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SAN DIEGO STATE UNIVERSITY

Lapse, Relapse and Maintenance in Physical Activity Interventions for Latina Women

A dissertation submitted in partial satisfaction of the
requirements for the degree Doctor of Philosophy

in

Public Health

by

Andrea Susana Mendoza Vasconez

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2019

The Dissertation of Andrea Susana Mendoza Vasconez is approved, and it is acceptable in quality and form for publication on microfilm and electronically:

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2019

DEDICATION

To my parents, Alicia and Nicolas, for believing in me, for teaching me to dream big and work hard, and for always prioritizing my education.

To my husband, Peter, for being by my side and supporting me through all these years, for all the sacrifices made for our family, and for taking pride in my accomplishments as if they were your own.

To my daughter, Olivia, for inspiring me to be a better version of myself and inspiring me to work to make the world a better place.

I love you all. There is a little piece of each of you in this work.

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ABSTRACT OF THE DISSERTATION

Lapse, Relapse and Maintenance in Physical Activity Interventions for Latina Women

by

Andrea Susana Mendoza Vasconez

Doctor of Philosophy in Public Health

University of California San Diego, 2019
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Background: This dissertation aimed to add to the limited body of research on the subjects of PA maintenance, lapses in PA, and relapse into inactivity among Latina participants in PA interventions.

Methods: Study 1 used survival analysis methods to determine the probability of lapses in PA and to identify predictors of time until lapse, among Latina participants in two PA interventions. Study 2 used qualitative methods (i.e., semi-structured individual interviews with 21 Latina women) to (1) identify facilitators and barriers to PA maintenance; (2) examine similarities and differences between those who maintained PA and those who did not; and (3)

create a conceptual model to understand determinants of PA maintenance. Study 3 was a pilot randomized controlled trial (N=27) that used a nested analysis of quantitative and qualitative data to (1) assess maintenance of PA among Latina women who completed a PA intervention; (2) understand whether participants were satisfied or dissatisfied with their maintenance; (3) evaluate the feasibility and preliminary efficacy of smartphone apps for PA maintenance; and (4), explore the role that smartphone apps played in PA maintenance (if any).

Results: Study 1 revealed predictors of earlier lapse, including 2-month scores of Self-Efficacy and various Processes of Change. With one exception, environmental and individual factors were not predictive of earlier lapse. Study 2 identified potential facilitators of PA maintenance: habit, ability to overcome obstacles, specific sources of motivation, having knowledge and skills to maintain PA, and a supportive social and built environment. In study 3, mean minutes/week of self-reported moderate to vigorous PA (MVPA) was 16.85 (SD=24.73) before the intervention, 230.50 (SD=199.29) immediately after the intervention, and 163.10 (SD=125.49) after the maintenance period. There were significant effects of time, but not of group assignment, on self-reported PA. Nine (64%) enhanced maintenance participants reported using apps for PA maintenance. Reasons for not using apps included not finding them appealing or necessary.

Conclusions: Lapse and relapse into inactivity were not pre-determined by individual or environmental factors; skills needed to prevent such events and achieve long-term maintenance of PA outcomes may be taught and need to be incorporated into future PA interventions.

CHAPTER 1:

INTRODUCTION

Physical Activity (PA) Among Latinos

Participation in regular physical activity (PA), particularly of moderate or vigorous intensity, is associated with numerous health benefits.[1] PA plays an important role in preventing and managing chronic illnesses that are leading causes of morbidity and mortality in the United States, such as cancer, cardiovascular disease, and diabetes.[2-4] Among adults, PA decreases risk of mortality, even if performed in low doses (i.e., low intensity, duration, and frequency).[5,6] Additional benefits of PA include improved sleep,[7] reduced depression and anxiety,[8] and higher cognitive functioning.[9]

Based on early releases from the National Health Interview Survey, in 2018 approximately half of the US population did not meet the 2008 National aerobic PA Guidelines,[10] which recommend that adults engage in a minimum of 150 minutes per week of moderate intensity activity or in 75 minutes per week of vigorous intensity activity.[11] Moreover, the prevalence of individuals meeting National PA guidelines is lower among ethnic minority populations.[12] For example, approximately 47.6% of Latinos, who are the largest ethnic minority group in the US, report meeting PA guidelines, compared to 57.4% of non-Hispanic Whites.[10] PA is particularly low among Latina women compared to men; findings of a large cohort study involving Latinos in four urban areas of the US found that only 31% of Latina women, compared to 51% of Latino men, met PA recommendations.[13]

Considering the multiple health benefits associated with PA, addressing the current disparities in PA participation will be necessary to "achieve health equity, eliminate disparities, and improve the health of all groups," which is one of the overarching goals of the National

health plan set forth in Healthy People 2020.[14(p3)] PA promotion research has increasingly

focused on identifying and implementing strategies to help individuals from at-risk minority

populations such as Latinas, to engage in PA and obtain the ensuing health benefits.

Nevertheless, PA promotion research has focused on PA initiation and maintenance of PA is less

well understood.[15] Similarly, among Latina women, multiple studies have succeeded in helping

inactive participants to increase their engagement in PA,[15-24] and there is limited research on how

to help participants to avoid relapsing and to attain long-term maintenance of PA.[25] PA

maintenance is important to achieve and sustain the health benefits associated with participation

in PA.[26]

Lapses in PA and Relapse into Inactivity

In behavioral research, relapse has been defined as "the lack of action or the lack of

performance of a particular behavior (or performing below a recommended level) that has been

previously performed."[27] Lapse, in comparison, has been conceptualized as a temporary slip in

PA enagement.[28] Across different behaviors, individual-level factors (e.g., depression, lack of

motivation, lack of coping skills) have been found to influence lapses in activity and relapse into

inactivity.[29,30] For example, in the field of smoking, abstinence self-efficacy and smoking

outcome expectancies have been shown to predict lapses and relapse.[31] Interpersonal factors,

such as lack of social support, and environmental factors, such as exposure to environmental

cues, have also been found to play a role in PA lapses and relapses.[29,30] While the study of lapse

and relapse requires the availability of multiple time points of data collection, in PA intervention

trials, PA is usually assessed at limited time points (typically at the beginning and upon

completion of interventions). Thus, to date little is known regarding factors that may lead to

lapses and relapses among participants in PA interventions, and factors that may help overcome

lapses. Our ability to implement strategies to prevent lapses and relapses in PA interventions is thus hindered by our limited knowledge on the predisposing factors.

Maintenance of PA

Long-term PA maintenance is important to achieve and sustain good physical fitness and to reap its health benefits, including decreased risk of all-cause mortality and of chronic illnesses such as cancer and cardiovascular disease.[32-34] However, most PA promotion studies reported in the literature (among the general population and among specific priority populations such as Latina women) do not assess maintenance of PA after intervention completion.[35-37] Thus, little is known regarding whether the PA is sustained once the support from research staff is withdrawn. Among the few studies that have assessed PA maintenance outcomes, few have reported successful maintenance of PA.[36-38]

Tapered intervention doses, or boosters, have been employed in various studies to support PA maintenance.[39-41] These "tapered maintenance" periods, however, still require researchers to maintain contact with participants, resulting in extended costs and staff time. Moreover, PA maintenance appears to be proportional to the amount of intervention boosters received, and fades once all support is withdrawn.[15] Little is known regarding specific strategies used by individuals to successfully maintain PA once interventions end and the support of researchers is withdrawn.[35,37,42] Thus, there is a need for further research on the long-term maintenance outcomes of PA interventions and on strategies to help individuals maintain PA once they have completed PA interventions.

Theoretical Basis for the Dissertation

The use of health behavior theories is important in health promotion, as theories may provide tools for the development of behavioral interventions to increase the desired behavior.[43]

The studies encompassed in this dissertation were conceived in the framework of the

Transtheoretical Model (TTM)[44] and Social Cognitive Theory (SCT).[45] The TTM and SCT are

two of the most widely used theories of health behavior for the promotion of PA among different

populations, including Latinos[46]; Many TTM and SCT-based PA interventions have shown

efficacy in helping individuals initiate PA, albeit with questionable and understudied long-term

maintenance effects.[47,48]

SCT stipulates that behavior is shaped by the interaction between personal factors (e.g.,

outcome expectations, self-efficacy), the environment, and characteristics of the behavior (e.g.,

enjoyment and outcomes obtained by performing the behavior).[45] SCT suggests that individuals

with higher self-efficacy (i.e., the confidence in one's ability to engage in a behavior), greater

behavioral capability (i.e., having the knowledge/skill to engage in a behavior) and more positive

outcome expectancies (i.e., outcomes expected when engaging in a behavior) are more likely to

adopt a behavior. Consequently, several behavior change strategies may be used to increase self-

efficacy, behavioral capability, and positive outcome expectancies, including modeling,

reinforcement, promoting enjoyment, social support, goal-setting, planning, self-monitoring, and

feedback. These strategies are further described in Table 1.1.

The TTM describes individuals' progression through different steps or stages to achieve

behavior change: Precontemplation, Contemplation, Preparation, Action, Maintenance, and

Termination; the latter stage is seldom used in practice, especially with behaviors like PA.[49]

TTM also outlines procedures and strategies, referred as processes of change (further described

in Table 1.2), which people may use to transition between stages. Processes of change have been

categorized as *experiential* and *behavioral*. *Experiential* processes are mainly used to aid in the

transition during earlier stages of change. The later stage transitions are hypothesized to rely on

behavioral processes of change.[49] The TTM thus offers a framework for tailoring intervention materials to individual needs according to their stage of change. Moreover, the TTM stipulates a maintenance stage, and suggested behavioral strategies (processes of change) that may be used to maintain behavior.

In previous studies, various SCT and TTM theoretical constructs (e.g., self-efficacy, social support, and expecting less negative outcomes from exercise) have been found to play different influential roles among relapsers and non-relapsers.[30,50-53] Consistent with SCT, characteristics of the behavior (e.g., intensity, duration, and frequency of PA), of the individual (e.g., educational attainment and body mass index), and of the environment (e.g., residing in an urban area) have been found to affect individuals' ability to sustain PA and avoid lapses and relapses.[30,54] Additionally, some research suggests that relapse may be associated with individual factors (e.g., depression), whereas lapses may be associated with social and environmental factors.[29,54] Additionally, theoretical constructs such as self-efficacy and social support appear to increase the likelihood of recovery from lapses.[27,55] Further exploration of these constructs' potential to influence lapse, relapse, and maintenance of PA is necessary given the scarcity of research on the subject.

Tables 1.1 and 1.2 outline the theoretical constructs and strategies that were used for data collection and analysis in each of the dissertation studies. For study #1 (a quantitative research study with aims described below), questionnaires that measured TTM and SCT constructs and strategies (e.g., self-efficacy, processes of change) were used for data collection. In data analyses, these TTM and SCT-based variables were studied as predictors of time to first lapse and of lapse recovery. For study #2 (a qualitative research study with aims described below) TTM and SCT constructs and strategies were used to formulate theory-based open-ended

questions. For study #3 (a nested analysis mixed-methods research study with aims described below), TTM and SCT variables guided the selection of smartphone apps to help with PA maintenance.

Dissertation Aims

The present dissertation aimed to add to the limited body of research on the subject of PA maintenance, lapses in PA, and relapse into inactivity among Latina participants in PA interventions. The dissertation is composed of three studies with the following aims:

Study #1 (Chapter 2): Lapse, Relapse and Recovery in Physical Activity Interventions for Latinas: a Survival Analysis

Aims:

1. To determine the probability of first lapse during two PA interventions for Latinas.

2. To assess demographic, psychosocial, and environmental predictors of the amount of time until first lapse.

3. To identify factors that are predictive of lapse recovery (i.e., re-engaging in PA after a lapse has occurred).

Study #2 (Chapter 3): "I Now Feel the Need to Exercise": A Qualitative Study of Physical Activity Maintenance among Latinas

Aims:

1. To identify potential facilitators of PA maintenance and obstacles that may lead to non-maintenance.

2. To examine similarities and differences between participants who reported maintaining their PA and those who did not.

3. To create a conceptual model that will help researchers to better understand determinants of PA maintenance and guide the development of strategies to encourage maintenance beyond PA interventions.

Study #3 (Chapter 4): What Is App with Maintenance? Regular and Enhanced Maintenance of PA after an Intervention for Latinas

Aims:

1. To quantitatively assess maintenance of PA among Latina women who increased their level of PA as a result of an individually-tailored PA intervention.

2. To qualitatively understand whether participants were satisfied or dissatisfied with their maintenance.

3. To quantitatively evaluate the feasibility and preliminary efficacy of using commercial smartphone apps as tools for maintenance of PA, compared to a no-treatment control

4. To qualitatively explore the role that smartphone apps played in PA maintenance (if any).

Implications

This dissertation thus will add to the research field by providing more information about areas of research that are not well understood (i.e., lapse, relapse, and maintenance of PA) among a specific priority population (i.e., Latina women). A greater understanding of PA maintenance will allow us to develop and implement strategies to prolong PA intervention effects, augmenting their public health impact. Similarly, increased knowledge on patterns of lapse and relapse will help us to develop and implement strategies to prevent such events in future interventions. Moreover, identifying participants who are at risk of lapse and relapse after beginning to exercise

will enable the tailoring of such strategies to their specific needs, potentially improving the

efficacy of PA interventions.

Table 1.1: SCT Constructs and Strategies Used in Each of the Studies

Construct	Strategy	Definition	Used in study		
			#1	#2	#3
Reciprocal determinism		Behavior influences and is influenced by personal and environmental factors.	✓	✓	
Observational Learning	Modeling	Learning by observing others perform a behavior.	✓	✓	✓
Outcome Expectancy		Outcomes expected when engaging in a behavior (may expect outcomes that models have attained).		✓	
	Reinforcement	Outcomes obtained when engaging in a behavior (Incentives for engaging in a desired behavior).		✓	✓
	Enjoyment	Increasing enjoyment of PA	✓	✓	✓
Self-efficacy*		The confidence in one's ability to engage in a behavior.	✓	✓	✓
Behavioral capability		Having the knowledge/skill to engage in a behavior (interventions use goal-setting, planning, self-monitoring, and feedback to increase behavioral capability).		✓	
	Goal-Setting	Setting PA goals that are specific, measureable, attainable, realistic, etc.		✓	✓
	Planning	Making specific plans to achieve the goals, including schedules, lists, anticipated barriers and high risk situations, etc.		✓	✓
	Self-monitoring and Feedback	Tracking the behavior and receiving feedback regarding progress in order to adjust behavior if needed.	✓	✓	✓

* Self-efficacy is also a construct of TTM

Table 1.2: TTM Constructs and Strategies Used in Each of the Studies

Construct	Strategy	Definition	Used in study #1	#2	#3
Cognitive Processes		Strategies used to aid in the transition during earlier stages of change.	✓		
	Consciousness Raising	Increasing knowledge and awareness of the behavior.	✓		
	Environmental Reevaluation	Realizing that one's behavior may affect and influence others around.	✓		
	Dramatic Relief	Feeling fear or anxiety over the unhealthy behavior, and relief when presented with the healthy option.	✓		
	Social Liberation	Realizing that others around support or are engaging in the healthy behavior.	✓		
	Self-Reevaluation	Changing the image of oneself to incorporate healthy behavior as part of one's identity.	✓		
Behavioral Processes		Strategies used to aid in the transition during later stages of change.	✓		
	Self-Liberation	Commit to make a change and adopt a health behavior.	✓		
	Helping Relationships	Finding people to provide social support for the behavior.	✓	✓	✓
	Counter Conditioning	Replacing unhealthy behaviors for healthy ones.	✓	✓	
	Reinforcement Management	Rewarding engagement in health behavior.	✓	✓	✓
	Stimulus Control	Replacing environmental cues that promote unhealthy behavior for those that promote health behavior.	✓	✓	✓
Decisional Balance		Weighing the *Pros* and *Cons* of engaging in the health behavior.		✓	

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CHAPTER 2:

LAPSE, RELAPSE AND RECOVERY IN PHYSICAL ACTIVITY INTERVENTIONS FOR LATINAS: A SURVIVAL ANALYSIS

ABSTRACT

Background: Physical activity (PA) research extensively focuses on initiation of PA, yet lapse and relapse among PA intervention participants are less well understood, particularly among minority populations such as Latinas.

Purpose: To (1) determine the probability of lapse during two PA interventions for Latinas; (2) assess demographic, psychosocial, and environmental predictors of the amount of time until first lapse; and (3) identify factors predictive of lapse recovery.

Methods: Data from 176 Latina intervention participants were pooled. Survival functions and Kaplan-Meier curves were used to illustrate the probability of lapse. Univariate and multivariate Cox proportional hazard models assessed predictors of time to lapse. Univariate logistic regression models identified predictors of lapse recovery.

Results: The probability of lapse after 1 month of starting to exercise was 18%; it gradually increased to 34% after 4 months. Variables predictive of earlier lapse included 2-month scores of Self-Efficacy and various Processes of Change. None of the measured environmental factors, and only one individual factor ($>= 2$ children under 18) significantly predicted time to lapse. Increased use of Consciousness Raising at 2 months was associated with lower likelihood of lapse recovery, yet use of Behavioral Processes of Change at six months was associated with higher likelihood of recovery.

Conclusions: Lapsing may not be pre-determined by individual or environmental factors. On the other hand, skills that can be learned through interventions, such as stimulus control or

skills to improve self-efficacy, seem important in the delay or prevention of lapses. ***Results***

pertaining to lapse recovery are less clear.

Key words: Hispanic, exercise, maintenance, Transtheoretical Model, Social Cognitive Theory

Introduction

Physical activity (PA) promotion research has extensively focused on initiation of PA,[1-3] yet issues pertaining to lapse and relapse into inactivity among PA intervention participants are less well understood.[4] Lapse and relapse prevention research is important, as individuals need to sustain exercise beyond an initial stage to see long-term health benefits.[5] Nevertheless, longitudinal epidemiologic studies suggest that individuals' PA levels do not remain constant throughout the years, and internal and external factors may lead to lapses of physical inactivity.[6-8] Research also suggests that individuals who are actively participating in PA interventions are at risk of lapse or relapse into inactivity once they have successfully managed to increase their PA.[9,10]

In behavioral research, a lapse has usually been conceptualized as a temporary slip,[11] while relapse has been defined as "the lack of action or the lack of performance of a particular behavior that has been previously performed."[12] Thus, while relapse may be an outcome, lapse is the process that could eventually, but not necessarily, lead to that outcome.[13] This distinction is important, as it invites researchers to identify strategies not only to prevent initial lapses, but also to preclude progression into relapse once an initial lapse has occurred.

Cross-sectional and cohort epidemiologic studies have found theoretical constructs such as self-efficacy, social support, and outcome expectations to be associated with decreased likelihood of lapse or relapse into inactivity.[9,14-16] The use of processes of change, a construct of the Transtheoretical Model (TTM).[17] has also been found to distinguish between individuals who relapse and those who do not relapse in PA promotion research; this is particularly true for behavioral processes of change such as Counter Conditioning, Helping Relationships, Self Liberation, and Stimulus Control.[18] Additionally, it has been posited that individual-level factors

such as depression, anxiety, stress, lack of motivation, and lack of coping skills, in conjunction with social factors (e.g., lack of support from family and friends), and environmental factors (e.g., exposure to environmental cues) may be associated with lapse and relapse across different behaviors.[13,15] Other studies have also identified factors that may lead to progression from lapse to relapse.[19] It has been suggested that relapse may be associated with individual and mental health-related factors, whereas lapses may be associated with social and environmental factors.[13]

Typically in PA interventions, PA outcomes are assessed at very limited time points (i.e., usually baseline and follow-up only). These standard assessment procedures might miss patterns of lapses and relapses that may arise throughout participation in the intervention. To advance the field of PA promotion and intervention research, it is vital that we understand the prevalence and probability of lapse and relapse among intervention participants. Moreover, to be able to prevent lapses and relapse into inactivity during PA interventions, researchers need to understand factors that may increase or decrease the risk of lapse and relapse, as well as factors that might lead to overcoming lapses of inactivity. It is also important to focus on populations that engage in less PA, such as Latina women. Latinas comprise a large ethnic subgroup in the US, and are at an elevated risk of inactivity and related diseases.[20-23] While in recent years various studies have focused on the promotion of PA among Latinas,[24-26] much like in the general population there is a dearth of research on lapse and relapse during PA interventions for Latinas.

The present study aimed to (1) determine the probability of first lapse during two PA interventions for Latinas; (2) assess demographic, psychosocial, and environmental predictors of the amount of time until first lapse; and (3) identify factors that are predictive of lapse recovery (i.e., re-engaging in PA after a lapse has occurred).

Methods

Study Sample and Data Collection

To achieve the study aims, we conducted a secondary analysis of data pooled from the intervention arm of two PA promotion studies, Seamos Saludables[27] and Pasos Hacia La Salud.[28] As shown in the flow diagram in Figure 2.1, the total sample comprised 176 participants who increased their PA levels to at least 60 minutes/week of moderate to vigorous PA (MVPA) at any point during the first five months of the interventions; 102 participants were from the Seamos Saludables study and 74 from the Pasos Hacia La Salud study.

The Seamos Saludables study was a randomized controlled trial of a culturally and linguistically adapted, individually tailored PA print intervention for Latinas, compared to a wellness contact control condition. Data were collected between 2009 and 2012 in Providence, RI. Eligible participants were underactive (< 60 minutes per week of moderate to vigorous PA) Latina women between the ages of 18 and 65 who could read and write in Spanish. Further details regarding the Seamos Saludables Study have been previously published.[27,29,30]

Similarly, the Pasos Hacia La Salud study was a randomized controlled trial of a culturally and linguistically adapted, individually tailored, Internet-based PA intervention for Latinas, compared to a wellness contact control condition. Data were collected between 2011 and 2014 in San Diego, CA. Further details regarding the Pasos Hacia La Salud study may be found in previous publications.[28,31,32] The same eligibility and exclusion criteria applied in Seamos Saludables was used in the Pasos Hacia La Salud study. Both studies, which were very similar in content but differed in the form of delivery (print versus internet), found that increases in self-report and accelerometer-measured PA were significantly greater for the intervention arm, compared to the control arm.[27,28] Both studies comprised active interventions that spanned 6

months (compared to wellness control groups), and both had an additional 6-month tapered maintenance period.

Physical Activity Measurement and Outcome Variables

Monthly PA information was collected via self-report using the Stages of Change for Physical Activity questionnaire.[33] This questionnaire uses two items to assess participants' PA: (1) How many days per week are you physically active? and (2) Approximately how many minutes do you participate in physical activity each of those days? For the present study, PA data collected through these monthly questionnaires, which significantly correlate with 6-month 7-day PAR (r=0.3, p<0.001) and accelerometer data (r=0.2, p<0.01, respectively) among our study sample, were used to create the following outcome variables:

Start Time

This categorical variable ranged from 2 to 5, depending on the month in which participants started engaging in more than 60 minutes of PA per week. While we contemplated using 150 minutes, in accordance with National PA recommendations,[34] various considerations led us to use 60 minutes as a cut off to classify participants as active or inactive: First, in previous research, including the Seamos Saludables and the Pasos Hacia La Salud studies, 60 minutes of PA per week has been used as a cut off to classify participants as inactive[29,32]; additionally, while most participants in the Seamos Saludables and Pasos Hacia La Salud trials increased their MVPA, few reached National guidelines.[27,28] Given that most of these participants started the interventions with really low levels of PA (averages of 9.9 and 38.6 minutes of accelerometer-measured MVPA per week for Seamos Saludables and Pasos Hacia La Salud participants, respecrively), we deemed 60 minutes of MVPA/week to be a more realistic threshold.

Time to First Lapse

Currently there is no consensus regarding the operationalization of lapse in PA research, and the PA threshold to determine whether a lapse has occurred.[11] In this study, a lapse was considered a drop below 60 minutes/week of PA among participants who had previously reported levels equal to or above 60 minutes/week of PA. This is consistent with some studies identified in the research literature.[8,12] Thus, the variable *Time to First Lapse* was a categorical variable ranging from 3 to 6 depending on the month in which participants' PA first dropped below 60 minutes/week of PA.

Censoring Variable

Participants who never experienced a lapse were censored using a dichotomous censoring variable that was set to zero if a participant did not lapse and set to one if a participant lapsed.

Lapse Recovery

There is no consensus regarding how to operationalize the distinction between lapse and relapse.[11] For the purposes of this study, we reassessed participants' status on a monthly basis. Among all participants who lapsed, if by the end of the study they started engaging in PA again (> 60 minutes/week of PA), we considered the interruption a lapse. If participants did not start exercising again, we considered the interruption a relapse. For this analysis, we excluded participants who never lapsed and those who lapsed during the last month of the study, and thus did not get the opportunity to show recovery. The dichotomous variable *lapse recovery* was created to distinguish between lapsers and relapsers.

Predictor Variables

Individual factors. Baseline demographic questionnaires were used to assess demographic variables (i.e., age, education, income, employment and marital status).

Additionally, height and weight were measured at baseline and 6 months using a stadiometer and a scale, and Body Mass Index (BMI) was calculated. The Center for Epidemiologic Studies Short Depression Scale (CES-D) was used to measure Depression Symptoms at baseline and six months; this scale has shown acceptable reliability and validity in previous studies with Latino populations in the United States.[35,36] Among our study sample, the scale had a reliability estimate (Cronbach's alpha) of 0.8 using 6-month data (note that 6-month data are reported because it had a wider range compared to baseline data). The Perceived Stress Scale (PSS) was used to measure perceived stress at baseline and 6 months; this scale has also shown good reliability and validity among different populations, including Latinos.[37-39] Among our study sample, the scale had a reliability estimate (Cronbach's alpha) of 0.85 using 6-month data.

Psychosocial mediators of behavior. Self-efficacy for PA was measured at baseline, 2-months, and 6 months using the Self-Efficacy for PA scale[40]; this scale has shown acceptable internal consistency and validity among different populations, including Latinas in the US,[41,42] and has been previously used in other studies with Latinos.[43,44] Among our study sample, the scale had a reliability estimate (Cronbach's alpha) of 0.8 using 6-month data. Social support was measured using the family and friends subscales of the Social Support for Exercise scale,[45] which have shown acceptable internal consistency and validity[45] and have been used in other studies with Latinos in the US.[43,44] Among our study sample, using 6-month data, reliability estimates (Cronbach's alpha) were 0.93 and 0.96 for the family and friends subscales, respectively. The PA Enjoyment scale[46] was used to measure enjoyment of PA at baseline and at the 6-month follow-up; this scale has been validated among different populations, including Spanish-speaking Latinos.[47-49] Among our study sample, the scale had a reliability estimate (Cronbach's alpha) of 0.97 using 6-month data. The Processes of Change for PA questionnaire[50]

was used at baseline, month 2, and month 6 to measure participants' use of each of the ten cognitive and behavioral processes of change outlined in the TTM.[51] The 4-item subscales in this questionnaire have shown acceptable internal consistency[50] and have been used in other studies with Latinos in the US.[43,44] Among our study sample, using 6-month data, the subscales' reliability estimates (Cronbach's alpha) ranged from 0.66 to .88.

Environmental factors. The Neighborhood Environment Walkability Scale, Abbreviated (NEWS-A)[52] was used at baseline and 6 months to assess different factors pertaining participants' perception of their built environment (e.g., Residential density, Land Use Mix). This scale has shown acceptable criterion and factorial validity[53] and has been used in other studies with Latino populations.[43,44] Among our study sample, using 6-month data, the NEWS subscales had reliability estimates (Cronbach's alpha) ranging from 0.28 to .95 (note: some subscales consist only of 3 items, which might account for low reliability estimates).

Data Analysis and Interpretation

All data analyses were conducted using RStudio Version 0.99.486. Descriptive analyses were conducted to summarize demographic characteristics. T-tests of differences between means and Chi Squares were used to identify differences between Seamos Saludables and Pasos Hacia La Salud participant characteristics (e.g., age, country of origin, education, income).

Illustrating the Probability of first lapse. A survival function was fit to our data, and Kaplan-Meier curves were generated to illustrate the probability of first lapse. We also generated survival functions and Kaplan-Meier curves for Seamos Saludables and Pasos Hacia La Salud participants separately to compare their probability of first lapse, using the likelihood ratio test to compare the two survival functions. Similarly, we generated survival functions and Kaplan-Meier curves for participants who increased their exercise immediately upon starting the

intervention, and for those who increased their exercise after the first two months of the intervention. We again compared the probability of first lapse among these two different groups of participants by comparing their survival functions using a likelihood ratio test.

Assessing the effect of different predictor variables on survival time. We first calculated the hazard ratio of the different baseline and 2-month predictor variables using univariate Cox proportional hazard models. We subsequently created a proportional hazard regression model to model the hazard of lapse as a function of multiple predictor variables at once, selecting those variables that had at least approached significance (i.e., $p<0.1$) in univariate analyses. Nevertheless, because of the high correlation among the variables corresponding to the different behavioral processes, and because of sample size restrictions, the overarching variable "Behavioral Processes of Change" was used, instead of the individual behavioral processes of change variables. To establish temporal precedence, 6-month predictor variables were not used in these models.

Identifying variables predictive of and associated with lapse recovery. We used univariate logistic regressions to identify predictor variables that had a significant effect on likelihood of relapse versus lapse. A dichotomous variable *Lapse Recovery (1=recovered, or increased PA again to >=60 minutes/week at any point after a lapse)* was created. This variable was regressed on all predictor variables, including all baseline, 2-month, and 6-month values.

Sensitivity analysis. We repeated all univariate and multivariate analyses under the assumption that having two or more missing time points consecutively represented a lapse. Thus, while some participants who had missing data were censored in the original analysis, per standard survival analysis techniques, in sensitivity analysis these participants were considered to have lapsed.

Results

Baseline sample characteristics are presented in Table 2.1. Participants in both Seamos

Saudables and Pasos Hacia La Salud had similar characteristics, yet Seamos Saludables

participants had significantly lower levels of education and were engaging in less PA, compared

to Pasos Hacia La Salud participants. Additionally, the majority of Pasos Hacia La Salud

participants were of Mexican origin (83%), while Seamos Saludables participants were mainly

Dominican (35%) and Colombian (30%).

Illustrating the Probability of First Lapse

The probability of first lapse after one month of having started to exercise was 18%, and

it periodically decreased so that after two months, the probability was 25%, then 30% after three

months, and 34% after four months. There was no significant difference between the two

interventions in terms of probability of first lapse. However, participants who started exercising

from the beginning of the intervention were significantly less likely to lapse than those who

started after longer than two months (comparing survival functions for both groups, likelihood

ratio test = 19.64, df=1, p<0.001). Those who did not start to exercise right away (by the second

month of the study) had a hazard of lapse that was 3.5 times higher than those who started right

away (HR = 3.5). Kaplan-Meier curves illustrating the probability of first lapse comparing

participants who started exercising from the beginning and those who did not are shown in

Figure 2.2.

Assessing the Effect of Different Predictor Variables on Survival Time

Individual Factors

Participants who had two or more children under the age of 18 were at increased risk of

lapse (β=0.67, SE=0.30); as shown in Table 2.2, the risk of lapse for these participants was

almost double compared to that of participants who had no children under 18. None of the other individual factors measured at baseline, including age, BMI, ethnic background, education, employment status, income, marital status, and number of children under 5, significantly predicted time to lapse among study participants.

Psychosocial Mediators of Behavior

None of the psychosocial mediators of behavior measured at baseline significantly predicted time to lapse. Social support from friends at baseline approached significance (β=-0.04, SE=0.02), as shown in Table 2.2. However, several psychosocial mediators of behavior measured two months after the beginning of the intervention significantly predicted time to lapse. Specifically, as shown in Table 2.2, participants with higher Self-Efficacy at two months had lower risk of lapse, as did those with greater use of processes of change including Consciousness Raising, Counter Conditioning, Reinforcement Management, and Stimulus Control. Additionally, Self Liberation approached significance. A one-point increase in Self-Efficacy (scale 1-5), for example, reduced the hazard of lapse by 58%, while a one-point increase in the use of Behavioral Processes of Change reduced the hazard by 46%, as shown in Table 2.3.

Environmental Factors

None of the environmental factors measured using the NEWS-A at baseline were significant predictors of time to lapse. Crime Safety approached statistical significance (β=0.27, SE=0.15).

Multiavariate Model

In a multivariate model that included all variables that at least approached significance (p<.1), only Self-Efficacy remained an important predictor of time to lapse, as shown in Table 2.3. A one-point increase in Self-Efficacy decreased the hazard of lapse by 41%.

Identifying Variables Predictive of and Associated with Lapse Recovery

Using baseline and 2-month predictor variables, Consciousness Raising at 2 months was the only variable that significantly predicted a lapse recovery (β=-1.06, SE=0.48, p=0.03); those who used Consciousness Raising more at 2 months were less likely to recover from lapses.

Six-month variables associated with lapse recovery included Behavioral Processes of Change (β=1.31, SE=0.56, p=0.02), Reinforcement Management (β=0.88, SE=0.41, p=0.03) and Stimulus Control (β=1.89, SE=0.69, p=0.01).

Sensitivity Analysis

For sensitivity analysis, we repeated all analyses assuming that two or more consecutive missing data points represented a lapse. Similar results were obtained, with some exceptions: In univariate analyses, crime safety did not approach significance as it did in the original analysis; social support from friends was statistically significant at the .05 level instead of just approaching significance.

In a multivariate model, sensitivity analyses revealed more variables that significantly contributed to the model, as shown in Table 2.3. Specifically, while in the original analysis only Self-Efficacy remained a significant predictor in the multivariate model, in sensitivity analyses having two or more children under 18 and use of Behavioral Processes of Change also remained significant in addition to Self-Efficacy.

Additional variables were predictive of lapse recovery. Specifically, higher BMI at baseline (β=-0.71, SE=0.35, p=0.04) and perception of high street connectivity in the neighborhood at baseline (β=-0.64, SE=0.3, p=0.04) were associated with lower likelihood of recovery from a lapse. Additionally, use of the following processes of change at 2 months was predictive of lapse recovery: Consciousness Raising (β=-0.69, SE=0.31, p=0.03); Self-Liberation

(β=-0.74, SE=0.31, p=0.02); and Reinforcement Management (β-0.71, SE=0.35, p=0.04). Use of the following processes of change at 6 months was associated with lapse recovery: Experiential Processes of Change (β=0.68, SE=0.31, p=0.03), Behavioral Processes of Change (β=1.31, SE=0.39, p<0.01), Social Liberation (β=0.90, SE=0.32, p= 0.01), Self-Liberation (β=0.64, SE=0.25, p=0.01), Helping Relationships (β=0.66 , SE=0.29, p=0.02), Counter Conditioning (β=0.84, SE=0.29, p<0.01), Reinforcement Management (β=0.80, SE=0.28, p<0.01), Stimulus Control (β=1.95, SE=0.51, p<0.001).

Discussion

This study employed survival analysis techniques to identify factors that predicted time to first lapse among intervention participants who had started to exercise. Our results showed that beginning to exercise within the first two months of the intervention was protective against lapses. Consistent findings have been reported in the smoking-cessation research: participants who set an earlier quit date are more likely to quit smoking and less likely to lapse sooner, compared to those who delay the quit date.[54-56] Perhaps it is important to capitalize on the initial motivation that drives participants to join a PA study, and to focus more efforts on those who start exercising later and may thus be at higher risk of lapse. Special attention should then be devoted to those first months of PA interventions to ensure participants' success. For example, perhaps intervention dosage needs to be distributed in a way that counters this lapse curve, as suggested before in the smoking cessation literature[57]; thus, intervention doses may be higher at the beginning, when the risk of lapse is greater, and taper down with time.

This study also examined factors that might influence lapse, including individual characteristics (e.g., age, education, depression scores), environmental characteristics (e.g., safety from traffic, residential density), and psychosocial variables that can be modified through

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PA interventions (e.g., self-efficacy and use of processes of change). Our findings revealed that neither individual characteristics, nor environmental factors influenced lapse or relapse (with the exception of having >=2 children under the age of 18). Likewise, baseline levels of psychosocial constructs were not related to lapse or relapse in our models; this result was expected given that participants had low baseline scores in all psychosocial constructs, as they had not started the intervention yet. By the second month of the intervention, the average scores of psychosocial constructs increased. Using 2-month psychosocial variables as predictor variables, many of our Cox Proportional Hazard models were predictive of time to lapse or relapse.

Our results suggest that strategies that can be taught through PA interventions may be more relevant in the delay or prevention of lapses and relapses than any of the pre-determined factors of individuals and their environments. These results are consistent with findings across the health behavior literature. In the fields of weight loss, smoking cessation and other addictive behaviors, as well as in PA research, constructs of Social Cognitive Theory (SCT)[58] and the TTM[17] have been found to be associated with lapses and relapses.[9,14-16,18,59]

Our results pertaining to lapse recovery (and preventing relapses) are less clear. In our original analysis the use of Consciousness Raising at 2 months was predictive of not recovering from a lapse, which is the opposite of what we expected. Additionally, sensitivity analyses (which entailed the same analyses but under the assumption that two or more missing time points equals a lapse) also identified the use of processes of change (specifically, Self-Liberation and Reinforcement Management) at 2 months as predictive of non-recovery. On the other hand, the use of several processes of change at 6 months was associated with recovery from lapses. This latter analysis lacks temporal precedence, which hinders our ability to discuss causation. However, we are able to assert that those who recovered from lapses reported greater use of

certain strategies at 6-months, compared to those who did not recover; these strategies include Reinforcement Management and Stimulus Control (per our original analysis), and Social Liberation, Self-Liberation, Helping Relationships, Counter Conditioning, Reinforcement Management and Stimulus Control (per sensitivity analysis).

Sensitivity analyses also identified individual (i.e., BMI) and environmental (i.e., street connectivity) variables as predictive of lapse recovery (i.e., higher BMI and greater street connectivity was associated with a decreased likelihood of recovery). It may be that lapse recovery is influenced both by learned strategies and by pre-determined variables that cannot be modified through an intervention, as suggested by previous research.[12,60,61] Thus, it may be more important to focus on preventing lapses from the beginning, as lapse recovery may be more complex and contingent on factors that are not modifiable.

When we analyzed and compared the probability curves of Seamos Saludables and Pasos Hacia La Salud participants, we found the two to be remarkably similar. These two groups of participants were very different in certain demographic variables, including Hispanic subgroup and education level, yet they showed very similar risk of lapse across study time points. As this line of research has received little attention in the literature, it is unclear whether similar results would also be found with other populations. If consistent, we may be able to generalize levels of lapses in PA interventions and better plan interventions to prevent this.

There are certain limitations to this study, mainly those inherent to secondary data analyses. It is possible that the sample size may have been to small and thus the study underpowered to detect significant associations. Moreover, we did not have data to operationalize and evaluate the effect of some relevant constructs and strategies, such as outcome expectancies or goal-setting, on lapse and relapse. However, in our analyses we have included

some of the most important constructs and strategies outlined in health behavior theories, including self-efficacy, social support, self-monitoring, and all the TTM processes of change. Likewise, the available data prevented us from distinguishing between situational lapses (e.g., sickness in family) and other types of lapses that may be more relevant to this study (e.g., lapse as a result of lack of confidence). Nevertheless, this study has various strengths. While interventions usually only collect PA data at limited time points, we have monthly PA data. This study thus enabled us to better understand patterns of lapse and relapse that might usually be overlooked, yet may be important in helping individuals attain and sustain PA-related behavior change.

Table 2.1: Participants' Baseline Characteristics (N=176)

	SS Intervention (n=102)	PHS Intervention (n=74)
	Mean (SD)	Mean (SD)
Age	42.4 (9.8)	40.4 (10.8)
BMI	29.3 (4.2)	28.6 (5.3)
Accelerometer Physical Activity**	9.9 (35.0)	38.6 (78.7)
	%	%
Ethnic Background***		
Mexican	3.9	83.8
Dominican	37.2	0
Colombian	31.4	1.4
Other	27.4	14.9
Education*		
High School or Less	45.1	26.0
Technical School/Some College	32.4	37.0
College or Graduate School	22.5	37.0
Employment		
Unemployed	41.6	52.0
Full Time Employment	37.6	23.3
Part Time Employment	20.8	24.7
Income		
<20,000	50.0	43.2
20,000 – 39,999	27.6	37.8
>= 40,000	14.3	17.6
Marital status		
Married or Have Partner	66.7	58.1
Number of Children Under 5		
1 Child (Compared to no Children)	23.8	15.1
2 or More Children	8.9	4.1
Number of Children Under 18		
1 Child (Compared to no Children)	29.7	20.3
2 or More Children	30.7	35.1

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

Table 2.2: Significant Predictor Variables in Univariate Cox Proportional Hazard Models for Time to Lapse (N=176)

	Likelihood Ratio (df)	Parameter Estimates	Hazard Ratio, CI
1 Child Under 18	5.07 (2) [+]	β=0.20, SE=0.36	1.22 (0.60, 2.47)
2 or More Children Under 18*		β=0.67, SE=0.30	1.96 (1.08, 3.55)
Baseline Social Support (Friends) [+]	3.28 (1) [+]	β=-0.04, SE=0.02	0.96 (0.91, 1.01)
Self-Efficacy at 2 months**	15.24 (1) **	β=-0.66, SE=0.18	0.52 (0.36, 0.73)
Experiential Processes of Change at 2 months [+]	3.52 (1) [+]	β=-0.34, SE=0.18	0.71 (0.50, 1.01)
Consciousness Raising**	8.79 (1) **	β=-0.43, SE=0.14	0.65 (0.49, 0.86)
Behavioral Processes of Change at 2 months ***	11.85 (1) ***	β=-0.62, SE=0.18	0.54 (0.38, 0.76)
Self Liberation [+]	3.38 (1) [+]	β=-0.27, SE=0.14	0.76 (0.57, 1.01)
Counter Conditioning***	16.4 (1) ***	β=-0.54, SE=0.13	0.58 (0.45, 0.75)
Reinforcement Management**	9.85 (1) **	β=-0.48, SE=0.15	0.62 (0.46, 0.83)
Stimulus Control**	11.81 (1) **	β=-0.53, SE=0.16	0.60 (0.43, 0.81)
Baseline Neighborhood Environment			
Crime Safety [+]	3.09 (1) [+]	β=0.27, SE=0.15	1.32 (0.97, 1.78)

[+] p<.1, * p<.05, ** p<.01, *** p<.001

Table 2.3: Multivariate Cox Proportional Hazard Models for Time to Lapse (N=176)

	Original Analysis Likelihood Ratio Test = 25.59, df=7, p<0.001	Sensitivity Analysis Likelihood Ratio Test = 43.21, df=6, p<0.001
1 Child Under 18	B=-0.03, SE=0.37	B=0.55, SE=0.30 [+]
2 or More Children Under 18	B=0.44, SE=0.32	B=0.56, SE=0.28*
Social Support (Friends)	B=-0.03, SE=0.02	B=-0.03, SE=0.02 [+]
Self-Efficacy	B=-0.52, SE=0.20*	B=-0.38, SE=0.16*
Consciousness Raising	B=-0.11, SE=0.21	B=-0.09, SE=0.15
Behavioral Processes of Change	B=-0.22, SE=0.28	B=-0.58, SE=0.15***
Crime Safety	B=0.20, SE=0.16	N/A

[+] p<.1, * p<.05, ** p<.01, *** p<.001
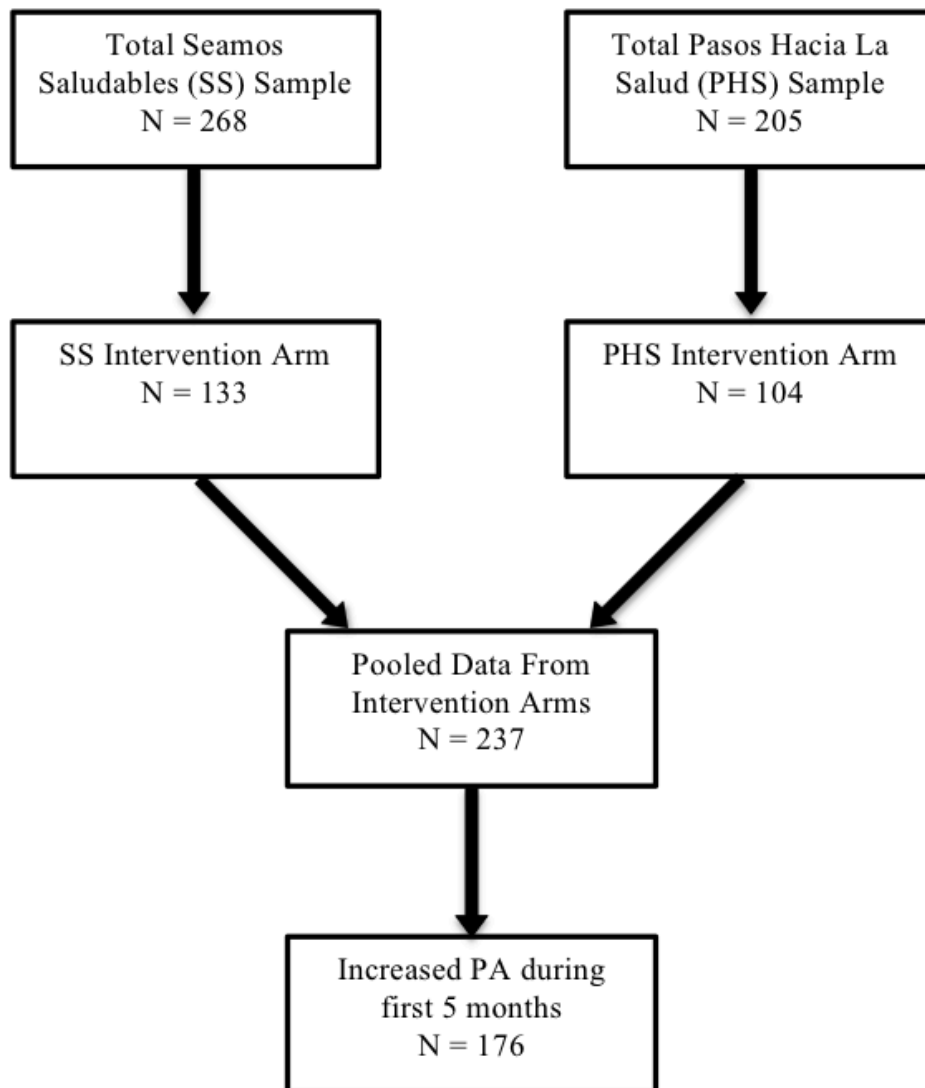
Figure 2.1: Flow diagram of analytic sample for the study.
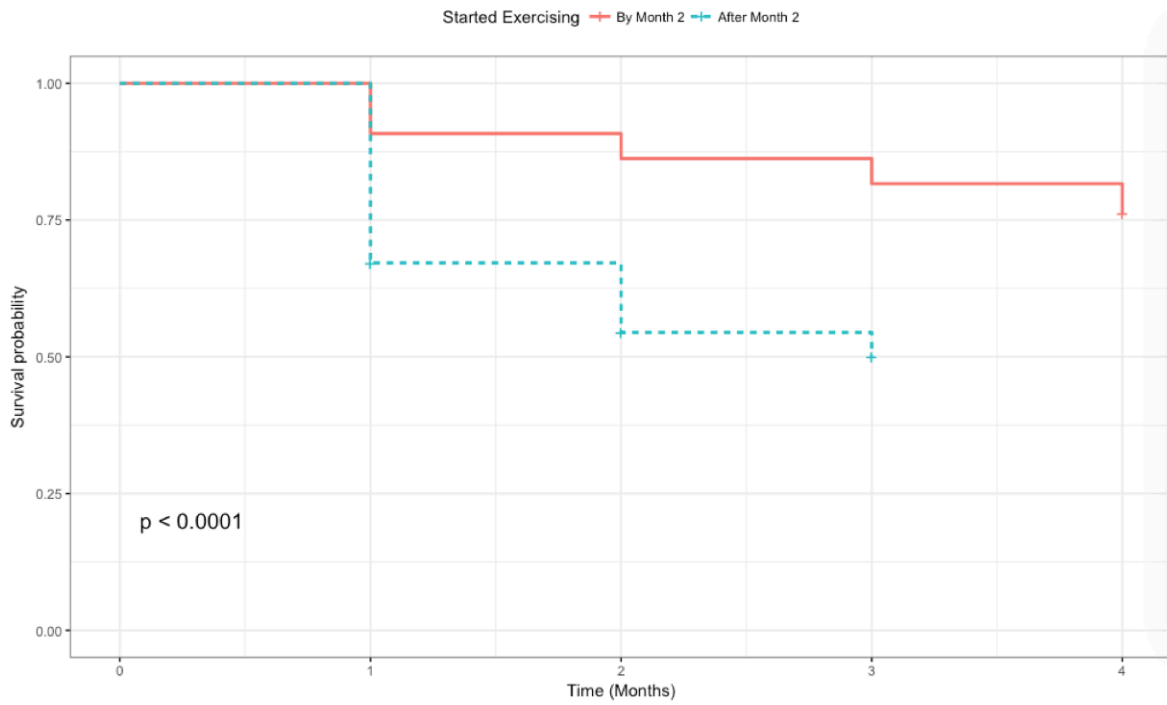
Figure 2.2: Kaplan-Meier curves illustrating the probability of lapse among participants who started exercising during the first two months of the intervention and those who started later.

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CHAPTER 3:

"I NOW FEEL THE NEED TO EXERCISE": A QUALITATIVE STUDY OF PHYSICAL ACTIVITY MAINTENANCE AMONG LATINAS

ABSTRACT

Background: The impact of physical activity (PA) interventions can be enhanced by identifying and implementing effective strategies to help Latina women begin exercising and achieve long-term maintenance. Because most PA promotion research has focused on helping individuals initiate PA, we know little regarding individual, interpersonal, or environmental factors that influence sustained PA maintenance.

Purpose: This qualitative study aimed to explore and understand factors associated with maintenance and non-maintenance of PA among Latinas.

Methods: Semi-structured individual interviews were conducted with 21 Latina women who increased their PA as a result of an intervention, and who completed a subsequent 3-month maintenance period without any contact from research staff. Data were analyzed using structural coding procedures under a thematic analysis framework.

Results: Among the most important facilitators of PA maintenance described by participants were having made PA a habit or part of their lifestyle, the ability to proactively overcome obstacles to engaging in PA, having specific sources of motivation such as satisfaction with outcomes obtained, having the knowledge and skills to maintain PA, and having a supportive social and built environment.

Conclusions: Teaching intervention participants skills to proactively overcome obstacles, and guiding them to form habits and set realistic expectations, could help participants to independently continue engaging in PA upon completion of PA interventions.

Key words: Hispanic, coding, barriers

Latinos are the largest ethnic minority in the United States, and have disproportionally high rates of many chronic conditions. For example, rates of diabetes are twice as high in Latinos (22.6%), compared to non-Hispanic whites (11.3%),[1] and 77% of Latinos nationwide are either overweight or obese, compared to 68% of non-Hispanic whites.[2] Adopting long-term lifestyle changes, such as sustained engagement in physical activity (PA), could help address these health problems. Physical activity can prevent and manage chronic conditions including cardiovascular disease, obesity, cancer, and diabetes.[3,4] Nevertheless, Latinos, particularly women, report low rates of compliance with national PA guidelines. A large cohort study of Latinos in four urban areas of the US, for example, found that only 51% of Latino men and 31% of Latina women engaged in the recommended amount of aerobic moderate to vigorous levels of physical activity (MVPA).[5] Special attention to inactive communities will be necessary in addressing the obesity epidemic and high rates of chronic illnesses in the country.[6] For this reason, it is important to identify and implement effective strategies to help Latinos, particularly women, to not only begin engaging in PA but to also achieve long-term maintenance by incorporating PA into their lifestyle.

Despite the importance of PA maintenance to obtaining long-term health benefits,[7] this is still an understudied area in PA promotion research.[8] To date, most PA promotion research has focused on helping individuals initiate PA, yet little is known about factors that influence sustained engagement in PA following participation of a PA program[9-11]; this is particularly the case among minority populations, such as Latina women.[12]

The psychosocial processes that facilitate maintenance of PA may be different from those influencing initiation of PA.[8] For example, while expectations of future outcomes (e.g., losing weight, improving health) may encourage initiation of PA, maintenance may be influenced by

satisfaction with outcomes achieved.[13] Nevertheless, constructs like self-efficacy for PA and

behavioral intention to engage in PA have been shown to be associated both with initiation and

maintenance of PA.[14] To gain a better understanding of PA maintenance, the present qualitative

study evaluates the role that different constructs (such as self-efficacy, stimulus control, outcome

expectations, reinforcement, and motivation) may play in PA maintenance.

This study thus aimed to explore and understand maintenance of PA among Latinas who

had increased their PA as a result of an intervention, and who completed a subsequent 3-month

maintenance period without any contact from research staff. Specifically, this study aimed to (1)

identify potential facilitators of PA maintenance and obstacles that may lead to non-maintenance,

(2) examine similarities and differences between participants who reported maintaining their PA

and those who did not, and (3) create a conceptual model that will help researchers to better

understand determinants of PA maintenance and guide the development of strategies to

encourage maintenance beyond PA interventions.

Methods

The present qualitative study is a sub-study of the parent study Seamos Activas

(described below). For this qualitative sub-study, semi-structured individual interviews were

conducted after a 3-month maintenance period with 21 Latina women who had increased their

PA as a result of their participation in the Seamos Activas trial. The study was conducted in a

thematic analysis framework. Thematic analysis is a method for analyzing qualitative data. Using

this method as a framework, researchers examine qualitative data (e.g., interview transcripts) to

identify patterns among themes, and then organize and report these themes to create

meaning.[15,16] The use of thematic analysis as a framework in the present study thus allowed us to

examine our qualitative data to identify patterns in themes that revealed potential facilitators of

PA maintenance and obstacles that may lead to non-maintenance; by organizing our data and recognizing patterns in themes, we were able to better understand PA maintenance among our study sample. Moreover, thematic analysis allows for the examination of similarities and differences in the responses of different research participants to provide insight.[17] In the present study, thus, the use of thematic analysis as a framework allowed for the examination of similarities and differences between participants who reported maintaining their PA and those who did not.

Seamos Activas Study

Seamos Activas (the parent study) was a randomized controlled trial of a 12-month culturally and linguistically adapted, individually tailored PA print intervention for Latinas, compared to an enhanced version of the intervention. The 12-month study, which recruited participants on a rolling basis, included a period of 6 months of active intervention, and a 6-month tapered maintenance period, in which a progressively less frequent dose of the intervention was delivered. To participate in the Seamos Activas intervention, women had to meet eligibility criteria that included being a Latina woman between the ages of 18 and 65, engaging in less than 60 minutes per week of MVPA, not having medical conditions that would render PA unsafe, not having plans to get pregnant or move away from the San Diego, California, area during the study period, owning a cellphone with capability for texting, and scoring at least adequate in the Short Test of Functional Health Literacy in Adults (STOFHLA).[18]

Study Participants and Sampling

Individuals were recruited to participate in this follow-up maintenance study on a rolling basis, immediately upon completing the parent study Seamos Activas. Following convenience

sampling methods,[19] from July 2017 to July 2018, we approached all potentially eligible

participants during their final visit for the parent study, to invite them to participate in this

maintenance sub-study. To be eligible for this maintenance study, women had to not plan to

move away from the area, nor plan to get pregnant, during a period of 3-months. Women were

also screened for owning a smartphone for the purpose of a parallel study, yet no one was found

ineligible based on this criterion. Additionally, women had to report engaging in ≥ 60 minutes of

MVPA per week, measured using the 7-day Physical Activity Recall (PAR) interview, by the

end of the Seamos Activas intervention. The 7-day PAR, a self-report measure of MVPA,

consists of a structured interview in which participants are guided to recall and report their

moderate and vigorous activity during the previous 7 days. This measure has demonstrated

acceptable reliability and validity across studies with different populations.[20-22] In a study among

Latinos, the 7-day PAR showed acceptable test-retest reliability (r=0.69) and good validity as

demonstrated by high correlations with Caltrac activity monitors (r=0.67 - 0.82).[22]

As shown in Figure 3.1, total of 31 potentially eligible women were screened and 30 of

them were eligible. One potential participant was ineligible because she required medical

clearance and did not obtain it. Twenty-seven of these 30 eligible participants attended an

individual in-person orientation session, where they received information about this maintenance

study, had the opportunity to ask questions, and provided their consent to participate following

procedures approved by the UC San Diego Institutional Review Board. As part of the consent

process, participants gave researchers access to data that had been collected during their

participation in the Seamos Activas trial, including demographic and PA data.

Besides a 5-minute phone call to all participants during the first week of this 3-month

maintenance period, participants had no further contact with study personnel during the 3

subsequent months. After the 3-month maintenance period, participants were contacted and invited to attend an in-person interview. As shown in Figure 3.1, a total of 21 participants agreed to be interviewed by study personnel, while 3 participants declined to come in for the in-person interview. Additionally, one participant was unreachable after the 3-month maintenance period, one participant reported a knee injury (which was not study-related) and was thus not asked to interview, and one participant was not interviewed because of scheduling conflicts.

After the 3-month maintenance period, the 7-day PAR was used again to assess participants' PA to classify individuals as "maintainers" and "non-maintainers." Given the lack of consensus on the definition of PA maintenance,[23,24] it was difficult to determine how to classify those who maintained PA and those who did not. We discussed the use of various cut points (e.g., ≥60 or ≥150 minutes/week of MVPA), which all seemed arbitrary upon inspection of our data and participants' interview responses. For example, had we used a cut point of ≥60 minutes/week of MVPA to classify those who maintained their PA (which is the cut point that was used to recruit participants into this maintenance study), we could have classified a participant who decreased from 250 to 75 minutes/week of MVPA, and who did not believe she was able to successfully maintain her PA, as a maintainer; alternatively, someone who may have decreased from 60 to 55 minutes of PA, and who was satisfied with her PA maintenance, would have been classified as a non-maintainer. Moreover, these arbitrary thresholds did not satisfy the need for an individual-centered definition of maintenance, which has been suggested in the literature, in acknowledgement of the benefits of even small amounts of PA.[24] To satisfy this need for an individual-centered approach, we decided to classify participants on the basis of percentile change during the 3-month period. Because this was a qualitative study, we let our qualitative data (i.e., participants' self-reported satisfaction with their maintenance) guide us in

selecting a threshold of 50% as a cut point (i.e., maintaining at least 50% of the PA that they were doing at the beginning of the maintenance period). All of the participants whose PA had decreased by more than 50% reported dissatisfaction with their PA maintenance, while most participants who were engaging in at least 50% of the activity that they had been doing at the beginning of the maintenance period reported being satisfied with their PA maintenance (only 1 of the 16 women who maintained their PA above the 50% threshold reported dissatisfaction with her PA maintenance). Using these criteria, our final sample comprises 16 individuals who maintained their PA (76%) and 5 individuals who did not (24%).

Data Collection

Qualitative data were collected from November 2017 through September 2018. Twenty-one individual in-depth semi-structured interviews[25] were conducted in Spanish, which was the language participants used during the Seamos Activas intervention. Interviews took place in a private room at the University of California San Diego, and the audio was recorded with the participants' consent. Participants received $20 as compensation for their time. A written guide was used to direct the interview. As seen in Table 3.1, theoretical constructs (e.g., motivation for PA maintenance, facilitation for PA maintenance, and self-efficacy for PA maintenance) were used to develop questions for this written guide. Occasionally, additional probes were used as needed to explore responses in greater depth and understand the concept of PA maintenance.

Data Analysis

Interviews were transcribed (non-verbatim) and analyzed in Spanish, as described below. Qualitative interview data were analyzed using the Dedoose software. The thematic analysis framework allows for inductive and deductive approaches to coding qualitative data.[15] While in an inductive approach themes are derived from the data, in a deductive approach themes are

generated using pre-determined constructs.[15] Our approach to data analysis was both deductive (because interview questions were developed from theoretical constructs we wished to explore in the study, as shown in Table 3.1) and inductive (because beyond these theoretical constructs, or themes, the potential for new "emergent" codes was also documented in our coding process). Thus, in addition to structural coding procedures, which entail the use of interview questions and constructs as codes during the analysis process,[26] we let participants' responses guide the development of new codes.

To begin the data analysis process, three bilingual investigators and three bilingual research assistants read through seven interviews and took notes (memoing), annotating particular quotes and ideas in the transcript responses that corresponded to the goals of our study questions. These notes, along with the specific interview questions, were used to construct an initial codebook that was developed by consensus among the research investigators and assistants. Additional discussion and revisions by the researchers led to the final version of the codebook that was used by the investigators to collaboratively code all the interviews, discussing and reaching agreements in the coding process.[27] Because all interviews were collaboratively coded, inter-rater reliability measures were not used. During the coding phase, investigators additionally added new or novel codes where necessary to account for emerging ideas that were not initially mapped on the original codebook. After all interviews were coded, the team of three investigators reviewed all the interviews to ensure that the codes that were created or modified during the coding process were applied correctly through all the interviews.

The investigators then identified patterns in themes that emerged from examining similarities and differences between responses of participants who maintained their PA and those who did not. Additionally, to understand the relationships between themes and how themes

worked with each other to influence PA maintenance, we examined the overlaps between codes applied to different sections of the transcripts.

As a final step in the analysis process, we refined the names of the themes to ensure that all the coded material was represented, and we selected segments of data to be used to illustrate different themes during the manuscript writing stage. These data excerpts are included in the results section of this manuscript.

Results

Table 3.2 contains the demographics of our sample. The majority of participants (95%) were of Mexican descent. Additionally, the majority (76%) was married or had a partner and more than half of the participants (67%) had at least 1 child. Participants' mean age was 48 (SD=9). Through the qualitative analysis process, several themes were identified as relevant for participants who maintained their PA and for those who did not. A summary of relevant themes for maintainers and non-maintainers is presented in Table 3.3, and discussed in detail in the following paragraphs. Additionally, Figure 3.2 is a conceptual diagram of the patterns and relationships between themes that were observed among individuals who maintained their PA, and how these themes are hypothesized to jointly influence maintenance of PA.

Facilitators of PA Maintenance

When specifically asked participants to identify facilitators of maintenance, maintainers were able to identify numerous factors that helped them maintain their PA, while non-maintainers did not identify many. All but one women who maintained activity, and all of those who did not, mentioned having a favorable environment or having access to classes or to the gym as a facilitator of PA maintenance. Additionally, most women who maintained, and even those who did not, mentioned having good social support. One participant who reported

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maintaining her PA for two months and then reported relapsing during the third month, described

the importance of having social support in the following way:

> I think it helped me a lot to exercise with her [my friend], because for example, if
> I had been doing it alone, I would get bored, and at least with her, we go hiking
> up the mountain... This past month [my friend's] schedule at work changed, and I
> was busy, so she would tell me 'no, I can't go today' and we didn't coincide.
> (female, aged 46)

An important facilitator that was only mentioned by the group of maintainers was habit; almost

all the women who maintained mentioned habit, or having made PA part of their lifestyle, as a

facilitator for maintenance of PA. Many of these women asserted that once the habit had been

formed, there was no longer a need for programs, reminders, monitoring, and other skills and

factors that helped them to initiate PA:

> I think that the first year that I was with you, with the monitoring and that thing
> with the steps and all that, and reporting what I was doing, that helped me to get
> into the habit. One year is enough so that your body starts demanding it
> [exercise]. (female, aged 40)

Additionally, most maintainers and only a few non-maintainers stated that having the knowledge

or skills to maintain PA (e.g., knowing what constitutes moderate intensity PA) was a facilitator.

Alternatively, several non-maintainers and only a few women who maintained physical activity,

mentioned self-motivation as a facilitator of PA maintenance:

> I was the one who said "I will go to the gym!" I did not need anyone else to tell
> me, because I had started to feel good. That motivated me to continue, that I don't
> have someone to push me, because even though they push me, I don't do it. But if
> I want to feel good, I do it on my own. (female, aged 44)

Obstacles to PA Maintenance

Obstacles to PA maintenance were much more frequently mentioned by the group of

non-maintainers compared to maintainers. Prevalent obstacles among those who did not maintain

PA included self-imposed barriers (e.g., being embarrassed of exercising in public), an

environment that was not conducive to exercising (e.g., living in an unsafe neighborhood), lack

of support from family, friends, or social network, and lack of accountability or support from our study staff. Obstacles such as lack of time and having other activities that take priority over PA were mentioned by both non-maintainers and maintainers, although much less frequently by the latter.

While it may seem contradictory, many participants (both maintainers and non-maintainers) mentioned social support as both a facilitator and an obstacle to PA maintenance; others identified social support as an irrelevant facilitator. Our data revealed that the support that participants received was not always useful to them, as it was not provided by the right people, at the right time, or in the right ways. For example, one participant shared:

> ... many [neighbors] have invited me to go to Zumba, but I insist, for me it's hard because of my children. Now I look for activities to do alone... (female, aged 41)

A similar situation arose with participants' perceptions of their environment: our data revealed that while some aspects of participant's environment reportedly facilitated PA maintenance (e.g., proximity to exercise facilities or parks, availability of space for exercising at home), other aspects, such as traffic or poorly maintained sidewalks, hindered it.

Being Proactive to Overcome Obstacles to PA Maintenance

Women who maintained were unable to identify many obstacles for their maintenance. Some barriers, such as lack of time and having other activities that take priority, were mentioned by a few women, but most of them also mentioned being proactive in overcoming these obstacles. Among the most common strategies used to overcome obstacles and to remain active were making time or scheduling PA, rewarding their PA behavior, self-monitoring their PA, looking for resources or information, finding alternative activities, modifying their environment, and substituting sedentary activities for active ones, Some women shared:

...if I have to go to the gym in the afternoon and I have to clean the house, if I cannot clean it completely, I clean it thoroughly once per week and the rest is easy. Or I get up earlier to be able to have more time. (female, aged 58)

My rewards have been to begin buying clothing that is more my size, because my other clothes are now lose on me on my waist... now I feel more confident using clothing that I didn't use before, and knowing that my attitude and my decision to change brings benefits. (female, aged 48)

Well now I know how to search. If I cannot go out walking because of the rain or because it's too hot, I can look things up. I know there are things on the Internet, or in YouTube also. You can search for videos, I already have a folder with exercise videos... the information you gave us said 'if you cannot do this, we can lend you videos.' Meaning, there are other tools you can use. And before I used to say 'well I didn't go out, oh well.' But now, I do get motivated. I can look up other things, right? And that's how the program helped me. (female, aged 42)

Non-maintainers were not as proactive. When asked to describe what would have helped them to maintain their PA, they identified additional external things that they would need in order to overcome obstacles. The most commonly cited need was the need for accountability, as described by one participant:

Well, maybe having the commitment like before. Sending in the paper, I mean I was embarrassed "I have to go exercise because I haven't done it in three days, I have to go at least one day per week." I had that commitment. But now, there were no papers anymore. There was nothing. So I chose to sleep, or stay in and watch TV. (female, aged 44)

Some participants also specifically mentioned the need for a structured program:

... For lazy people like me, who need someone to excite them, I say, if people agree, it would be possible to walk as a group of three or four people... (female, aged 63)

Motivation as a Facilitator of PA Maintenance

There was considerable overlap between the themes of motivation and facilitation; having the motivation to stay active also seemed to act as a facilitator of PA maintenance. For example, most of the women who maintained their PA mentioned leadership or being an example to others when asked to identify facilitators or sources of motivation for maintenance.

Being a leader or an example to other people thus seemed to both motivate women and also facilitate their maintenance of PA:

> Well my friends know that I exercise... and when they want to begin to do something, they call me... it does help when people know that a person exercises. Because they know that they can count on you. (female, aged 42)

> ... I want my children to also have the routine of walking, not to be on their phones all the time, and that's why I take them walking. And they happily run or walk, and that also is motivating for me and for them. We support each other. (female, aged 41)

Health, either physical or mental, was mentioned as a source of motivation by almost all participants who maintained. Health seemed to be a powerful motivator. For example, one participant made the distinction between the type of PA that she thought was good for her heart and health, which she was able to maintain, and the type that she thought was good for weight loss, which she had forgone:

> I don't know if this is just in my head, but I have been told that doing stairs works your heart a lot, and I like that because they say it helps with cholesterol and many other things... while walking, right now, I'm not looking to have a beautiful body, but I would like to maintain a good weight... And walking, I do sweat a lot, more than with the stairs. (female, aged 54)

Besides health, sources of motivation among women who maintained were diverse; among the most common were being a leader or an example to others, weight loss, and living longer. Among non-maintainers, most participants also mentioned health and living longer as a source of motivation. Another commonly cited source of motivation for non-maintainers was witnessing others performing PA. In fact, non-maintainers were much more likely than those who maintained to compare themselves to others who engage in PA:

> There are women that motivate me, because they come alone and play their music, they start dancing and create their own Zumba class, as if they were in a huge group... I say to myself, "I should do that, too." (female, aged 50)

Outcomes Obtained, Enjoyment and Outcomes Expected as Sources of Motivation

Both outcomes obtained and outcomes expected seemed to be an important source of motivation to maintain PA. In fact, there was much overlap between reporting health both as a motivator for PA maintenance and as an outcome expected for the future. For example, one participant shared:

> ... I hope that when I'm old, I have a healthier old age and to last longer for my children, precisely because I'm taking care of myself, because I see so many people with problems like diabetes, high blood pressure, embolisms. My mother had an embolism and I don't want that to happen to me. (female, aged 42)

Improved health was the number one outcome that women who maintained expected to obtain in the future by continuing to engage in PA. Less than half of the women expected to continue losing weight, which was the second most commonly cited outcome desired by women who maintained.

Among the group of maintainers, the most commonly reported outcome obtained by engaging in PA was weight loss, followed by a decrease in fatigue, as well as stress relief and mental health benefits. Women who did not maintain also mentioned having seen a decrease in fatigue and some weight loss by engaging in PA in the past. However, not obtaining outcomes that were expected seemed to be very relevant in undermining PA maintenance. All non-maintainers, compared to a fourth of those who maintained, mentioned that they had an expectation to lose weight (or to lose more weight) and did not achieve that goal. Moreover, the four maintainers who mentioned an unmet weight loss goal seemed to prioritize other outcomes over weight loss. For example, one participant shared:

> Well losing weight, changing the shape of my body, that was secondary. First is my heart, lowering the cholesterol, I mean not reaching the diabetes level, health over all. (female, aged 56)

Maintainers, for the most part, had no unmet expectations.

Overall, participants who maintained thought the pros of PA were more important than the cons. Nevertheless, more than half of the participants were still able to identify things they did not like or did not enjoy about PA, such as soreness, getting dirty or sweaty, or exercising during bad weather. They were still much more likely to identify things that they enjoyed about PA. The most common themes for enjoyment included enjoyment of alone time and prioritizing self, and the way PA makes them feel, either physically or mentally. Non-maintainers also did not identify many things that they dislike about PA, and they shared that they actually enjoy exercising because of the way they feel, both physically and mentally, and because they get energized by PA.

Self-Efficacy for PA Maintenance

Among our sample, both maintainers and non-maintainers had good self-efficacy for PA maintenance; participants who were not able to maintain their PA were still confident in their ability to maintain in the future. One participant, for example, stated:

> Like Alcoholics Anonymous, I took a few steps and then relapsed during this last month. But it doesn't matter, I can get up again and continue moving forward. (female, aged 46)

For this reason, we did not include self-efficacy as part of our model of PA maintenance, as it did not seem to differentiate those who maintained from those who did not.

<div align="center">

Discussion

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The present study aimed to explore and understand maintenance of PA among Latina women. Our findings among this priority ethnic minority group suggest that important facilitators of PA maintenance include habit, having a built environment that is conducive to exercising (e.g., proximity to exercise facilities or parks, availability of space for exercising at home), social support, and having the knowledge and skills needed to maintain PA (e.g., knowing what constitutes moderate intensity PA), and having specific sources of motivation

(e.g., enjoyment of PA and satisfaction with outcomes obtained). Additionally, while "being proactive in overcoming obstacles for PA maintenance" was not explicitly identified by participants as a facilitator, our analysis suggests that these proactive steps appear to help participants to overcome obstacles, facilitating PA maintenance. These findings considerably overlap with themes identified by a synthesis of one hundred theories of behavior change and maintenance.[28] Themes identified in this synthesis included: maintenance motives, which refers to sources of motivation to stay active, such as satisfaction with the outcomes of the behavior and enjoyment; self-regulation, which refers to having the knowledge and skills to regulate and monitor the new preventive behavior and to overcome obstacles; psychological and physical resources; habit; and having social support and a supportive environment.[28] Our qualitative study thus provides further evidence of the importance of these constructs for a specific behavior (PA) and among a specific priority ethnic minority group (Latina women), adding to the limited body of research on the subject of PA maintenance.

Habit emerged as one of the strongest facilitators of PA maintenance in the present study. When discussing habit, our participants indicated that they had managed to made PA part of their routine and their lifestyle. Thus, as recommended in the weight-loss literature, PA promotion research would benefit from incorporating habit-formation strategies in PA interventions (e.g., repetition of the behavior in a consistent context, using positive reinforcements) to help individuals to adopt PA as part of their lifestyle.[29] Existing preliminary data from small studies that have incorporated habit formation strategies to PA interventions is encouraging.[30]

In line with previous hypotheses,[13] we found that satisfaction with outcomes obtained (particularly satisfaction with weight loss, decrease in fatigue, stress relief, and mental health) motivated individuals to stay active. Moreover, unfulfilled outcome expectations, particularly

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related to not losing the desired amount of weight even if some weight loss was achieved, seemed to be a powerful factor affecting PA maintenance. Thus, in PA interventions among this population, it would be beneficial to help participants to set realistic expectations from the beginning, so they are better positioned to maintain PA after the intervention has ended. For example, focusing on the more immediate outcomes of PA, such as enjoyment, could lead to more successful maintenance outcomes.[31] Women could also be guided to have a more realistic expectation for weight loss goals. In the present study, women who did not maintain their PA were focused on not having lost as much weight as they had hoped for, although they did mention enjoying the way PA made them feel. Alternatively, women who maintained their PA were satisfied with the outcomes they had achieved, including the amount of weight that they had lost, but also immediate outcomes such as stress relief and the enjoyment of having alone time.

Perhaps because maintainers were satisfied with the amount of weigh they had lost, they mentioned weight loss as a source of motivation, which was not often the case with non-maintainers. Alternatively, health expectations and living longer were mentioned by both maintainers and non-maintainers as sources of motivation. Thus, it appears that these sources of motivation were not enough by itself to achieve PA maintenance, but perhaps worked in conjunction with other facilitators. Likewise, facilitators such as social support and living in an environment that is conducive to PA were mentioned by both women who maintained and those who did not. Thus, while some prior studies have found that these types of facilitators do not influence maintenance,[14] it might be that they are necessary but not sufficient to help participants maintain PA; they might work in combination with other variables to enable maintenance. For example, among our sample, having an environment that is conducive to PA seemed to enable

women to take proactive steps to maintaining their PA, while social support reportedly helped women to stay motivated.

A study limitation pertains the classification of participants as maintainers or non-maintainers. There is no consensus among PA researchers on the definition of PA maintenance,[23,24] which made it difficult to determine the best approach to classifying participants who were able to maintain and those who did not. As explained previously, because this is a qualitative study, we chose to let our qualitative data guide the selection of an individual-centered threshold. In qualitative interviews, all of the participants whose PA had decreased by more than 50% discussed being dissatisfied with their maintenance, while only 1 participant who was above this threshold was dissatisfied with her maintenance. Thus, our qualitative data guided us to select the threshold of 50% as a cut point to classify maintainers and non-maintainers. Nevertheless, results could be different with a different cut point. As the field of PA maintenance continues to grow, it is important to reach a consensus on what constitutes PA maintenance, to be able to compare findings across studies.

An additional limitation of the present study pertains the uneven distribution of maintainers and non-maintainers in our sample. While we had originally intended to recruit similar numbers of maintainers and non-maintainers, per our definition of maintenance, disproportionally more individuals were classified as maintainers. Thus, our final sample for this study is comprised by more participants who maintained their PA than those who did not. Given the small number of participants who were classified as non-maintainers (N=5), there may be additional factors affecting PA maintenance, which were not captured by our interviews. Nevertheless, it is encouraging that, as mentioned previously, our findings significantly overlap with previous literature, which supports the credibility of our results.

There is also strength in this qualitative study, as we were able to obtain detailed and in-depth information that enabled us to formulate hypotheses of how Latina women maintain PA after interventions, and how different facilitators may interact to jointly influence maintenance. Moreover, while it is not the intention of qualitative studies to be able to make generalizations, future research could focus on empirically testing the hypotheses formulated in this study. For example, the mediating role of different hypothesized facilitators of maintenance (e.g., habit, motivation, ability to proactively overcome obstacles) could be quantitatively assessed among larger samples of participants who have completed interventions and increased their PA levels.

Overall, maintainers were able to identify more facilitators of PA maintenance, while non-maintainers were more likely to identify obstacles. Likewise, maintainers were more likely to discuss their ability to overcome obstacles and take proactive steps for maintenance. Non-maintainers discussed additional external factors that they would require to maintain PA, such as the need for accountability or for structured PA programs. Thus, adding to the conclusions of previous research,[32,33] it is imperative to teach PA intervention participants the skills to proactively overcome some of the obstacles that they may encounter upon intervention completion, once they no longer have the support of the research staff. Important skills include knowing how to make time or schedule time for PA, rewarding themselves for achieving PA goals, self-monitoring their PA, looking for resources (e.g., information, PA classes, social support) on their own, finding alternative activities when their plans fall through, modifying their environments to support PA, and learning how to substitute sedentary activities for active ones. Such skills, in addition to forming habits and setting realistic expectations, as mentioned previously, could help participants to independently continue engaging in PA upon completion of interventions. Beyond initiation of PA, it is important for individuals to maintain PA to obtain

its health benefits.[7] Thus, incorporating strategies that will help participants maintain PA will maximize the impact of PA promotion programs.

Acknowledgements

Table 3.1: Examples of Theory-Based Open-Ended Interview Questions

Theoretical Construct	Sample Questions
Motivation for PA Maintenance	What do you think has been your main motivation to stay active during these past few months?
Facilitators of PA Maintenance	What do you think has helped or facilitated your maintenance of PA?
Helping Relationships/ Social Support	What role do you think your friends, family, or other people around you have had in helping you to maintain PA?
Built Environment / Reciprocal Determinism	How do you think your surroundings (meaning your neighborhood, your house, etc.) maybe helped or maybe were an obstacle for your PA maintenance?
Stimulus Control	How do you modify your surroundings (again your house, for example) to help you to maintain PA, if you do so?
Observational Learning	Perhaps you observe other people around you being active. How does that help you to maintain your PA, if it helps at all?
Reinforcement	How do you reward yourself for having successfully maintained your PA and for achieving your activity goals? (Prompt: rewards are not necessarily physical, it could be congratulating yourself, for example).
Behavioral capability/ Self-Regulation (Knowledge/ skills)	What knowledge or skills that you have learned or acquired do you think have helped you or have not helped you to maintain your PA? (Prompt: goal-setting, planning, self-monitoring, feedback).
Outcomes Achieved	What outcomes have you seen or obtained by maintaining your PA during these past few months? What outcomes were you hoping to obtain but did not?
Outcome Expectations	What outcomes do you hope to see if you maintain your PA in the future?
Enjoyment	What do you enjoy about PA? What do you dislike about PA?
Barriers	What have been barriers or obstacles in maintaining PA?
Decisional Balance	Do you think the benefits of PA outweigh the negative aspects of exercising, or is it the other way around?
Self-Efficacy	How confident are you in your ability to maintain your PA in the future and why?

Table 3.2: Demographic Characteristics of the Sample (N=21)

	Mean (SD)
Age	48.29 (9.00)
BMI	29.81 (4.88)

	N (%)
Ethnic Background	
Mexican	20 (95.24)
Education*	
High School or Less	8 (38.10)
Technical School/Some College	6 (28.57)
College or Graduate School	7 (33.33)
Employment	
Unemployed	8 (40.00)
Full Time Employment	4 (20.00)
Part Time Employment	8 (40.00)
Income	
<20,000	7 (33.33)
20,000 – 39,999	10 (47.62)
>= 40,000	4 (19.05)
Marital status	
Married or Have Partner	16 (76.19)
Number of Children Under 18	
1 Child (Compared to no Children)	8 (38.09)
2 or More Children	6 (28.57)

Table 3.3: Important Themes for Maintainers and Non-Maintainers

	Both Maintainers and Non-Maintainers	Unique to Maintainers (N=16)	Unique to Non-Maintainers (N=5)
Facilitators	• Environment/access to classes / gym • Social support	• Habit, or having made PA part of her lifestyle • Knowledge/ skills	• Self-motivation
Obstacles	• Lack of time/ Prioritizing other activities	• Unable to identify many obstacles	• Self-imposed barriers • Environment • Lack of support / accountability
Proactive for Maintenance/ Overcoming Obstacles		• Make time or scheduling PA • Rewards • Self-monitoring • Look for resources • Find alternative activities • Modify environment • Substitute sedentary activities	• Were not as likely to mention being proactive in overcoming obstacles
Additional Needs for Maintenance		*Maintainers were not asked to report additional needs.*	• Accountability • Structured program
Sources of Motivation	• Health (either physical or mental) • Living longer	• Leadership/ Example to Others • Weight Loss	• Witnessing others performing PA
Outcomes Obtained	• Decrease in fatigue • Weight loss	• Stress relief, mental health	
Outcomes Not Obtained			• (More) Weight Loss
Enjoyment/ Dislike	• Not many things they dislike • Enjoy "the way PA makes me feel" physically and mentally	• Enjoy alone time/ prioritizing self	
Self-efficacy	• Good self-efficacy		

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┌─────────────────────────────────────┐
│ Assessed for eligibility (n= 31)     │
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            │
            │          ┌──────────────────────────────────────────┐
            │          │ Excluded  (n= 4)                          │
            ├─────────▶│  ♦ Required medical clearance (n= 1)      │
            │          │  ♦ Declined to participate (n= 1)         │
            │          │  ♦ Unable to reach (n= 2)                 │
            │          └──────────────────────────────────────────┘
            │
            ▼
┌─────────────────────────────┐
│ Enrolled (n= 27)            │
└─────────────────────────────┘
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│ 3-Month Maintenance         │
│ Period                      │
└─────────────────────────────┘
            │
            │          ┌──────────────────────────────────────────────────┐
            │          │ Not interviewed (n= 6)                            │
            │          │  ♦ Lost to follow-up (unable to reach) (n= 1)    │
            ├─────────▶│  ♦ Declined to be interviewed (n= 3)             │
            │          │  ♦ Not interviewed, knee injury (n=1)            │
            │          │  ♦ Scheduling conflicts (n=1)                    │
            │          └──────────────────────────────────────────────────┘
            │
            ▼
┌─────────────────────────────┐
│ Interviewed (n= 21)         │
│  ♦ Maintainers (n=16)       │
│  ♦ Non-maintainers (n=5)    │
└─────────────────────────────┘
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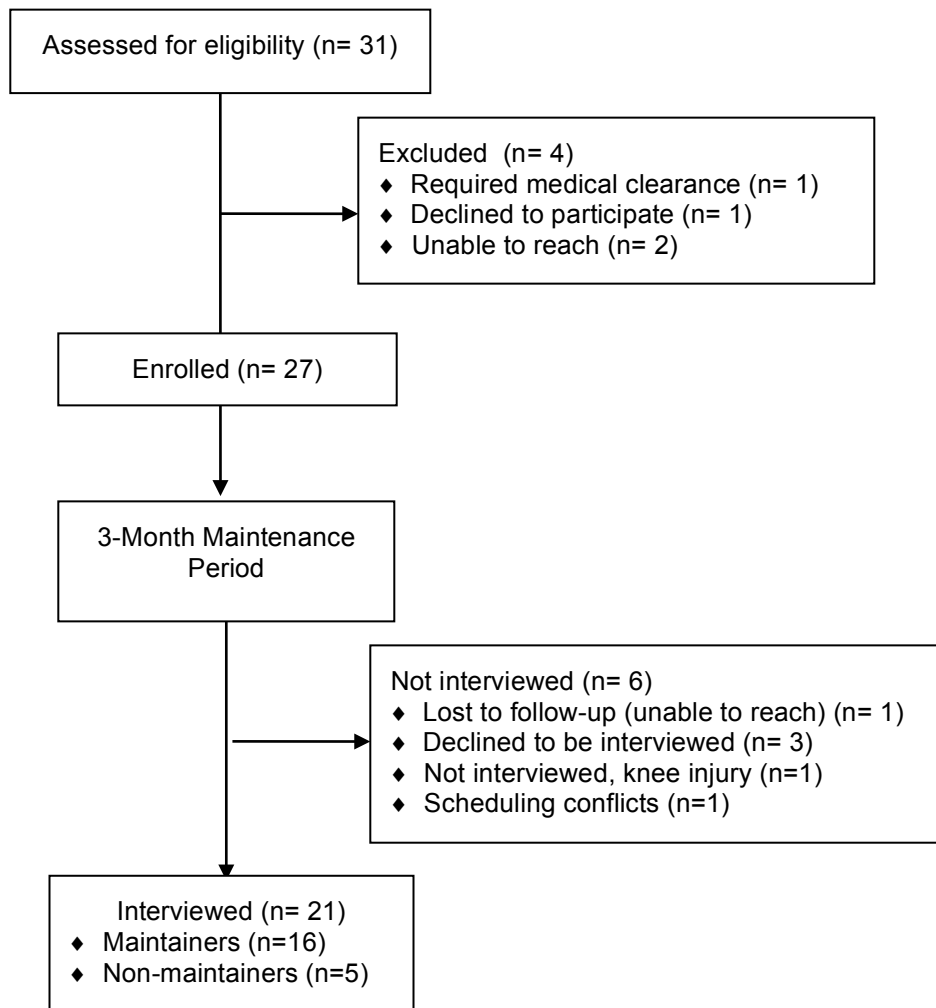
Figure 3.1: Diagram of enrollment and follow-up of study participants.
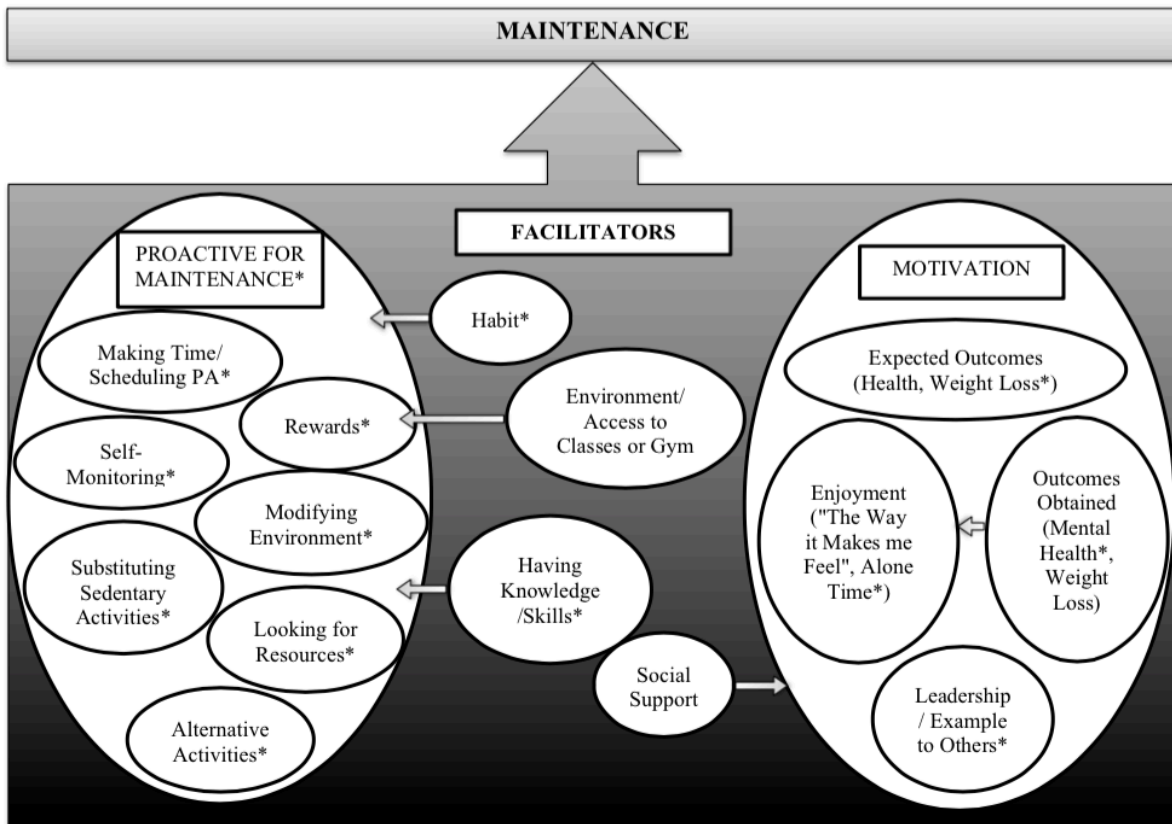
Figure 3.2: Conceptual diagram of hypothesized relationships between themes.
* Facilitators that are unique to Maintainers.

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CHAPTER 4:

WHAT IS APP WITH MAINTENANCE? REGULAR AND ENHANCED

MAINTENANCE OF PA AFTER AN INTERVENTION FOR LATINAS

ABSTRACT

Background: There is scarcity of research on maintenance of physical activity (PA) among Latina women, who have become a priority population for PA promotion.

Purpose: To: (1) assess maintenance of PA among Latinas who complete a PA intervention; (2) understand whether participants were satisfied or dissatisfied with their maintenance; (3) evaluate the feasibility and preliminary efficacy of commercial smartphone apps as tools for maintenance of PA; and (4) explore the role that smartphone apps played in PA maintenance (if any).

Methods: For this nested analysis of quantitative and qualitative data, 27 participants who, upon completion of a PA intervention, reported increasing their moderate to vigorous PA (MVPA) to ≥ 60 minutes/week, were randomly assigned to enhanced maintenance (i.e., taught how to use 2 commercial smartphone apps, N=14), or no-treatment control (N=13). After a 3-month maintenance period with no contact, participants' PA was re-assessed. Longitudinal mixed effects regression models assessed group by time effects on PA. Individual interviews were conducted and analyzed.

Results: Mean minutes/week of self-reported MVPA was 16.85 (SD=24.73) before the intervention, 230.50 (SD=199.29) immediately after the tapered intervention, and 163.10 (SD=125.49) after the maintenance period. Thirteen of the 21 participants interviewed expressed satisfaction with their PA maintenance. There were significant effects of time (β=102.24, SE=42.06 for pre-intervention to post-maintenance, and β=-85.17, SE=34.62 for post-tapered

intervention to post-maintenance), but not of group assignment, on self-reported PA. Nine out of 14 participants in the enhanced maintenance group reported using apps at least a little to help with PA maintenance. Reasons for not using apps included not finding them appealing or necessary.

Conclusion: This study used quantitative and qualitative data to provide new knowledge regarding maintenance of PA (an understudied area of research) among a priority population. Few women reported returning to pre-intervention levels of PA, yet there was a significant drop in self-reported PA after the tapered intervention ended. Smartphone apps contributed little to PA maintenance.

Key words: Hispanic, cellphone, technology, trial

Latinos have become a priority population for the promotion of Physical Activity (PA) in the United States, as they comprise the largest ethnic minority group in the country, yet report comparatively lower rates of PA.[1] The health benefits of PA, which include a decreased risk of all-cause mortality and of chronic illnesses such as cancer and cardiovascular disease, have been well documented.[2-4] However, while achieving and sustaining health benefits through participation in PA is contingent upon maintenance of exercise behavior,[5] most PA promotion studies with Latinos have focused only on initiation of PA. There is little research regarding maintenance of PA outcomes after intervention completion among this priority population.[6]

The dearth of research in this area, not only among Latinos but also among the general population, may be due to the multiple challenges to the assessment of PA maintenance.[7] Most PA promotion studies do not assess maintenance of PA outcomes after intervention completion[8-10]; one systematic review, for example, found that less than one fifth of randomized controlled trials reported PA maintenance outcomes after periods of at least three months.[8] Among studies that do examine PA maintenance, few interventions have resulted in successful maintenance of PA.[9-11] Some researchers have used "tapered maintenance" or "tapered intervention" periods to examine whether intervention effects can be sustained for longer periods of time.[12-14] Tapered maintenance or tapered intervention entails employing reduced doses of the intervention to achieve maintenance, after the initial intensive intervention has ended.[7] Maintenance, however, seems to be proportional to the dosage of tapered intervention received (i.e., as exposure to the intervention decreases, so does PA), and seems to dwindle once all intervention activities cease.[7]

Prolonging the tapered intervention timeline for several months or years beyond intervention completion would be impractical and unsustainable if it requires continued involvement of researchers and continued investment of resources. However, technology such as

smartphone applications (apps) could provide tools to simulate tapered intervention, helping individuals sustain their PA after all intervention activities have ceased. Apps provide a unique opportunity for PA maintenance research, as they can incorporate evidence-based features but function autonomously (without the intervention of a researcher). Although the use of apps to promote PA initiation is rapidly increasing, we are currently not aware of any published study pertaining the use of apps for maintenance of PA.

The present study had four aims: (1) to quantitatively assess maintenance of PA among Latina women who increased their level of PA as a result of an individually-tailored PA intervention; (2) to qualitatively understand whether participants were satisfied or dissatisfied with their maintenance; (3) to quantitatively evaluate the feasibility and preliminary efficacy of using commercial smartphone apps as tools for maintenance of PA, compared to a no-treatment control; and (4) to qualitatively explore the role that smartphone apps played in PA maintenance (if any). Given the scarcity of research on maintenance of PA among Latina women and on the use of smartphone apps to promote PA maintenance, a nested analysis[15,16] employing quantitative and qualitative methods was conducted to provide a more thorough understanding of the research questions.

Methods

This study was conducted in a nested analysis[15,16] framework, in which quantitative data is used for empirical testing, while qualitative data is used to gain in-depth insight about specific cases or phenomena observed. In our study, quantitative data was collected and analyzed to assess how participants maintained their PA, and whether the use of smartphone apps was a feasible and efficacious approach to helping participants to maintain PA. Subsequently, qualitative interviews were conducted to understand whether participants were satisfied or

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dissatisfied with their maintenance and to examine one of the multiple factors that potentially influenced PA maintenance outcomes: the use of smartphone apps.

As part of the study procedures, we first conducted a pilot randomized controlled trial (RCT) with 27 participants who completed the Seamos Activas study (described below) and who reported increasing their PA to at least 60 minutes/week of moderate to vigorous intensity PA (MVPA). Figure 4.1 shows the timeline of the present maintenance study in relation to the Seamos Activas study, which entailed a 6-month period of active intervention and a 6-month period of tapered intervention to support maintenance. Participants in the present study were randomly assigned to one of two groups: (1) An enhanced maintenance group, in which participants (n=14) received information about 2 commercial smartphone apps and assistance to download and learn how to use them; and (2) A regular maintenance (no-treatment) group (n=13). After a period of three months, participants' PA was quantitatively re-assessed (as described in detail below), and qualitative interviews were conducted to provide additional information to understand participants' views on their PA maintenance and on the use of apps for PA maintenance.

Seamos Activas Study

Seamos Activas was a 12-month RCT of a culturally and linguistically adapted, individually tailored PA print intervention for Latinas, which was found in a previous trial to successfully increase MVPA by a mean of 41.36 minutes per week (SE=7.93, p<0.01),[17] and was now being compared to an enhanced version of the intervention. Both the original and the enhanced versions of the intervention were based on principles of Social Cognitive Theory (SCT)[18] and the Transtheoretical Model (TTM),[19] and they promoted behavioral strategies to help participants increase PA, such as goal-setting, self-monitoring, and seeking social support.

Intervention materials included manuals that matched participants' stage of change (per TTM), individually tailored self-help print materials, and tip sheets. The first six months comprised the active intervention period, in which participants received regular mailings, two in-person goal-setting sessions, and one goal-setting session over the phone. After the first six months, there was a 6-month tapered intervention period, in which participants received 2 additional booster mailings (at month 8 and 10). Additionally, the enhanced intervention arm received information in their tailored report that further addressed theoretical constructs (e.g., social support, enjoyment and expectations), additional print materials (including a tailored report that discussed places to be active around the participant's home), and text messages meant to increase accountability and interactivity.

Participants and Recruitment

Participants for this pilot maintenance study were adult Latina women who were recruited upon completion of the Seamos Activas study. Participants had already been screened to participate in Seamos Activas; eligibility criteria included being a Latina woman between the ages of 18 and 65, and engaging in less than 60 minutes per week of MVPA. Participants were excluded if they had a medical condition that would render physical activity unsafe, had a current or planned pregnancy, or planned to move away from the area during the study period. They also had to score at least adequate in the Short Test of Functional Health Literacy in Adults (STOFHLA).[20]

For the current study, the only additional eligibility criteria were having a smartphone, not planning to move away from the area within the following 3 months, not being or planning to become pregnant during the study period, and reporting at least 60 minutes of MVPA per week upon completion of the intervention. While it would have been ideal to use 150 minutes/week of

MVPA as a cut off point, according to 2008 National Guidelines,[21] our participants started the PA intervention with extremely low PA levels (17 minutes/week of MVPA). Thus, using 150 minutes/week of MVPA as a cut off point was not feasible. Nevertheless, research shows that people who engage in little or no PA can obtain significant benefits with even small increases in their PA, such as 60 minutes of MVPA/week.[22] Consequently, this more realistic threshold of 60 minutes of MVPA/week was used as a cut off point.

As shown in the consort diagram in Figure 4.2, a total of 31 potentially eligible women were screened and 30 of them were eligible. One potential participant was ineligible because she required medical clearance and did not obtain it. Of the 30 eligible participants, 27 attended an orientation, enrollment, and randomization session. Twenty-six participants completed the 3-month study, and one participant was unreachable at the end of the study. For qualitative interviews, 24 participants were invited to come in for an in-person interview; twenty-one participants agreed to be interviewed, while three participants declined to come in for the in-person interview.

Orientation, Enrollment and Randomization Session

Eligible participants returned for a first enrollment and randomization study visit, where they heard the details of the study, had the opportunity to ask questions, and, if interested, were consented following procedures approved by the UC San Diego Institutional Review Board. Participants were then enrolled and randomized to enhanced (smartphone apps) or regular maintenance (i.e., no intervention). Based on self-report PA data collected immediately post-tapered intervention, participants were randomized using block randomization procedures[23] with 3 strata: participants engaging in (1) < 90 minutes of MVPA/week, (2) 90-120 minutes of MVPA/week, and (3) >120 minutes of MVPA/week. Assuming participants exercised for 30

minutes per day (as recommended in the Seamos Saludables intervention), this would divide them into those engaging in PA 2-3 days per week, 3-4 days per week, and 4 or more days per week. Additionally, during this session, participants in the enhanced maintenance arm received brief training (approximately 1 hour) on how to use the smartphone apps. This training entailed a detailed explanation of how apps could help them to maintain PA by providing several theory-based tools, such as the ability to set goals and monitor their activity. Participants were provided with a manual on how to use the different features of the apps, and a researcher reviewed the manual with participants and answered questions. Staff then helped the participant download and personalize the apps (e.g., enter their goals, connect with friends).

One week after this orientation, enrollment, and randomization session, participants in both arms were contacted through a phone call and given the opportunity to ask any questions that they had regarding the study or the use of apps for maintenance of PA.

App Selection

Limited publications on the use of apps for PA research have primarily focused on PA promotion (versus maintenance).[24] Some studies have assessed the effect of commercial fitness apps on PA and found no significant increases in MVPA (Direito et al., 2015). Other studies have found theory-based smartphone apps to be effective in increasing MVPA,[25] yet maintenance has not been assessed.

For this study, we selected two commercially-available, cost-free smartphone apps that are available both in English and Spanish, the Fitbit app and the Nike+ Training Club app. As outlined in Table 4.1, both apps provide users with evidence-based tools and strategies that can be mapped to constructs of the TTM[19] and SCT.[18] TTM and SCT have been extensively used as frameworks for PA promotion among different populations, including Latino populations.[26]

However, less is known regarding the application of these theories to maintenance of MVPA. These two theories were used in the Seamos Activas intervention and during the 6-month tapered intervention period. Thus, for purposes of continuity and consistency, we explored apps that would provide participants with TTM and SCT-based strategies and tools (see Table 4.1) that they had learned to use during the intervention, yet in an unsupervised way.

Quantitative Data Collection

Data used in this pilot maintenance study were collected between February 2016 and October 2018 in San Diego, CA. Demographic data (collected via questionnaires) and self-reported PA data for pre-intervention and post-tapered intervention time points were collected as part of the Seamos Activas intervention. PA data for an additional final time point (post-maintenance) were collected 3 months after the tapered intervention ended (see Figure 4.1).

Self-reported minutes of MVPA per week, collected via the 7-day physical activity recall (PAR) interview,[27] was the main study outcome measure. The 7-day PAR is a semi-structured interview that facilitates recall of PA during the previous 7 days by guiding participants to remember, day by day, their sleep time and their physical activity. Participants are specifically asked to remember activities of different intensities performed at different times of the day in bouts of at least 10 continuous minutes. The 7-day PAR has demonstrated acceptable reliability and validity across studies with different populations.[27,28,29] For example, among a sample of Latinos, the 7-day PAR showed acceptable test-retest reliability (r=0.69) and good validity as demonstrated by high correlations with Caltrac activity monitors (r=0.67 - 0.82).[29]

At the end of the three-month maintenance period, participants were also asked to complete a Likert-style questionnaire regarding frequency of use of smartphone apps and their different features. Participants in the enhanced maintenance group received a questionnaire that

specifically asked about their use of the apps that had been presented to them when they

completed the Seamos Activas intervention, and any additional app that they used for

maintenance of MVPA through the three-month period. Participants in the regular maintenance

group received a more generic questionnaire that asked whether they had used any app for

maintenance and whether they found it helpful.

Quantitative Data Analysis

Given that this is a pilot study, power calculations were not used to determine sample

size. All data analyses were conducted using R Studio Version 1.0.153. Descriptive statistics and

graphs were used to inspect data and to observe differences between MVPA at baseline and

follow-up (3 months after completing the tapered intervention). For such purpose, in addition to

using the continuous MVPA variable, we converted these data into a categorical variable using

the 3 strata we had used at randomization (< 90, 90-120, and >120 minutes of MVPA/week),

plus an additional stratum for those whose MVPA dropped below the 60 minutes/week of

MVPA enrollment cutoff.

To determine whether MVPA decreased with time, and whether having

knowledge/access to the selected apps led to improved maintenance, we used a longitudinal

mixed effects regression model with minutes/week of self-reported MVPA as an outcome

variable. Using the NLME R package,[30] we entered group and time as fixed effects in the model,

plus an interaction of time and group, while random effects included random intercepts for

subjects. As shown in Figure 4.1, we used three time points: pre-intervention (baseline or month

0), post-tapered intervention (month 12), and post 3-month maintenance (15 months after

baseline). For these models, a visual inspection of residual plots did not reveal any obvious

deviations from homoscedasticity or normality in residuals. To better understand changes in

MVPA from post-tapered intervention to the post-3-month maintenance period, we used an additional longitudinal mixed effects regression model with only these two time points.

Descriptive statistics were also used to determine the frequency of use of smartphone apps in each group separately and in both groups combined.

Qualitative Data Collection and Analysis

Twelve participants from the enhanced maintenance group and nine from the regular maintenance group provided additional information through a semi-structured individual in-person interview,[31] upon completion of the 3-month maintenance period. All participants were asked about their satisfaction with their PA maintenance during these three months in which they had no contact with study personnel. Additionally, participants in the enhanced maintenance group provided information regarding their use or lack thereof of the smartphone apps to aid with MVPA maintenance; this information was used to further understand their experience with the smartphone apps. Enhanced maintenance group participants were asked to describe their use of smartphone apps for MVPA maintenance, if any, and to discuss how this use might have helped them. All interview procedures took place in a private room at a university location, and participants' responses were audio recorded with the participants' consent. Participants were interviewed in Spanish, as this was the language that was used during the Seamos Activas intervention.

Participants' responses were transcribed and analyzed in Spanish, using the dedoose qualitative and mixed-methods analysis software. Three researchers (ASMV, NB, and ES) conducted qualitative data analysis, following steps stipulated in previous literature[32,33]:

1. The three researchers got familiarized with the data at hand by reading through seven interviews and physically annotating the transcripts;

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2. The three researchers used the notes and interview questions to generate codes for analysis, and a codebook was developed.[34] New codes were generated throughout the coding process, if necessary, to capture new ideas that were spontaneously shared by participants. The three investigators used the codebook to collaboratively code all interviews, discussing and reaching agreements in the coding process; because all interviews were jointly coded, inter-reliability measures were not used.[35]

3. The three researchers compared different codes and explored the relationships between themes to find patterns.

4. The three researchers refined the names of the themes and selected excerpts to be used in the manuscript to illustrate themes.

Results

Demographics

Table 4.2 shows baseline demographic data for the regular and enhanced maintenance conditions. There were significant differences in education between the two groups, as more participants in the regular maintenance group reported having a college or graduate education, compared to participants in the enhanced maintenance group, while fewer reported having only a high school degree or less. Mean age for all participants at pre-intervention was 48 (SD=9). The great majority of participants (93%) was of Mexican descent and was married or had a partner (74%).

Maintenance of Physical Activity

Quantitative Results

Results of our quantitative data showed that mean minutes/week of self-reported MVPA was 16.85 (SD=24.73) before the intervention, 230.50 (SD=199.29) immediately after the tapered intervention, and 163.10 (SD=125.49) after the maintenance period.

As depicted in Figure 4.3, after the 3-month maintenance period, 12 out of 26 participants (46%) reported engaging in more than 120 minutes/week of MVPA, compared to none before the intervention and 21 (78%) immediately after the tapered intervention. After the 3-month maintenance period, only 3 participants (12%) reported engaging in less than 60 minutes/week of MVPA, compared to none immediately after the tapered intervention, and compared to the 25 participants (93%) that had reported engaging in less than 60 minutes/week of MVPA before the intervention. Figure 4.3 shows a complete breakdown of the number of participants in each MVPA category at each time point.

Qualitative Results

Among the twenty-one participants who were interviewed upon completion of the three-month maintenance period, thirteen were satisfied with their PA. Qualitative data results provided an insight into satisfaction with PA maintenance, as they revealed that many women tended to compare their PA after the maintenance period with their PA before the intervention, not with their PA after the intervention. Thus, when asked about how they felt regarding their PA after the maintenance period, some referred back to how inactive they were before the beginning of the intervention, expressing satisfaction with what they had achieved. For example, one participant (38 year old female) shared: "[I feel] good because before I did not use to do any exercise at all, and now I have it in my mind that I have to exercise for my own good." Two

participants were ambivalent about their maintenance, as they had managed to maintain some but not all of their exercise. One of them (54 year old female) shared: "I feel really bad because instead of continuing like I was, well yes, I say 'Jeez.' But I have not stopped completely, so that's why I don't feel so bad... I have continued, but not the same way I was doing it before." Six participants expressed dissatisfaction with their PA maintenance, as they had reportedly relapsed into inactivity. As one participant (45 year old female) expressed, "I feel something is missing. I feel like I lost my goal, or like I have to start again. I feel that everything I had achieved, like I lost my way."

Various participants who, after the three-month maintenance period, were not engaging in as much exercise as they were immediately upon completion of the Seamos Activas intervention, still expressed satisfaction with their PA level. For example, one participant (40 year old female) shared, "Well I did not maintain my activity all the same. It was my children's vacation and my routine changes. But I tried to be constant. I did not do the 5 or 7 days, but I did try to move, to not stay sitting" and later she added, "I feel that I'm doing something for myself, to be healthier, because it's something that, truthfully, I had not done exercise before. And now that my activity is moderate, I feel that my heart speeds up and everything feels different. I feel good, and that motivates me to look for ways to continue doing it."

Most participants also expressed confidence in their ability to continue engaging in PA in the future. For example, one participant (41 year old female) noted: "I believe I will [continue exercising in the future] because it has become a habit. This is my lifestyle, I have to do exercise."

MVPA Change Across Time - Differences Between Enhanced and Regular Maintenance Group

Figure 4.4 depicts the MVPA trajectories for participants in the regular and the enhanced maintenance groups. As shown in Table 4.3, results of linear mixed effects regression models showed a statistically significant effect of time on self-reported PA. Compared to pre-intervention (time 1), participants in the regular maintenance group reported doing on average 186 (SE=41, $p<0.01$) more minutes of MVPA per week immediately upon completing the intervention (time 2). Additionally, after the 3-month maintenance period (time 3), they reported doing on average 102 (SE=42, $p<0.05$) more minutes of MVPA per week, compared to pre-intervention; this difference was statistically significant. Based on the interaction terms shown in Table 4.3, compared to participants in the regular maintenance group, enhanced group participants reported slightly more pronounced changes in MVPA from pre-intervention to time 2 (53 more minutes on average, SE=57) and time 3 (81 more minutes on average, SE=58), although these differences were not statistically significant.

Table 4.3 presents results of linear mixed effects regression models with only two time points: time 2 (immediately post-tapered intervention) and time 3 (after the 3-month maintenance period). Time had a statistically significant effect on self-reported PA: participants in the regular maintenance group reported doing on average 85 (SE=34, $p<0.05$) fewer minutes of MVPA per week at time 3, compared to time 2. While participants in the enhanced maintenance group started this 3-month maintenance period reporting more MVPA than those in the regular maintenance group (40 more minutes, on average, SE=64), this difference was not statistically significant. Participants in the enhanced maintenance group reported a smaller drop in MVPA

from time 2 to time 3 (29 fewer minutes on average, SE=47), yet this difference was not statistically significant either.

Use of Apps for Maintenance

Quantitative Results

Overall, 12 participants (9 from the enhanced maintenance group and 3 from the regular maintenance group) reported using any app at least a little (in a Likert-style scale, as shown in Table 4.4) to help with MVPA maintenance. Table 4.4 includes more detail pertaining which apps were used and how much they were used. In addition to participants in the enhanced maintenance group, one participant in the regular maintenance group found and was using the Fitbit app for PA maintenance, and two participants reported using other apps.

Qualitative Results

Results of qualitative analyses provided a deeper understanding of app use for PA maintenance, by revealing that the main reasons for not using the apps were not finding them appealing and not finding them necessary. Various women were already engaging in other activities that they enjoyed, and they were not interested enough in the apps to make more time for them. One participant shared, "Maybe I will use the applications, but I do not need them because at the gym I have everything and I even have a trainer for free," while another woman stated, "The apps look good but I am already doing Zumba and Yoga and I like that better. They are group activities. Because on the phone I just say I will do it later..." One participant explained that once the habit was formed and once she did not have to report her MVPA for purposes of an intervention, she did not find it necessary to track her PA, "... because exercising became a habit to me, I no longer had to... I did not feel I had a commitment with you but with myself. And when you do something often then you form the habit and you no longer need reminders or you

don't need to write down... you know that you run for 30 or 40 minutes, you know that you run two or three miles, you learned how the time and distance works through the applications so you no longer have to use them."

Another very commonly cited reason for not using the apps was not being tech savvy enough. One participant expressed her frustration with the use of technology, "Technology, I would like to use it, but I have no patience. The apps that you put on my phone, I open them and then I have to put a password in, and then I don't know it, and it sends me there and it sends me an email and then I lose patience and then that's it... I did not manage to get in." Another participant explained that she does not always carry her phone with her, "I did like it on my phone. I am not too tech savvy on my phone or anything, but maybe if I carried it with me more often, I would do it."

Only two participants stated that they had problems with their phone or with the apps, which kept them from using the apps to help with their maintenance, "I was not able to use the one that you taught me, the Nike one, because my phone does not have too much capacity, and it required too much space." One participant shared that she started using one of the apps but stopped once an upgrade affected her favorite app features, "I did not use it anymore because it no longer had the graphics. They did an upgrade and it did not show them to you anymore. You couldn't go back to see what you had done before. And it would just crash. My phone was like rejecting it."

Some of the women who did use the apps expressed their approval: "I liked it, when I downloaded the app I liked how it looked, it looked very, very easy to use and I liked them. I am very visual so I liked the colors and the appearance so I liked the app a lot, how it's configured, how you can enter the information, and it is very complete to say the truth." Another participant

seemed to use the apps to provide alternatives to overcome obstacles: "The videos I use when the weather outside is too hot or it's raining or it's too cold, then I do it better at home and I use the videos." Some women also stated that they downloaded other apps that were more fit for their needs, "... first I analyzed it and said, 'this one seems like it will work.' Then I started combining them, 'this will not work but the warm up will.'"

Overall, even participants who used apps seemed to not be reliant on them for their maintenance. Maintainers seemed to have learned, acquired skills, and created habits during the preceding intervention months; as one participant shared, "[Apps] have been a great motivation, but lets suppose that I didn't have them, I would have continued, it would not have been an obstacle... maintenance would not have been hard because for me it was not like 'Oh, it's over, what will I do now?' No, it was like 'I will be on my own, I already learned to walk, or I mean to crawl, now like babies who learn to walk you cannot stop them."

Discussion

The present study aimed to assess maintenance of MVPA three months after completion of a PA intervention for Latinas. Using quantitative research methods, we were able to observe some, but not complete, maintenance of PA following participation in a PA intervention: while there was a statistically significant drop in self-reported MVPA between the time the intervention ended and the end of the three-month maintenance period, most women still reported engaging in significantly more PA than when they started the intervention. In fact, only 3 women reported having returned to levels comparable to those in pre-intervention. Moreover, more than half of the women who were interviewed reported being satisfied with their maintenance, even if they acknowledged drops in their PA levels during the maintenance period. Thus, the definition of PA maintenance, which is still evolving,[36] might need to allow some

flexibility for linear decreases in PA, focusing rather on the bigger picture. In the area of weight loss, which is better established, for instance, maintenance has oftentimes been defined categorically (e.g., maintaining a loss of 10% of the body weight for at least one year).[37] To advance the field of PA maintenance research, it is clearly imperative to reach a clear consensus on what constitutes maintenance.

In terms of differences between enhanced and regular maintenance group participants, those in the enhanced group reported a slightly smaller (non-significant) drop in MVPA during the maintenance period. Based on these results and the small differences observed between groups, it seems that introducing our participants to these commercial smartphone apps upon successful completion of the PA intervention did not make much of a difference in their PA maintenance. Among this population, then, there was not enough quantitative evidence to suggest that the selected smartphone apps could help women in maintaining their MVPA.

Results of the feasibility survey indicate that most participants in the enhanced group did not use smartphone apps, which may account for the observed results. Moreover, results of qualitative interviews provide insight as to possible reasons why some participants did not incorporate the use of apps to help with PA maintenance. For example, most women who were interviewed were engaging in activities such as Zumba or dancing. Our study participants might not have been interested in adding the apps to their toolset because their needs might have already been fulfilled by other activities that they had previously adopted.

Another possible explanation is that participants might have needed more training and assistance to be able to use apps. In qualitative interviews, some women explained that the apps were difficult to use. While the Seamos Activas study used text messages as part of the intervention, smartphone apps may require a different level of skill and training. Perhaps

increasing the number of training sessions before withdrawing the support of research staff would result in increased engagement with smartphone apps during the maintenance period.

Alternatively, it may be that participants who managed to maintain did not need the apps. A recent systematic review found that apps seem to be helpful in the short-term (3 months or less) but not very effective in maintaining engagement in the long term.[38] Moreover, it has been suggested that maintenance is a product of factors that are completely different from those related to initiation of behavior.[39,40] Some studies have found that fulfillment of outcome expectancies, a sense of commitment or obligation, beliefs about the consequences of PA, or the ability to overcome barriers may influence maintenance of behavior change.[41-43] Through qualitative research, our own team has determined that maintenance could be a product of specific facilitators (i.e., the ability to overcome obstacles, habit, an environment conducive to exercise, knowledge/tools to maintain, social support, and specific sources of motivation) (see chapter 3 of this dissertation). Perhaps apps can be helpful but not essential for maintenance of PA, as those who have all these other facilitators could choose to use apps as part of their tool set, but might not necessarily rely on them. Thus, our attempt to use technology to prolong and simulate periods of tapered intervention might not have lead to better maintenance outcomes, as other factors may have already been facilitating maintenance by the time we gave participants access to apps.

A limitation of this pilot study was the short 3-month time frame used when assessing maintenance. In previous research, maintenance has been studied as a period of at least 3 months after tapered intervention completion; nevertheless, longer periods of follow-up time have been recommended.[8] Additionally, the selection of apps included in this research also entailed certain limitations: while there is a large supply of commercially-available exercise apps that offer

access to potentially useful strategies, for the purpose of this pilot study we had to select and were only able to test two of them. Future studies could potentially assess the impact of other apps on maintenance of PA, considering the need for culturally appropriate instruments that are user-friendly. Finally, while randomization procedures should have ideally balanced our key covariates, due to the small sample size we did not achieve a balance in all covariates (i.e., the variable education is unequally distributed among groups). While we considered adjusting for education in our models, because of the small sample size, adjusting for covariates may not be reliable.

In conclusion, this study contributes to the literature by employing quantitative and qualitative data to provide new knowledge regarding maintenance of PA, which is an area of research that is still not well understood, among a priority population (Latina women). Overall, among our sample of Latina participants who had reportedly increased their PA levels to at least 60 minutes per week by the end of a PA intervention, few women reported returning to pre-intervention levels, and more than half reported being satisfied with their maintenance. Nevertheless, there was a drop in self-reported MVPA between the time the intervention ended and the end of the three-month maintenance period. This study also explored the use of new technologies to assist with PA maintenance. Using smartphone apps to simulate the effects of tapered intervention, which to our knowledge has not been attempted before, did not seem to contribute to maintenance of PA among our sample. Future studies should consider using formative research to select or design apps that meet participants' needs and are desirable potential additions to participants' toolset for PA maintenance. Additionally, future research could consider introducing apps earlier on (i.e. before the end of the intervention) and increasing the number of training sessions to promote engagement with apps.

Acknowledgements

Table 4.1: Theory-Based Strategies in Commercial Smartphone Apps Used in the Proposed Study

Theory	Construct	Strategy	Fitbit App	Nike Training Club
SCT[17]	Observational Learning	Modeling: Role models exemplify strategies for engagement in MVPA.		
	Outcome Expectations	Enjoyment: Promoting increased enjoyment of PA.		
	Self-Efficacy and Self-Regulation	Goal Setting: Setting realistic goals, starting small and increasing.		
		Planning: Creating specific plans to achieve goals.		
		Self-monitoring: Tracking progress towards MVPA goals.		
		Feedback: Providing feedback and congratulations when goals are achieved.		
TTM[18]	Behavioral Processes of Change	Stimulus Control: Reminders to be physically active.		
		Reinforcement Management: Rewards and positive reinforcement for engaging in MVPA.		
		Helping Relationships (Social Support): Interactions with people who are supportive of MVPA.		

Note: Both apps are available in English and Spanish
Reinforcement Management and Helping Relationships can also be used in the context of SCT

Table 4.2: Participant Characteristics (N=27)

	Enhanced Maintenance (n=14)	Regular Maintenance (n=13)	All Participants (n=27)
	Mean (SD)	Mean (SD)	Mean (SD)
Age	49.50 (10.63)	46.92 (7.15)	48.26 (9.04)
BMI	30.14 (5.30)	29.46 (5.05)	29.81 (5.10)
PA before intervention (7-day PAR)	10.36 (15.99)	23.85 (30.76)	16.85 (24.73)
PA after tapered intervention (7-day PAR)	249.60 (172.66)	210.00 (229.95)	230.50 (199.29)
PA after 3 month maintenance (PAR)[+]	193.30 (133.11)	127.90 (111.09)	163.10 (125.49)
	N (%)	N (%)	N (%)
Ethnic Background			
Mexican	13 (92.86)	12 (92.31)	25 (92.59)
Education*			
High School or Less	7 (50.00)	3 (23.08)	10 (37.04)
Technical School/Some College	6 (42.86)	3 (23.08)	9 (33.33)
College or Graduate School	1 (7.14)	7 (53.85)	8 (29.63)
Employment[+]			
Unemployed	5 (38.46)	4 (30.77)	9 (34.61)
Full Time Employment	3 (23.08)	2 (15.38)	5 (19.23)
Part Time Employment	5 (38.46)	7 (53.85)	12 (46.15)
Income			
<20,000	5 (35.71)	4 (30.77)	9 (33.33)
20,000 – 39,999	7 (50.00)	7 (53.85)	14 (51.85)
>= 40,000	2 (14.29)	2 (15.38)	4 (14.81)
Marital status			
Married or Have Partner	9 (64.29)	11 (84.61)	20 (74.07)
Number of Children Under 18			
1 Child (Compared to no Children)	5 (35.71)	6 (46.15)	11 (40.74)
2 or More Children	3 (21.43)	4 (30.77)	7 (25.92)

* $p<.05$, ** $p<.01$, *** $p<.001$
[+] Missing data for 1 participant, [++] Missing data for 2 participants

Table 4.3: Physical Activity Changes by Study Arm: Linear Mixed Effects Model Results

	Pre-Intervention to Post-Maintenance	Post-Tapered Intervention to Post-Maintenance
Time 2 (Post-tapered intervention)	β=186.15, SE=40.97 [a] **	N/A
Time 3 (Post-Maintenance)[a]	β=102.24, SE=42.06 [a] *	β=-85.17, SE=34.62 [c] *
Enhanced Group[b]	β=-13.48, SE=52.95 [b]	β=39.57, SE=64.50 [b]
Time 2 * Enhanced Group	β=53.06, SE=56.90	N/A
Time 3 * Enhanced Group	β=80.69, SE=57.69	β=28.88, SE=47.29

Notes: a) Compared to Pre-Intervention; b) Compared to Regular Maintenance Group; c) Compared to Post-Tapered Maintenance
** $p<0.01$; * $p<0.05$; [+] $p<0.1$

Table 4.4: Perceived Helpfulness, Pleasantness, Ease, and Use of Apps - Enhanced Group Participants

	Nike + Training Club			Fitbit			Other App		
	Not at All	A Little	A Lot	Not at All	A Little	A Lot	Not at All	A Little	A Lot
Used	8	5	1	10	1	3	7	2	5
Found Helpful	10	1	2	9	1	3	7	1	5
Found Pleasant	9	4	0	9	1	3	7	1	5
Found Easy	8	3	2	8	2	3	6	1	6

Note: data on perceived helpfulness, pleasantness and ease are missing for one participant.
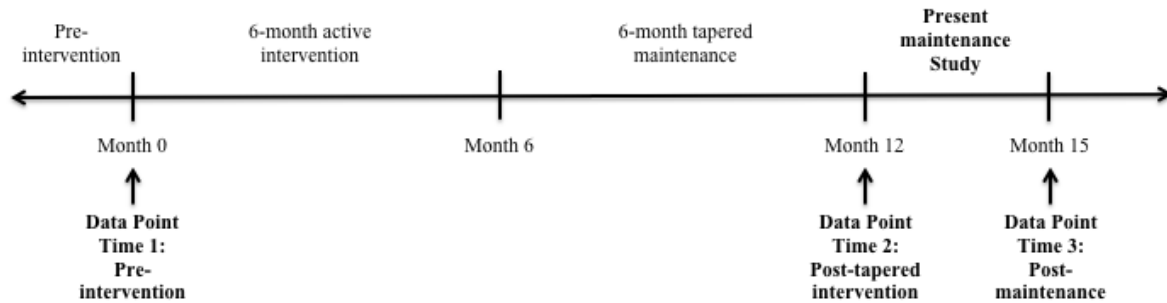

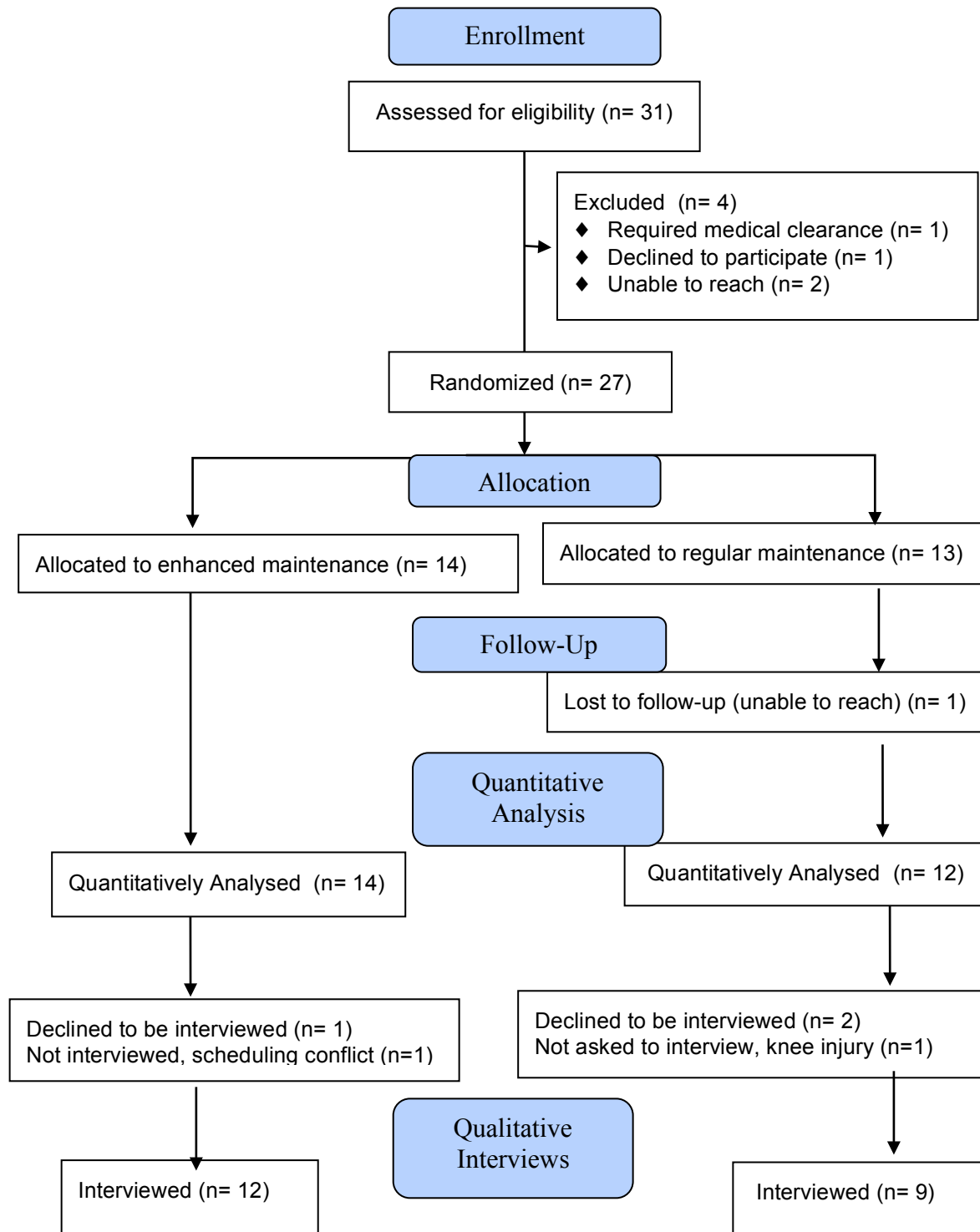**Figure 4.1:** Present maintenance study timeline in relation to Seamos Activas study.

Figure 4.2: CONSORT flow diagram.

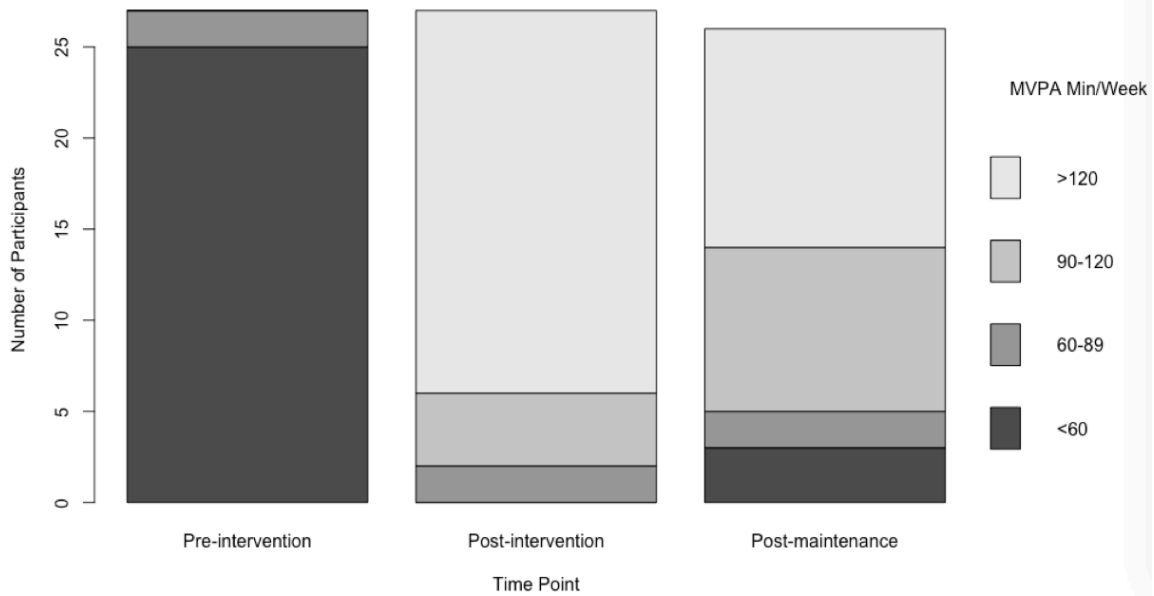**Figure 4.3:** Proportion of participants engaging in <60, 60-89, 90-120, and >120 minutes/week of MVPA at pre-intervention, post-tapered intervention, and post-maintenance.
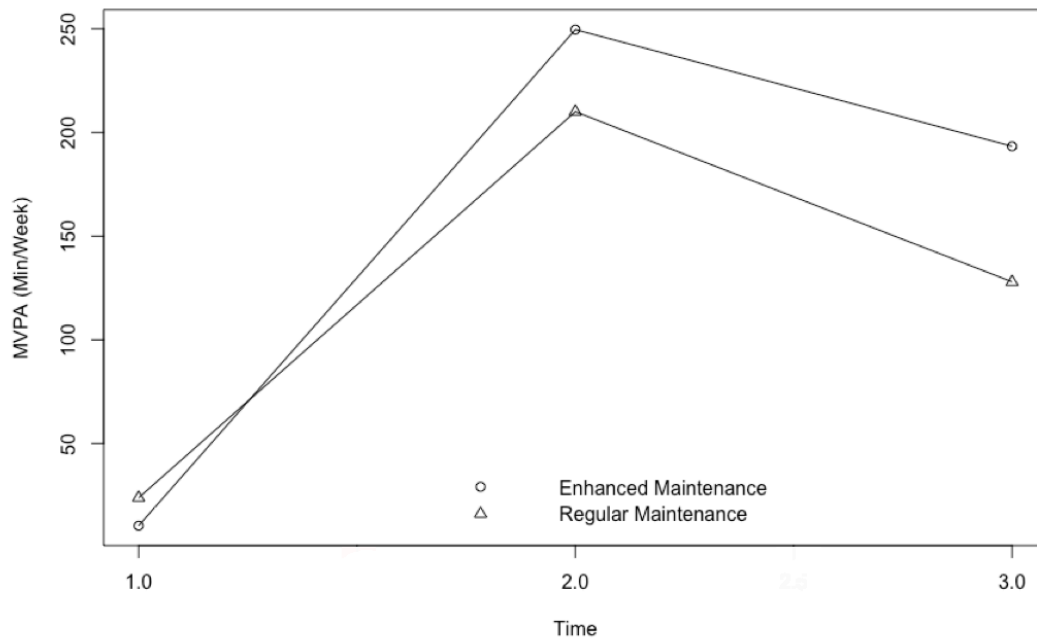

Figure 4.4: MVPA trajectories - comparison between regular and enhanced maintenance group participants.

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CHAPTER 5:

CONCLUSION

The three studies conducted as part of this dissertation add to the limited body of research on the subjects of lapse, relapse, and maintenance in PA promotion studies among Latina women. First, in terms of lapse and relapse during participation in PA interventions, in dissertation study #1 we observed that the risk of lapse among our sample of Latina PA intervention participants rose to 34% after four months of beginning to exercise. Considering this high risk of lapse, identifying mechanisms and strategies to help PA intervention participants to prevent lapses is an important research gap to address. Results from this study also revealed that individual factors (e.g., age, education), and environmental factors (e.g., street connectivity) did not influence likelihood of lapse (with the exception of having >= 2 children under the age of 18). Alternatively, factors that can be changed through interventions (e.g., self-efficacy for PA, use of processes of change for PA) were associated with a lower risk of lapse. Beginning to exercise during the first two months of the intervention, as opposed to beginning later during the intervention, was also protective against lapses. These findings suggest a need to identify (early on during the intervention) those participants who are not fully engaged from the beginning, and to implement strategies to engage them. Our results pertaining lapse recovery were harder to interpret: contrary to our hypothesis, the use of behavioral strategies at the beginning of the intervention was predictive of non-recovery, yet use of these strategies at 6 months was associated with lapse recovery. Moreover, in sensitivity analyses, individual and environmental variables (i.e., body mass index and street connectivity) were also predictive of lapse recovery. Given the inconclusive results pertaining lapse recovery, PA intervention research may benefit from prioritizing lapse prevention early on during interventions.

In study #2, through qualitative research, we achieved a deeper understanding of factors that may facilitate and hinder maintenance of PA among Latinas that completed a PA intervention. Factors identified as important to PA maintenance included having made PA a habit, living or working in an environment that is conducive to PA, having social support for PA, having the knowledge and skills needed to maintain PA, being proactive in overcoming obstacles for PA maintenance, and having specific sources of motivation, such as enjoyment of PA and satisfaction with outcomes obtained. These findings may guide researchers to develop and implement strategies to bolster PA maintenance in interventions for Latinas. For example, future interventions could incorporate habit-forming strategies (e.g., repetition of the behavior in a consistent context, using positive reinforcements)[1] and teach participants skills to proactively overcome obstacles for PA maintenance, such as scheduling time for PA and looking for resources like exercise classes. Interventions could also work with participants to set attainable goals and have realistic expectations from the beginning, perhaps focusing on more immediate outcomes of exercise (e.g., enjoyment of having alone time) instead of long-term outcomes such as substantial loss of weight.[2] The findings of this study among a priority population of Latina women significantly overlap with the results of a previous research study that synthesized one hundred theories of behavior change and maintenance,[3] providing further support to the hypothesized factors that influence behavior maintenance.

The third dissertation paper used mixed-methods to evaluate PA maintenance among Latina women and to assess the feasibility and preliminary efficacy of using smartphone apps to help with maintenance. There was a statistically significant decrease in self-reported PA between the time all intervention activities (including a tapered intervention period) ended and the end of the three-month maintenance period. Nevertheless, most women still reported engaging in

significantly more PA than when they started the intervention. Moreover, more than half of the women reported being satisfied with their maintenance, even if they did experience a drop in PA, and only 11% of the participants (3 out of 27 women) reported a return to pre-intervention PA levels. This study highlighted the need for a clear and appropriate definition of PA maintenance; instead of looking at thresholds for maintenance, an individual-centered approach to determining maintenance may be more appropriate.[4] In the area of weight loss maintenance, which is better established, for instance, maintenance has oftentimes been analyzed in a categorical way (e.g., maintaining a loss of 10% of the body weight for at least one year).[5] Because in our study, participants were satisfied with being able to sustain at least 50% of the PA they had attained by the end of the tapered intervention, future research could consider this threshold to define maintenance of PA

Through this study we also learned that using the selected apps to enhance PA maintenance, simulating the effects of "tapered maintenance" periods, did not appear to be efficacious in helping participants to maintain PA. This may be a product of methodological limitations such as the small sample size or the selection of apps (e.g., apps may not have been sufficiently culturally appropriate). However, particularly considering the results obtained in the second dissertation study, it is possible that apps were unnecessary tools for PA maintenance; participants who maintained PA upon completion of interventions might have acquired the necessary skills, developed habits, and amassed other facilitators to support their PA maintenance, and might not have needed smartphone apps to maintain PA.

In conclusion, based on the research conducted in the three dissertation studies, we observed the need to focus on teaching intervention participants the skills to prevent lapses/relapses and to maintain PA beyond intervention completion. Lapses may be preventable

because they do not appear to be predetermined by individual and environmental factors (e.g., age, street connectivity), but by the active use of intervention strategies such as processes of change for PA. Moreover, our hypothesis is that PA maintenance beyond intervention completion is affected by factors and skills that participants acquire throughout their participation in interventions (e.g., being proactive in overcoming obstacles, creating habits); alternatively, providing additional tools after interventions have ended might not be as effective.

Limitations and Strengths

Study #1 may have been underpowered to identify significant predictors of time to lapse and of lapse recovery. While post-hoc power calculations could reveal whether the study was underpowered, we would still not be able to increase the sample size, as this was a secondary data analysis. Additionally, data were not available to operationalize and evaluate additional potential predictor variables, such as outcome expectancies; nor did we have the ability to assess the predictive effect of variables related to situational lapses (e.g., sickness in family). For study #2, given the lack of consensus on a definition of maintenance in the field of PA promotion research,[4,6] we selected an individual-centered threshold of 50% (i.e., maintaining at least 50% of the PA that participants were doing at the beginning of the maintenance period) as a cut point to differentiate participants who maintained from those who did not. Although the selection of this cut point was guided by our qualitative data, our study results could have been different had we decided on a different cut point. Similarly, study #3 revealed that analyzing maintenance outcomes using linear variables might not capture all the dimensions of PA maintenance. For example, while there was a significant drop in PA during the maintenance period, more than half of the participants were satisfied with their maintenance of PA, and very few participants returned to pre-intervention levels, indicating some of the intervention effects were maintained.

Thus, as the field of PA maintenance continues to grow, it is important to reach a consensus on what constitutes PA maintenance, to be able to compare findings across studies. Study #3 is also limited by the short 3-month time frame and the process of selection of apps (i.e., while there is a large supply of commercially-available exercise apps that offer access to potentially useful strategies, for the purpose of this pilot study we had to select and were only able to test two of them).

Strengths of this dissertation research include the combination of different methods (i.e., quantitative and qualitative methods) to study lapse, relapse, and maintenance of PA. While quantitative methods allowed us to draw inferences and empirically test our hypotheses, qualitative methods provided rich data to better understand the concepts under study. Moreover, the use of pooled secondary data in study #1 allowed for the analyses of a larger sample, while the use of primary data for study #2 and #3 provided greater control and flexibility to answer some of the study questions. Each study also has its own strengths. Study #1 used monthly PA data, which is very rare in PA promotion research, to understand patterns of lapse and relapse that might have otherwise been overlooked, yet may be important in helping individuals attain and sustain PA-related behavior change. Study #2 capitalized on qualitative methods to obtain detailed and in-depth information that enabled us to formulate hypotheses of how Latina women maintain PA after interventions, and how different facilitators may interact to jointly influence maintenance. Study #3 provided innovative and important information regarding the use of smartphone technology to influence maintenance of PA (which is an understudied area of research) among an at-risk priority population (Latina women).

Contributions to the Field and Recommendations for Future Research

While PA is an important preventive behavior,[7] PA promotion research to date has mostly focused on helping sedentary individuals initiate PA, neglecting important issues of lapse, relapse, and maintenance of PA.[8] Our lack of understanding of these issues may be limiting the efficacy and the public health impact of PA interventions, which often help participants only in the short-term.[9] By acquiring a better understanding of lapse, relapse, and maintenance in PA intervention research, we were able to provide recommendations for the development and implementation of strategies to help a greater number of individuals to attain their long-term PA goals and reap the ensuing health benefits. Future research can test the implementation of such strategies in PA intervention trials to empirically determine their effect on lapse, relapse, and maintenance of PA. Specifically, we concluded that it will be useful to (1) Encourage participants to start exercising and using behavioral strategies early on (i.e., from the beginning of the intervention) by distributing intervention doses so they are more frequent at the beginning and taper down with time; (2) Include information throughout the intervention to encourage participants to develop skills to overcome obstacles once the intervention has concluded; (3) Incorporate habit-forming strategies from the beginning of PA interventions; and (4) Help participants to develop realistic expectations from the beginning, perhaps focusing more on immediate outcomes of exercise such as enjoyment of alone time. We also concluded that, to advance the field of PA maintenance research, it is imperative to reach a clear consensus on what constitutes maintenance.

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