of other relationships.

There is more research available that looked at the effects of various mediating variables

on the relationship between tailored messages and a specific health behavior. For example, in a

print-based tailored intervention regarding skin cancer risk reduction, the results showed that sun

protection intentions mediated the tailoring intervention effects on sun protection (64). In non-

tailored interventions, several mediators of PA have been found including self-efficacy (26,62),

social support (62), perceived barriers (22), and enjoyment (27). A review conducted on seven

PA intervention studies found that self-efficacy was the most examined mediating variable (59).

Although the research has suggested various mediating variables of PA, there is a need for future

researchers to study the impact of tailored messages, and the role the messages play in mediation

analysis of PA.

The mediation analysis utilized in the current study indicated that perceptions of tailoring

(measured through the PA Evaluation subscale) mediated the effect between the psychosocial

variable of barriers to PA and post-intervention levels of MPA. Perceived barriers to PA has

previously been identified as a main correlate of physical activity. For example, Zakarian et al

(1994) and Bungum et al (1999) found that perception of barriers was a significant predictor of

PA among female adolescents from low SES and minority backgrounds (13,129). Several

studies have examined barriers to PA in both males and females in order to identify age- and

gender- related barriers so that researchers can conduct PA interventions to help target these obstacles (29,87,89). Generally, individuals who perceive to have fewer barriers to PA are more physically active compared to those who have more perceived barriers to PA, and the current study was consistent with this relationship. Girls who had fewer perceived barriers to PA had higher levels of post-intervention LPA, MPA, VPA, MVPA, and were less sedentary compared to girls who had more perceived barriers to PA. Similarly, a comprehensive review of 108 studies examining the correlates of PA in children and adolescents found perceived barriers as the most consistent negative psychological correlate of PA (95).

However, changing or influencing an individual's perceptions of barriers to PA is difficult. For example, one PA intervention study examined the change in perceived barriers to PA in 15- to 16- year-old adolescent girls and found that the girls' perceived barriers to PA did not change from pre- to post-intervention over a 12-week period (84). Ransdell et al (2004) explained that it is important to identify 'age- and location- specific benefits and barriers' related to PA to help professionals figure out ways to 'increase benefits and decrease barriers,' which might impact the success of PA Intervention programs (84). This is especially important in adolescent girls because this population is known to be a very inactive population so targeting the barriers of PA in adolescent girls can be beneficial in improving PA behaviors. Therefore, perceived barriers to PA is an important psychosocial correlate that needs to be further investigated as it is important to target individuals' barriers to PA and in turn help individuals see the benefits of PA and living an active lifestyle. The current study helped show a possible mechanism of addressing individuals' barriers to PA of adolescent girls through tailored messages but this needs to be further explored in various populations such as boys and other age groups.

Strengths and Limitations

The most important strength of the current study is that it addressed a gap in the tailored messaging research as it is the only study that used a unique approach to deliver messages (via an iPad) to a need-based population of adolescent girls that focused on determining the relationship between psychosocial characteristics related to PA and perceptions of tailored messages, and how perceptions of tailored messages influence PA behavior. Other strengths include the large sample size, inclusion of participants from low income, disadvantaged backgrounds, and the strength of the psychometric properties of the Perceptions of Tailoring scale that can be utilized in future studies. These strengths demonstrate the significant contributions that the current study adds to not only the PA intervention research but to tailored messaging interventions as well.

One main limitation of the current study is the inability to separate the effects of the tailored message component of the intervention from the two other components (after-school PA club and motivational interviewing). In a multicomponent intervention, it is hard to single out which aspect of the intervention most effectively influenced behavior. Other studies examined the effectiveness of the tailoring by comparing groups (tailoring group vs a general/control group) and the current study specifically looked at the intervention group to determine how the messages influenced PA. Another limitation that needs to be addressed is the mediation analysis approach (Baron and Kenny) used to determine which variables mediate the effects between psychosocial perceptions related to PA and PA behavior. Although recent literature criticizes the Baron and Kenny approach, it has been used in previous studies and was successful in identifying various mediating variables (45,74).

Conclusions

Perceptions of tailored messages delivered during the GOTM PA intervention were related to adolescent girls' PA behavior. Similarly, perceptions of tailoring mediated the relationship between perceived barriers to PA and post-intervention levels of MPA. Therefore, girls who had fewer barriers to PA were more likely to become physically active following the tailored messages they were exposed to during the GOTM PA intervention. These findings significantly contribute to the literature and help fill the gap in the effectiveness of web-based tailored messaging on PA. Specifically, no other studies thus far have examined the effectiveness of tailored messages in a multi-component intervention program, utilized a unique mode of message delivery, targeted adolescent girls, and investigated tailored messages as a mediating variable.

Previous studies have examined the effectiveness of print-based and computer-based interventions delivered through various modes such as e-mails, videos, pamphlets, letters, and other similar forms of media. Studies that examined a web-based tailored intervention were mostly single-component interventions and studied various adult populations. The current study looked at 10- to 15- year- old adolescent girls, which is an inactive population and needs help and motivation to increase their PA behavior.

Given the gaps that the current study fills, there are still areas of the tailoring messages research that need to be examined further or addressed in future studies: 1) Examine the effect of tailoring messages on the psychosocial variables related to PA; 2) Analyze tailored messages themselves as a mediating variable; and 3) Assess what variables mediate the relationship between tailored messages and PA behavior; 4) Determine methods to examine single components of multi-component interventions; and 5) Identify ways to address barriers of

physical activity in individuals who have multiple obstacles to overcome to engage in physical activity.

APPENDIX

Perceived Benefits Logic Definitions:

BenActualCount = each benefit scored either a 2 or a 3 added 1 to the *BenActualCount*

BenActualCount > 0 = Girls see the benefit and rate it 'somewhat true' or 'very true'

BenActualCount = 0 = Girls don't see the benefit rate it 'not at all true' or 'not very true'

BenEnergy = Top benefit is 'To have more energy'

BenFriend = Top benefit is 'To spend time with friends or others my age

BenFun = Top benefit is 'To have fun'

BenHlth = Top benefit is 'To be healthier'

BenLook = Top benefit is 'To look better'

BenMood = Top benefit is 'To put me in a better mood'

BenMove = Top benefit is 'To have a chance to move around'

BenProve = Top benefit is 'To prove to myself what I can do physically'

BenShape = Top benefit is 'To get or keep me in shape'

BenSkill = Top benefit is 'To get better at sports or other activities

BenWt = Top benefit is 'To be the weight I want to be'

TopBenEnergyMI= What are some things you need energy for?

TopBenFriendMI= What kinds of exercise do you like to do with your friends?

TopBenFunMI= What are some other ways you can think of to make exercise fun?

TopBenHlthMI= What do you think being healthy and active does for your body or your mood or attitude?

TopBenLookMI= How might physical activity help *you* look or feel your best?

TopBenMood= What changes have you seen in your mood after you exercise?

TopBenMove= What are some ideas you have to 'get moving' every day?

TopBenProveMI= What are some activities you hope to do in the future that you have not been able to do well in the past?

TopBenShapeMI= What are some of your reasons for wanting to be in shape?

TopBenSkillMI= How would getting more skills or getting better at sports help you?

TopBenWtMI= How do you feel about your weight right now? What types of exercise can you do to help you reach or stay at a healthy weight?

NoBenMI = What, if any, are your reasons for wanting to be physically active?

YesBenNoPAMI= What, if any, might help you be more active?

YesBenYesPAMI= What kinds of things do you do to stay active?

SedBenMI= What could you do to be more active?

BenefitsMI1= How do people in your family feel about exercise you or they are getting?

BenefitsMI2= How does the amount of physical activity you get compare to what your friends or other girls your age are doing?

BenefitsMI3= How do you see your physical activity changing as you get older

Perceived Barriers Logic Definitions:

BarEmbarr = Top barrier is 'I feel embarrassed about the way I look whenever I exercise

BarLazy = Top barrier is 'I feel too lazy to exercise'
BarBusy = Top barrier is 'I am too busy'
BarAlone = Top barrier is 'I would have to exercise alone'
BarSkill = Top barrier is 'I need to have better skills'
BarPain = Top barrier is 'I have some pain from activity'
BarTired = Top barrier is 'I am tired'
BarBadDay = Top barrier is 'I have a bad day'
BarHard = Top barrier is 'I think exercise is hard work- "too much" for me to do
BarSweat = Top barrier is 'I hate to sweat during the school day'
BarDoOth = Top barrier is 'I want to do things other than physical activity with my time'
BarWeather = Top barrier is 'The weather is bad'
BarCost = Top barrier is 'It costs too much to do physical activities that I like'
BarPlace = Top barrier is 'It's hard to find good places to do physical activities that I like'
BarOthWant = Top barrier is 'Some people want me to do other things other than physical activity with my time
BarProgs = Top barrier is 'It's hard to find physical activity programs or classes that I like to do
BarrierMI1 = Which, if any, of the ideas on the previous page might work for you?
BarrierMI2 = What are some other ideas you have for getting past the things that are in your way?
BarrierMI3 = What is one thing you would be willing to try in the next few days?
ImpFunSpt == 'Somewhat' or *ImpFunSpt* == 'Very' = What would make it more fun so that you keep doing it?
WillBeActiv == 'Somewhat' or *ImpFunSpt* == 'Very' = What things could you start doing now that you want to do in the future?
FacActCount > 0 How could you make this something you do almost every day?
FavActCountSed = 3 = How could you make your favorite things more active?
PAClub = 'High' = What do you like about the club? How might you keep up your activity level after it's over?
PAClub = 'Low' = You haven't been coming to GOAL club after school very much- what is stopping you?

**Social Support Logic Definitions*:*
SSTake = Someone takes me to play sports or exercise
SSPlaysW = Someone exercises or plays active games or sports with me
SSEnc = Someone encourages me to exercise
SSWatch = Someone watches me exercise, play active games, or do sports
SSCongrat = Someone congratulates or tells me I am going well with my exercise, physical activity, or sports

SSPlan = Someone plans things to help me be physically active (brings friends over; sets up car pool)

SSPay = Some pays money for physical activities or sports for me

SSBuy = Someone buys clothes or equipment for me so I can be physically active or do sports

SSCount = How many types of social support girls report as 'sometimes' or 'often'

SSWho = How many people the girls report as people who help her exercise, be active, or do sports by doing things for or with her

Support = High = The sum of the social support responses $\geq$ 12

Support = Low = The sum of the social support responses < 12

SupportMI1= What types of support do you need to be active every day? What kinds of things would you like people to help you with?

SupportMI2= What are some things you might do to be active every day, even if you do not have a lot of support?

SupportMI3= How can each person help you be active?

Self-Efficacy Logic Definitions*:*

EffMostDays = I can be active in my free time on most days

EffTV = I can be active in my free time on most days instead of watching TV or playing video games

EffHotCold = I can be active or play games or sports in my free time on most days when it is hot or cold outside

EffHome = I can be active in my free time on most days when I have to stay home

EffSkill = I have the skills I need to be active in my free time on most days

EffBusy = = I can be active in my free time on most days even when I am busy

Self-Efficacy = High = The average score of the responses was > 2.5

Self-Efficacy = Low = The average score of the responses was < 2.5

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