Title

Long-term physical activity outcomes in the Seamos Activas II trial

Authors

Marcus, Bess H
Larsen, Britta A
Linke, Sarah E
et al.

Publication Date

2021-12-01

DOI

10.1016/j.pmedr.2021.101628

Peer reviewed

Preventive Medicine Reports 24 (2021) 101628

Contents lists available at ScienceDirect

Preventive Medicine Reports

journal homepage: www.elsevier.com/locate/pmedr

Long-term physical activity outcomes in the Seamos Activas II trial

Bess H. Marcus [a,*], Britta A. Larsen [b], Sarah E. Linke [b], Sheri J. Hartman [b], Dori Pekmezi [c], Tanya Benitez [a], James Sallis [b], Andrea S. Mendoza-Vasconez [d], Shira I. Dunsiger [a]

[a] Department of Behavioral and Social Sciences, Center for Health Promotion and Health Equity, Brown School of Public Health, Providence, RI, USA
[b] Herbert Wertheim School of Public Health and Human Longevity Science, UC San Diego, La Jolla, CA, USA
[c] Department of Health Behavior, School of Public Health at University of Alabama at Birmingham, Birmingham, AL, USA
[d] Stanford Prevention Research Center, Stanford School of Medicine, Stanford, CA, USA

ARTICLE INFO

Keywords:
Exercise
Maintenance
Hispanic
Theory
Technology

ABSTRACT

Latinas report disproportionately low physical activity (PA) levels and related health conditions. Reducing chronic disease in Latinas requires interventions to increase and maintain health-enhancing PA levels; yet limited intervention studies have examined PA maintenance among Latinas. The present study evaluated the efficacy during the maintenance phase (months 6–12) of the Enhanced PA intervention for Latina adults in Seamos Activas II compared to the Original PA Intervention. Seamos Activas II was conducted in San Diego, California from 2015 to 2020. Underactive adult Latina women (N = 199), mainly of Mexican descent (89%) were randomized to the original intervention or a theory- and technology-enhanced intervention. Their PA was measured objectively (via accelerometers) and via self-report at baseline, 6, and 12 months. Quantile regression models assessed treatment effects on min/week of moderate to vigorous PA (MVPA) at 12 months. Generalized linear models examined treatment effects on indicators of meeting 2008 National PA Guidelines. Both groups maintained the significant gains in MVPA they had made during the first 6 months of the intervention, neither increasing nor decreasing their MVPA over the maintenance period, with no significant between-group differences. At 12 months, 46.3% of Enhanced Intervention participants were meeting self-reported PA guidelines (vs 35.6 % of the Original PA Intervention arm, p = .02). Even with minimal contact throughout the maintenance phase, participants maintained their MVPA, which underscores the importance of continued use of evidence-based behavior change tools and techniques to reinforce newly established habits. Theoretical and technological enhancements may help Latinas to continue meeting PA guidelines during maintenance periods.

1. Introduction

Latinas in the US report a disproportionate prevalence of lifestyle-related health conditions, such as diabetes, stroke, and obesity (Blackwell and Villarroel, 2017; National Center for Health Statistics (US), 2016; National Health Interview Survey, 2008). Engaging in regular physical activity (PA) can lead to long-term positive health outcomes, and is a key behavior for preventing chronic disease and obesity (US Department of Health and Human Services, 2018); yet few Latinas achieve health-enhancing PA levels recommended by the national PA guidelines (≥150 min/week of moderate-intensity aerobic PA, 44% vs. 55% of non-Latina white women) (US Department of Health and Human Services, 2018; Villarroel et al., 2018), which represents a critical public health challenge (Office of Disease Prevention and Health Promotion, 2021).

Reducing PA-related chronic disease in Latinas requires interventions that increase and maintain health-enhancing PA levels over time; yet, limited intervention studies have examined PA maintenance at 12 months or beyond (Fjeldsoe et al., 2011; Rhodes and Quinlan, 2015; Spark et al., 2013), particularly among minority populations such as Latinas (Perez et al., 2010; Joseph et al., 2019; Loya, 2018; Ickes and Sharma, 2012). Of the few culturally appropriate interventions that have examined long-term PA gains in Latinas, results have often been modest. The Seamos Saludables Study (Marcus et al., 2013; Marcus et al., 2015; Pekmezi et al., 2012) for example, tested a theory-driven culturally and linguistically adapted, mail-delivered PA intervention

* Corresponding author at: Center for Health Promotion and Health Equity, Brown School of Public Health, 121 South Main Street, Providence, RI, USA.
E-mail addresses: bess_marcus@brown.edu (B.H. Marcus), blarsen@health.ucsd.edu (B.A. Larsen), slinke@health.ucsd.edu (S.E. Linke), sjhartman@health.ucsd.edu (S.J. Hartman), dpekmezi@uab.edu (D. Pekmezi), tanya_benitez@brown.edu (T. Benitez), jsallis@health.ucsd.edu (J. Sallis), amenvasc@stanford.edu (A.S. Mendoza-Vasconez), shira_dunsiger@brown.edu (S.I. Dunsiger).

https://doi.org/10.1016/j.pmedr.2021.101628
Received 4 January 2021; Received in revised form 24 October 2021; Accepted 30 October 2021
Available online 2 November 2021

for Latina adults (18–65 years). The intervention produced significantly more increases in minutes/week of moderate to vigorous PA (MVPA) from baseline to six months (1.9 to 73.4 min/week) compared to the wellness contact control (3.0 to 33.0 min/week) (Marcus et al., 2013). While MVPA increases were maintained at 12 months, few participants (16.8% intervention arm and 6.0% control arm) reached national PA guidelines (Marcus et al., 2015).

Rapid increases in technology use, particularly in cell phone ownership which is now nearly universal among Latinos (Pew Research Center, 2021), present an opportunity to incorporate technology-based elements in PA interventions for this population. While the use of technology such as mobile phones for PA promotion has shown promise (Fanning et al., 2012; Flores Mateo et al., 2015), there is only a limited number of PA interventions using technology among Latinas (Joseph et al., 2019). We thus refined the Seamos Saludables Intervention (Marcus et al., 2013; Marcus et al., 2015; Pekmezi et al., 2012) to include technology- and theory-based enhancements guided by study results and participant feedback (e.g., desire for greater accountability and interactivity). These enhancements included 1) further targeting constructs of Social Cognitive Theory (SCT) (Bandura, 1986), including social support, enjoyment of PA, and outcome expectancies, which were identified among participants with the highest PA increases and not directly addressed in the Original PA Intervention, and 2) incorporating the use of text messaging for PA tracking and goal setting. The theory- and technology-enhanced PA arm (Enhanced Intervention) was then tested against the original print-only condition (Original PA Intervention) in a 12-month randomized trial for Latinas (*Seamos Activas II*) (Benitez et al., 2020; Marcus et al., 2021).

This study aimed to evaluate the efficacy of the enhanced PA intervention for Latina adults in Seamos Activas II relative to the Original PA Intervention during the maintenance phase (months 6 through 12). We hypothesized that the Enhanced Intervention would result in greater PA maintenance (i.e., greater number of min/week of MVPA) at 12 months, compared to the Original PA intervention. Secondary aims included 1) examining the proportion of participants meeting PA guidelines in the Enhanced Intervention at 12 months, compared to the Original PA intervention; 2) assessing differences in acceptability between the Original and Enhanced PA interventions; and 3) comparing PA maintenance outcomes in *Seamos Activas II* to those in *Seamos Saludables*.

2. Methods

2.1. Study design and sample

Seamos Activas II (Benitez et al., 2020; Marcus et al., 2021) was a 6-month randomized controlled trial with a maintenance phase from 6 to 12 months that compared two PA interventions for Latina women: 1) the original Seamos Saludables (Marcus et al., 2013; Marcus et al., 2015; Pekmezi et al., 2012) empirically-supported print-based PA intervention (Original PA Intervention); and 2) a theory- and technology-enhanced version of the Seamos Saludables Intervention (Enhanced Intervention). PA was assessed at baseline, 6 months, and 12 months via 7-Day Physical Activity Recall (7-Day PAR) interviews and accelerometers. The study was conducted at the University of California, San Diego from 2015 to 2020. All participants gave written informed consent, and study activities were approved by the university's institutional review board (protocol #150723).

Eligible participants were underactive (<= 60 min/week of self-reported MVPA) adult (18–65 years) women who self-identified as Latina/Hispanic, could read and speak Spanish, and owned a cellphone with text messaging capability. Exclusion criteria included health conditions that would make unsupervised PA unsafe as reported on the Physical Activity Readiness Questionnaire (PARQ) screening tool (American College of Sports Medicine, 2005) (participants could seek medical clearance if eligibility was questionable due to health screening), taking medications that may impair PA tolerance or performance (e.g., beta blockers), BMI over 45 kg/m^2, psychiatric hospitalization in the previous three years, planned or current pregnancy, or plans to move out of the area within the 12-month study period.

2.2. Protocol

A detailed description of the study protocol and recruitment has been previously published (Benitez et al., 2020). Briefly, participants were recruited through a variety of methods, including advertisements on Facebook and other websites, postings in Spanish-language newspapers and radio, and outreach at community events. Potential participants were screened over the phone for eligibility. Eligible women attended an in-person orientation where they received information about the study and provided written informed consent. Participants returned for a second visit to start baseline measures and were given an ActiGraph GT3X + accelerometer to wear for seven days. One week later, participants returned the accelerometers and finished baseline measures. Participants were randomized to one of two PA conditions: 1) Original PA intervention, or 2) Enhanced Intervention. Randomization was stratified by PA stage of change (Marcus et al., 1992) to ensure equal distribution of the different levels of motivational readiness for PA (precontemplation, contemplation, preparation). Participants returned at 6 and 12 months for assessments.

2.2.1. Original PA intervention

Details of the Original PA Intervention compared with a Wellness Contact Control group in a previously conducted study in Rhode Island are published elsewhere (Benitez et al., 2020). Briefly, participants received an existing empirically supported, individually tailored Spanish-language intervention (Marcus et al., 2013; Marcus et al., 2015; Pekmezi et al., 2012). The program was based on SCT (Bandura, 1986) and the Transtheoretical Model (TTM) (Prochaska and Velicer, 1997), and emphasized behavioral strategies for increasing PA, such as goal setting, self-monitoring, increasing social support for PA, and self-efficacy. The intervention was culturally adapted for Latinas using formative research (described in detail elsewhere) (Pekmezi et al., 2012), which included a series of focus groups and cognitive interviews that determined the mode of intervention delivery and revealed culturally-relevant attitudes and barriers to PA engagement.

At the initial in-person intervention session, participants set PA goals with their health coach who utilized motivational interviewing techniques; goals were realistic and aimed to work up to 2008 National guidelines of $\geq$ 150 min per week of MVPA (US Department of Health and Human Services, 2008), which was the study goal. Participants identified potential barriers and solutions to achieving PA goals. Additionally, they received a pedometer to wear daily and monthly PA logs to record their daily MVPA and number of steps. The health coach called participants at week 1 and week 4 to check progress and address barriers. Throughout the 6-month active intervention phase, participants received eleven mailed intervention packets with individually tailored materials, including feedback reports based on participant's answers to monthly questionnaires, and manuals specific to participant's stage of change (Marcus et al., 1992), as well as tip sheets that addressed SCT constructs and barriers to PA (Pekmezi et al., 2009). At the start of the maintenance phase at month 6, participants attended another in-person goal setting session with their health coach and received a brief phone check-in at month 9. Participants also received mailed packets of materials at months 8, 10, and 12.

2.2.2. Enhanced intervention

Participants in the Enhanced Intervention received all of the intervention components described above. In addition, they received check-in phone calls from their health coach at months 2 and 3. The tailored print reports and tip sheets provided more targeting of SCT constructs (e.g., social support, enjoyment of PA, and expectancies), and participants were provided with an individualized report that mapped PA locations

(walking routes, gyms, parks) near participants' homes. Another key enhancement was an automated daily text message for the first 6 months that included PA tips addressing SCT constructs (four per week), goal setting (one per week asking participants to set a PA goal for the coming week), and self-monitoring (two per week asking participants to report their min/week of MVPA during the previous week). Participants' responses prompted automated responses thanking them for setting a PA goal and reporting their activity, respectively. During the maintenance phase, Enhanced intervention participants received one text message per week asking them to set a goal and one asking them to report their MVPA minutes for the week, with the respective automated responses. These were the only text messages they received during months 7 through 12.

2.3. Measures

The primary outcome, objectively measured PA, was assessed at baseline, 6, and 12 months using ActiGraph GT3X + accelerometers worn by participants for seven continuous days prior to the measurement visit. Accelerometer data were collected at 30 Hz and processed using ActiLife software with 60-second epochs. Using common procedures (Migueles et al., 2017), valid wear time was classified as five days of at least 600 min of wear time on 5 or more days or at least 3000 min of wear time over four days, and a cut point of 1952 was used to establish the minimum threshold for MVPA (Freedson et al., 1998). Bouts of at least 10 min of MVPA were considered in these analyses, for comparability with prior work and per the 2008 National PA Guidelines for Americans (US Department of Health and Human Services, 2008).

To corroborate accelerometer findings, 7-Day PAR (Sallis et al., 1985) interviews were conducted at baseline, 6 and 12 months. Trained interviewers used the 7-Day PAR to prompt participants to recall and report bouts of at least 10 min of moderate and vigorous intensity activities in the previous 7 days. This instrument has consistently demonstrated acceptable reliability, internal consistency, and congruent validity with more objective PA measures (Prince et al., 2008; Hayden-Wade et al., 2003; Leenders et al., 2001), as well as among Latino participants (Rauh et al., 1992).

To assess the acceptability of the intervention, participants completed an 18-item consumer satisfaction questionnaire during the 12-month visit. This was adapted from our previous study, (R01NR011295), and asked participants to indicate their satisfaction with the intervention and study staff.

Additionally, data on participants' baseline characteristics (age, generation status, language spoken at home, country of origin, education, employment status, income, marital status, and stage of motivational readiness for change) were collected via a baseline questionnaire. Anthropometric measures (BMI, waist circumference, blood pressure, resting heart rate and percent body fat were objectively measured using procedures described in the protocol paper (Benitez et al., 2020).

2.4. Analysis

2.4.1. Baseline characteristics

Baseline characteristics of the study sample were described by treatment arm. Between-group differences were examined using t-tests, chi-squared tests, and a Wilcoxon rank sum tests (for continuous, categorical, and skewed variables, respectively). Unadjusted (subjectively reported and objectively measured) PA at follow-up is presented by arm.

2.4.2. Efficacy of the enhanced intervention

The primary goal was to assess treatment effects both within- and between-arms during the maintenance phase (6–12 months). As MVPA was skewed at baseline and follow-up, and a transformation towards normality was not successful, we present quantile regression models in lieu of mean min/week of MVPA models. Quantile regression models with bootstrapped standard errors (10,000 replications), run separately for objectively measured MVPA and self-reported outcomes, were used to regress min/week of MVPA at 12 months adjusting for baseline and 6-month outcomes, treatment effects (Enhanced vs. Original PA Intervention), and treatment*MVPA at 6 months. In the case of objectively measured outcomes, accelerometer wear-time was included as a confounder (Katapally and Muhajarine, 2014). Because there were no statistical confounders, no other covariates were included in models. All analyses were conducted on the intent to treat sample, with estimation via likelihood and quasi-likelihood methods (allowing for estimation without directly imputing missing data).

2.4.3. Meeting guidelines

Generalized linear models (with logit link) were used to examine treatment effects on indicators of meeting 2008 national guidelines for PA (>= 150 min/week of MVPA, per self-report data) (US Department of Health and Human Services, 2008) at 12 months controlling for PA at 6 months. A binary variable was created based on MVPA (1 = met national guidelines for PA vs. 0 = did not meet guidelines). Odds ratios with 95% confidence intervals were the effect estimates of interest.

2.4.4. Acceptability

Consumer satisfaction data were summarized and compared between groups using chi-squared tests.

2.4.5. Comparison to Seamos Saludables

A similar modeling approach was used to compare PA outcomes in the present study (*Seamos Activas II*) to the prior study (*Seamos Saludables*). Quantile regression models were specified to compare both the Enhanced and the Original Intervention arms of the *Seamos Activas II* study vs. the PA intervention and the wellness contact control arms of the *Seamos Saludables* study (Marcus et al., 2015). Models adjusted for an indicator of study to remove effect of participant population differences.

3. Results

Participants were 199 women randomized to an Enhanced Intervention (N = 102) or Original PA Intervention (N = 97). The sample was predominantly Mexican American (89%), 43.8 years old on average (SD = 10.11), with 41% reporting at least some college-level education. Mean BMI at baseline was 30.6 (SD = 7.56). There were no differences between groups at baseline for any demographics or PA measures (p's > 0.05). Table 1 provides a full description of the study sample. Overall, 69% of participants completed the 12 m visit (63% Enhanced Intervention vs. 75% of Original PA Intervention).

Unadjusted PA outcomes are presented in Tables 2 and 3. At 6 months, 96% of participants who completed the visit provided valid accelerometer data and 97% provided valid data at 12 months. Adjusted models for accelerometers and self-report data indicate both groups maintained the significant MVPA gains they made during the first 6 months of the intervention, neither increasing nor decreasing their MVPA over the maintenance period (p = .95 self-report; p = .62 objectively measured). For both accelerometers and self-report, Enhanced Intervention participants engaged in more min/week of MVPA at 12 months than Original PA Intervention participants, though differences were not significant (b = 15.39, SE = 16.15, p = .34 self-report; b = 2.00, SE = 11.75, p = 0.86 objectively measured).

At 12 months, 46.3% of Enhanced Intervention participants self-reported meeting PA guidelines, compared to 35.6 % in the Original PA Intervention arm, p = .02. Adjusted models indicate a significant between-group difference such that the odds of meeting PA guidelines were 53% greater for Enhanced Intervention participants compared to Original PA Intervention participants (OR = 1.53, 95% CI:1.07–3.02).

There were no differences in intervention satisfaction between the Enhanced and Original PA Intervention arms (p's > 0.05). Overall, 92.4% of participants reported the staff was friendly, 99.2% said the program was at least somewhat motivating, and 72.3% reported the

Table 1
Baseline demographics and physical activity level by treatment arm, N = 199.

	Enhanced Intervention N = 102	Original PA Intervention N = 97
BMI (kg/m^2)	30.50 (9.31)	30.79 (5.19)
Age (years)	43.55 (10.63)	44.14 (9.57)
Generation Status [a]		
First	83 (82%)	79 (82%)
Second	18 (18%)	16 (17%)
Third	0	1 (1%)
Speak only or mostly Spanish at home (%)	83 (81%)	75 (79%)
Country of Origin		
Puerto Rican	1(1%)	0
Dominican	0	0
Mexican-American/ Mexican/ Chicana	92 (90%)	85 (87%)
Cuban	1 (1%)	0
Guatemalan	0	1 (1%)
Columbian	1 (1%)	1 (1%)
Other	9 (9%)	10 (10%)
Education (% at least some college)	44 (44%), N = 100	37 (39%), N = 96
Employment (% unemployed)	37 (37%)	47 (50%)
Income (N = 197)*		
<$20,000	32 (32%)	50 (52%)
$20,000–29,999	27 (27%)	9 (9%)
$30,000–39,999	16 (16%)	12 (13%)
$40,000–49,999	11 (11%)	5 (5%)
>=$50,000	10 (10%)	16 (17%)
Don't Know	5 (5%)	4 (4%)
Marital Status (% Married/ Partnered)	59 (58%)	64 (67%)
Stage of Motivational Readiness		
Pre-contemplation	2 (2%)	4 (4%)
Contemplation	91 (89%)	84 (88%)
Preparation	9 (9%)	8 (8%)
Baseline min/week Objectively Measured MVPA	33.61 (71.29), median = 0, IQR = 38	45.72 (70.93), median = 10.00, IQR = 68.5
Baseline min/week of Self-reported MVPA	14.33 (25.06), median = 0, IQR = 20	10.51 (19.47), median = 0, IQR = 15
Waist Circumference, inches	36.73 (4.80)	37.95 (5.11)
Blood Pressure		
Systolic	110.16 (14.03)	112.99 (13.73)
Diastolic	69.90 (9.49)	71.07 (8.61)
Resting Heart Rate	68.72 (9.03)	68.72 (9.07)
Percent Body Fat	39.41 (7.01)	39.66 (6.76)

Between-group differences were assessed with t-tests, chi-squared tests and non-parametrics as appropriate.
[a] Generation Status: First = foreign born; Second = at least one foreign-born parent; Third = two U.S. native parents.

Table 2
Unadjusted MVPA by group over time (Self-reported).

	Baseline, N = 199	6 month, N = 153	12 month, N = 137
Enhanced Intervention	14.33(25.06) Median = 0, IQR = 20	127.89(98.91) Median = 110, IQR = 109	145.88(149.81) Median = 130, IQR = 150
Original PA Intervention	10.51(19.47) Median = 0, IQR = 15	119.55(117.57) Median = 100, IQR = 142	132.47(130.47) Median = 100, IQR = 139.5

program shared new PA information.

When comparing *Seamos Activas II* to the prior study, Enhanced Intervention participants reported 145.88 min/week of MVPA at 12 months compared to 95.87 in the *Seamos Saludables* Original PA Intervention group and 43.42 in the wellness contact control group

Table 3
Unadjusted MVPA by group over time (Objectively Measured).

	Baseline, N = 199	6 month, N = 147	12 month, N = 133
Enhanced Intervention	33.61(71.29) Median = 0, IQR = 38	54.25(63.47) Median = 28, IQR = 98.5	63.03(65.81) Median = 40, IQR = 111
Original PA Intervention	45.72(70.93) Median = 10, IQR = 68.5	66.37(80.20) Median = 26, IQR = 109.75	84.94(109.88) Median = 36, IQR = 127

($p > 0.01$). Additionally, Enhanced Intervention participants were more likely to meet PA guidelines (46.3%) at the 12-month follow-up relative to participants in the *Seamos Saludables* Original PA Intervention (16.67%) and wellness contact control groups (5.97%, p's < 0.001).

4. Discussion

This study evaluated the maintenance phase (months 6–12) of an Enhanced PA Intervention relative to the Original PA Intervention among Spanish-speaking Latinas. Both groups maintained MVPA gains (self-report and accelerometer-measured), neither increasing nor decreasing MVPA. Results are encouraging especially given the minimal contact throughout the maintenance phase. Our findings support the importance of continuing to use evidence-based behavior change techniques throughout a maintenance phase to reinforce newly established habits.

Individuals in the Enhanced Intervention were more likely than those in the Original PA Intervention to meet PA guidelines (US Department of Health and Human Services, 2008) at 12-months. Although the Enhanced Intervention in large part replicated the Original Intervention, Enhanced Intervention participants may have benefitted from the additional materials, including weekly text messages, to continue to self-monitor and set/adjust weekly PA goals. Enhanced arm participants also received a brief phone call from our research team at 9 months, which may have helped them remain engaged. We are conducting analyses to examine potential mechanisms of change, including engagement with intervention components and changes in psychosocial constructs, to better understand how the interventions supported maintenance (results to be presented in a future manuscript).

This is one of the few published studies to examine longer-term PA maintenance among Latinas. Results are consistent with an Internet-based version of this study, which showed a similar pattern of increased MVPA during the 6-month intervention phase, and then no change during the additional 6-month maintenance phase (Marcus et al., 2016). Other PA interventions have had varied success in maintaining behavior change. A recent review (Howlett et al., 2019) found a statistically significant effect on PA during the maintenance phase among studies enrolling initially inactive but otherwise generally healthy participants, but the effect size was smaller than after the intervention phase ($d = 0.21$ [0.12–0.30] vs. $d = 0.32$ [95% CI = 0.16–0.48]). In the review, the number of minutes of increased PA between the post-intervention (31–247 min/week) and post-maintenance (5–95 min/week) was small relative to our study. Furthermore, none of the studies included in the review focused on Latinos, making the present study's results particularly valuable. Despite its relevance to prevention and reduction of chronic diseases, PA maintenance is rarely examined in intervention trials.

When comparing *Seamos Activas II* with the previous *Seamos Saludables* study (Marcus et al., 2015), we found the Enhanced and Original PA arms of *Seamos Activas II* outperformed the Intervention and Control groups in *Seamos Saludables*, both in min/week of MVPA and in likelihood of meeting PA guidelines during the maintenance period. These findings are consistent with differences found in the active intervention stage (baseline-6 months), which were previously reported with the

main study outcomes (Marcus et al., 2021). Differences in demographics between the prior study and the current study may account for some of the variation; *Seamos Saludables* was completed in New England and enrolled primarily participants of Dominican and Cuban decent, while the current study was completed in San Diego and enrolled primarily participants of Mexican decent. Cultural differences in attitudes and social norms surrounding PA may have accounted for some of the differences in PA outcomes. Previous research has found significant differences in PA among subgroups of Latinas in the US (Neighbors et al., 2008; Abraído-Lanza et al., 2017). Moreover, societal norms within the regions in which they reside may have also contributed. For example, the percentage of the overall adult population and specifically the Hispanic adult population meeting PA guidelines is higher in California (55% and 45.7%) than in Rhode Island (50.5% and 33%) (Centers for Disease Prevention and Control, 2021). Our findings are encouraging, as they suggest the PA intervention may work (albeit at different extents) for different Latino subgroups. Moreover, the theory and technology-based enhancements to the intervention may help more individuals to reach PA guidelines while maintaining good acceptability among participants.

4.1. Strengths & limitations

The current study had a number of strengths. PA was measured using gold standard objective measures (ActiGraph GT3X + accelerometers) in addition to validated self-report measures. Both the Original and Enhanced versions of the intervention were based on behavior change theory and were developed through multiple iterations of formative research with the target population. Additionally, by comparing our outcomes to those of the prior study (*Seamos Saludables*), we compared the efficacy of multiple versions of the intervention delivered to different Latina populations.

Despite the notable strengths of the current study, its limitations should be considered. The National PA Guidelines now recommend engaging in aerobic MVPA, flexibility, and muscle-strengthening PA (US Department of Health and Human Services, 2018). While our study's focus on MVPA is consistent with most PA research among Latinas (Ickes and Sharma, 2012), this demonstrates a need to incorporate muscle-strengthening and flexibility activity in future PA interventions for this population. Additionally, given our study timeline, we based our protocol, assessments, and analyses in 2008 PA guidelines (US Department of Health and Human Services, 2008); several important changes were introduced in 2018 to national PA guidelines (US Department of Health and Human Services, 2018). Mainly, activity is no longer recommended to be in bouts of at least 10 min; our results may be different if analyses were based on new guidelines.

The generalizability of our findings may be limited because we enrolled relatively healthy, educated, predominantly Mexican-American women. Additionally, the 6-month maintenance phase in our study is still relatively short, considering the notable lifestyle change asked of participants, who reported close to 0 min of MVPA/week upon enrollment. However, since only a few interventions for Latinas have examined PA maintenance for six or more months (Salinas et al., 2018; Arredondo et al., 2017; Van Name et al., 2016), our study contributes to the lack of literature in this area. Future studies should examine longer follow-up periods. Finally, given the scope of this manuscript, which presents the results of intention-to-treat analyses, we did not report fidelity analyses that would help to clarify the extent to which engagement with intervention components influenced PA outcomes. These analyses are underway and will be reported in a future manuscript, and should be considered when interpreting our results.

5. Conclusions

This study evaluated the maintenance phase of a theory- and text-enhanced PA intervention for inactive Spanish-speaking Latinas of primarily Mexican descent, compared to the original version of the PA intervention. Results of this study support and advance those found in previous iterations (Marcus et al., 2015) and similar versions (i.e., web-based) (Benitez et al., 2020); participants in both arms maintained MVPA gains even with minimal contact throughout the maintenance phase (6–12 months). Results underscore the importance of continued use of evidence-based behavior change techniques, even in minimal amounts, to reinforce newly established habits. Additionally, participants in the Enhanced arm were more likely to meet PA guidelines (≥150 min/week of MVPA) at 12 months, suggesting low-touch and low-burden theoretical and technological enhancements may help Latinas to continue meeting PA guidelines during the maintenance phase of PA interventions.

Funding

This work was supported by the National Institutes of Health [NIH HHS/United States, and T32 HL007034/HL/NHLBI NIH HHS/United States].

CRediT authorship contribution statement

Bess H. Marcus: Conceptualization, Methodology, Writing – original draft, Writing – review & editing, Supervision, Funding acquisition. **Britta A. Larsen:** Conceptualization, Writing – original draft, Writing – review & editing. **Sarah E. Linke:** Conceptualization, Writing – original draft, Writing – review & editing. **Sheri J. Hartman:** Conceptualization, Methodology, Writing – original draft. **Dori Pekmezi:** Conceptualization, Methodology, Writing – original draft. **Tanya Benitez:** Conceptualization, Writing – original draft, Writing – review & editing. **James Sallis:** Conceptualization, Methodology. **Andrea S. Mendoza-Vasconez:** Writing – review & editing. **Shira I. Dunsiger:** Methodology, Formal analysis, Writing – original draft, Writing – review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

Abraído-Lanza, A.F., Shelton, R.C., Martins, M.C., Crookes, D.M., 2017. Social Norms, Acculturation, and Physical Activity Among Latina Women. J. Immigr. Minor. Health 19 (2), 285–293.

American College of Sports Medicine, 2005. ACSM's Guidelines for Exercise Testing and Prescription, 7th ed. Lippincott Williams & Wilkins, Philadelphia, PA.

Arredondo, E.M., Elder, J.P., Haughton, J., Slymen, D.J., Sallis, J.F., Perez, L.G., Serrano, N., Parra, M.T., Valdivia, R., Ayala, G.X., 2017. Fe en Acción: Promoting Physical Activity Among Churchgoing Latinas. Am. J. Public Health 107 (7), 1109–1115.

Bandura, A., 1986. Social Foundations of Thoughts and Action: A Social Cognitive Framework. Prentice Hall, Englewood Cliffs, NJ.

Benitez, T.J., Dunsiger, S.I., Pekmezi, D.J., Larsen, B.A., Mendoza-Vasconez, A.S., Linke, S.E., Bock, B.C., Gans, K.M., Hartman, S.J., Marcus, B.H., 2020. Design and Rationale for a Randomized Trial of a Theory-and Technology-enhanced Physical Activity Intervention for Latinas: The Seamos Activas II Study. Contemp. Clin. Trials 96, 106081. https://doi.org/10.1016/j.cct.2020.106081.

Blackwell D, Villarroel M. Tables of Summary Health Statistics for U.S. Adults: 2017 National Health Interview Survey. National Center for Health Statistics. 2018. Available from: http://www.cdc.gov/nchs/nhis/SHS/tables.htm.

Centers for Disease Prevention and Control. Nutrition, Physical Activity, and Obesity: Data, Trends and Maps. Centers for Disease Prevention and Control. Retrieved from: https://www.cdc.gov/nccdphp/dnpao/data-trends-maps/index.html on June 22, 2021 2021.

Fanning, J., Mullen, S.P., McAuley, E., 2012. Increasing Physical Activity With Mobile Devices: A Meta-Analysis. J. Med. Internet Res. 14 (6), 159–169.

Fjeldsoe, B., Neuhaus, M., Winkler, E., Eakin, E., 2011. Systematic Review of Maintenance of Behavior Change Following Physical Activity and Dietary Interventions. Health Psychol. 30 (1), 99–109.

Flores Mateo, G., Granado-Font, E., Ferré-Grau, C., Montaña-Carreras, X., 2015. Mobile Phone Apps to Promote Weight Loss and Increase Physical Activity: A Systematic

Review and Meta-Analysis. J. Med. Internet Res. 17 (11), e253. https://doi.org/10.2196/jmir.4836.
Freedson, Patty S., Melanson, Edward, Sirard, John, 1998. Calibration of the Computer Science and Applications, Inc. accelerometer. Med. Sci. Sports Exerc. 30 (5), 777–781.
Hayden-Wade, Helen A., Coleman, Karen J., Sallis, James F., Armstrong, Colin, 2003. Validation of the Telephone and In-person Interview Versions of the 7-day PAR. Med. Sci. Sports Exerc. 35 (5), 801–809.
Howlett, N., Trivedi, D., Troop, N.A., Chater, A.M., 2019. Are physical activity interventions for healthy inactive adults effective in promoting behavior change and maintenance, and which behavior change techniques are effective? A systematic review and meta-analysis. Transl. Behav. Med. 9 (1), 147–157.
Ickes MJ, Sharma M. A Systematic Review of Physical Activity Interventions in Hispanic Adults. J Environ Public Health. 2012;2012:156435-.
Joseph, R.P., Royse, K.E., Benitez, T.J., 2019. A Systematic Review of Electronic and Mobile Health (e-and mHealth) Physical Activity Interventions for African American and Hispanic Women. J. Phys. Act Health 16 (3), 230–239.
Katapally, T.R., Muhajarine, N., 2014. Towards Uniform Accelerometry Analysis: A Standardization Methodology to Minimize Measurement Bias Due to Systematic Accelerometer Wear-Time Variation. J. Sports Sci. Med. 13 (2), 379–386.
Leenders, N.Y., Sherman, W.M., Nagaraja, H.N., Kien, C.L., 2001. Evaluation of Methods to Assess Physical Activity in Free-living Conditions. Med. Sci. Sports Exerc. 33 (7), 1233–1240.
Loya, J.C., 2018. Systematic Review of Physical Activity Interventions in Hispanic Adults. Hisp. Health Care Int. 16 (4), 174–188.
Marcus, B.H., Dunsiger, S.I., Pekmezi, D.W., Larsen, B.A., Bock, B.C., Gans, K.M., Marquez, B., Morrow, K.M., Tilkemeier, P., 2013. The Seamos Saludables study: A Randomized Controlled Physical Activity Trial of Latinas. Am. J. Prev. Med. 45 (5), 598–605.
Marcus, B.H., Dunsiger, S.I., Pekmezi, D., Larsen, B.A., Marquez, B., Bock, B.C., Gans, K. M., Morrow, K.M., Tilkemeier, P., 2015. Twelve-month Physical Activity Outcomes in Latinas in the Seamos Saludables Trial. Am. J. Prev. Med. 48 (2), 179–182.
Marcus, Bess H., Dunsiger, Shira, Pekmezi, Dorothy, Benitez, Tanya, Larsen, Britta, Meyer, Dawn, 2021. Physical activity outcomes from a randomized trial of a theory- and technology-enhanced intervention for Latinas: the Seamos Activas II study. Journal of Behav. Med. doi:10.1007/s10865-021-00246-6.
Marcus, B.H., Selby, V.C., Niaura, R.S., Rossi, J.S., 1992. Self-efficacy and the stages of exercise behavior change. Res. Q Exerc. Sport 63 (1), 60–66.
Marcus, B.H., Hartman, S.J., Larsen, B.A., Pekmezi, D., Dunsiger, S.I., Linke, S., Marquez, B., Gans, K.M., Bock, B.C., Mendoza-Vasconez, A.S., Noble, M.L., Rojas, C., 2016. Pasos Hacia La Salud: A Randomized Controlled Trial of an Internet-delivered Physical Activity Intervention for Latinas. Int. J. Behav. Nutr. Phys. Act. 13 (1) https://doi.org/10.1186/s12966-016-0385-7.
Migueles, J.H., Cadenas-Sanchez, C., Ekelund, U., Delisle Nyström, C., Mora-Gonzalez, J., Löf, M., Labayen, I., Ruiz, J.R., Ortega, F.B., 2017. Accelerometer Data Collection and Processing Criteria to Assess Physical Activity and Other Outcomes: A Systematic Review and Practical Considerations. Sports Med. 47 (9), 1821–1845.
National Center for Health Statistics (US). Health, United States, 2016: With Chartbook on Long-term Trends in Health. Hyattsville (MD): National Center for Health Statistics (US); 2017 May. Report No.: 2017-123PMID: 28910066.
National Health Interview Survey. Adults engaging in regular physical activity—Light or moderate for 150+ minutes/week or vigorous for 75+ minutes/week (age adjusted, percent, 18+ years) By Race/Ethnicity. National Health Interview Survey. 2018.
Neighbors, C.J., Marquez, D.X., Marcus, B.H., 2008. Leisure-time Physical Activity Disparities among Hispanic Subgroups in the United States. Am. J. Public Health 98 (8), 1460–1464.
Office of Disease Prevention and Health Promotion. Healthy People 2030: Social Determinants of Health. U.S. Department of Health and Human Services. 2021. Accessed from: https://health.gov/healthypeople/objectives-and-data/social-determinants-health.
Pekmezi, D., Dunsiger, S., Gans, K., Bock, B., Gaskins, R., Marquez, B., Lee, C., Neighbors, C., Jennings, E., Tilkemeier, P., Marcus, B., 2012. Rationale, Design, and Baseline Findings from Seamos Saludables: A Randomized Controlled Trial Testing the Efficacy of a Culturally and Linguistically Adapted, Computer- tailored Physical Activity Intervention for Latinas. Contemp. Clin. Trials 33 (6), 1261–1271.
Pekmezi, D.W., Neighbors, C.J., Lee, C.S., Gans, K.M., Bock, B.C., Morrow, K.M., Marquez, B., Dunsiger, S., Marcus, B.H., 2009. A Culturally Adapted Physical Activity Intervention for Latinas: a Randomized Controlled Trial. Am. J. Prev. Med. 37 (6), 495–500.
Perez, A., Fleury, J., Keller, C., 2010. Review of Intervention Studies Promoting Physical Activity in Hispanic Women. West J. Nurs. Res. 32 (3), 341–362.
Pew Research Center. Mobile Fact Sheet. Internet & Technology: Pew Research Center; 2021. Retrieved from https://www.pewresearch.org/internet/fact-sheet/mobile/.
Prince, S.A., Adamo, K.B., Hamel, M., Hardt, J., Connor Gorber, S., Tremblay, M., 2008. A Comparison of Direct versus Self-report Measures for Assessing Physical Activity in Adults: A systematic review. Int. J. Behav. Nutr. Phys. Act 5 (1), 56. https://doi.org/10.1186/1479-5868-5-56.
Prochaska, J.O., Velicer, W.F., 1997. The transtheoretical model of health behavior change. Am. J. Health Promot. 12 (1), 38–48.
Rauh, Mitchell J.D., Hovell, Melbourne F., Hofstetter, C. Richard, Sallis, James F., Gleghorn, Alice, 1992. Reliability and Validity of Self-reported Physical Activity in Latinos. Int. J. Epidemiol. 21 (5), 966–971.
Rhodes, R.E., Quinlan, A., 2015. Predictors of Physical Activity Change Among Adults Using Observational Designs. Sports Med. 45 (3), 423–441.
Salinas, J.J., McDaniel, M., Parra-Medina, D., 2018. The Role of Social Support and the Neighborhood Environment on Physical Activity in Low-income, Mexican-American Women in South Texas. J. Prev. Med. Public Health 51 (5), 234–241.
Sallis, J.F., Haskell, W.L., Wood, P.D., Fortmann, S.P., Rogers, T., Blair, S.N., et al., 1985. Physical Activity Assessment Methodology in the Five-City Project. Am. J. Epidemiol. 121 (1), 91–106.
Spark, L.C., Reeves, M.M., Fjeldsoe, B.S., Eakin, E.G., 2013. Physical Activity and/or Dietary Interventions in Breast Cancer Survivors: A Systematic Review of the Maintenance of Outcomes. J. Cancer Surviv. 7 (1), 74–82.
US Department of Health and Human Services. 2008 Physical Activity Guidelines for Americans. US Department of Health and Human Services; 2008.
US Department of Health and Human Services. Physical Activity Guidelines for Americans, 2nd Edition. US Department of Health and Human Services. 2018. Retrieved from: https://health.gov/sites/default/files/2019-09/Physical_Activity_Guidelines_2nd_edition.pdf.
Van Name, M.A., Camp, A.W., Magenheimer, E.A., Li, F., Dziura, J.D., Montosa, A., Patel, A., Tamborlane, W.V., 2016. Effective Translation of an Intensive Lifestyle Intervention for Hispanic Women With Prediabetes in a Community Health Center Setting. Diab. Care 39 (4), 525–531.
Villarroel M, Blackwell D, & Jen A. Tables of Summary Health Statistics for U.S. Adults: 2018 National Health Interview Survey. National Center for Health Statistics. 2019. Retrieved from http://www.cdc.gov/nchs/nhis/SHS/tables.htm.