

# Moderating Effects of Health Literacy on Change in Physical Activity Among Latinas in a Randomized Trial

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Received: 16 September 2014 / Revised: 30 November 2014 / Accepted: 19 December 2014 / Published online: 15 January 2015  
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## Abstract

**Introduction** Latinas report low rates of physical activity (PA) and are at risk for poor health outcomes. Language and literacy barriers impede access and utilization of PA-related resources. This study examined health literacy as a moderator on changes in moderate-to-vigorous physical activity (MVPA) in 196 Latinas enrolled in Seamos Saludables, a randomized-controlled trial of a 6-month culturally and linguistically adapted PA print intervention

**Methods** Secondary analyses were conducted on demographics, acculturation and generation status, and health literacy (Newest Vital Sign). MVPA was determined by 7 day physical activity recall, assessed at baseline and 6 months. General linear models examined interaction effects between health literacy (HL), experimental condition (treatment vs. control), and generation status.

**Results** Health literacy moderated change in MVPA from baseline to 6 months. The intervention effect was greater among first-generation Latinas with limited health literacy.

**Discussion** Differences in health literacy level appear to influence MVPA outcomes. Formative research is recommended to ensure that materials are appropriate when developing print-based PA interventions, particularly among first-generation Latinas who are more likely to have limited health literacy.

**Keywords** Health literacy · Physical activity · Latinas · Newest Vital Sign

## Introduction

Nearly half (48 %) of all US adults do not participate in regular physical activity (PA) [1], and women consistently report less activity than men [1, 2]. Among women, Latinas report the highest rates of inactivity compared to non-Latino white and black women (47.8 vs. 29.2 %, 45.4 %, respectively) [1] and are disproportionately affected by diabetes, obesity, and metabolic syndrome [1, 3]. Multiple factors are known to influence PA among Latinas [4–9]. Behavioral influences include PA knowledge [9–12], self-efficacy [7, 13], social support [5, 7, 13], and perceived access and availability of PA-related resources [7, 8, 12]. Because of the strong relationship between sedentary lifestyle and chronic disease, identifying and targeting behavioral influences affecting PA adoption and adherence among Latinas is therefore an important public health concern.

First-generation Latinas with limited English proficiency are at greatest risk for poor health outcomes [1, 3]. Compared to Latinos born in the USA, recent immigrants face greater socio-economic challenges including lower educational attainment and income, limited English language proficiency, and are more likely to lack health insurance [14, 15]. These disadvantages contribute to low health literacy, a critical determinant of health behavior, defined as an individual's capacity to obtain,

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process, and understand basic health information and services to make appropriate health decisions [16–21]. Having adequate health literacy is associated with preventive health behaviors including diabetes self-management [22], medication adherence [22, 23], cancer screening utilization [24, 25], consuming a healthy diet [26–28], and engaging in PA [16, 29, 30].

Although the exact mechanisms that explain the association between health literacy and health behaviors are not clearly understood, there is some evidence to suggest that self-efficacy may partially mediate this association [16, 29, 30]. A recent study reported that self-efficacy explained 32 % of the association between health literacy and compliance with PA guidelines in a sample of older adults [30]. Clearly, self-efficacy is an important influence on the adoption and maintenance of PA behavior; however, research has also demonstrated that differences in PA self-efficacy and PA outcomes can vary by health literacy level [31–34].

Non-English speaking Latinas with limited literacy have only recently been examined within the context of PA-based interventions [35–38]. To date, only one study has examined the temporal relationship between health literacy, PA self-efficacy, and PA outcomes from a 6-month randomized trial of a print-based PA intervention among healthy Latinas. Results indicated that higher baseline health literacy scores predicted greater changes in PA self-efficacy, regardless of treatment assignment; although the study was underpowered to detect changes in PA outcomes and therefore the moderating influence of health literacy could not be determined [31]. Because health literacy facilitates interpersonal communication and skills to effectively manage personal health, it is therefore important to consider the potential influence of health literacy on the effectiveness of PA interventions [30, 31].

We recently conducted *Seamos Saludables*, a randomized-controlled trial of a culturally and linguistically adapted, individually tailored, print-based Spanish language PA intervention for Latinas with at least basic literacy skills [38]. The aim of the current study was to examine the moderating effects of health literacy on change in PA from baseline to 6 months in a subsample of participants (74 %) who completed health literacy measures at baseline. It was hypothesized that there would be a significant interaction between health literacy, group assignment (treatment vs. control), and the intervention effect on moderate-to-vigorous physical activity (MVPA) at 6 months, such that the intervention effect on MVPA would be stronger for participants with lower health literacy scores and differ by generation status.

## Materials and Methods

### Study Design

Data for the current study are taken from *Seamos Saludables*, a randomized-controlled trial ( $N=266$ ) of a Spanish language

print-based intervention delivered through regular mailings over 6 months versus a contact control [38]. Previously published findings indicated that this intervention produced significant increases in PA [38, 39]. In this study, baseline measures of health literacy and generational status were included in secondary analyses to examine the potential moderating effect of health literacy on changes in MVPA at 6 months, among Latinas who participated in this print-based PA intervention.

### Participants

The current study included 196 adults (aged 18–65) from the greater Providence area in Rhode Island who self-identified as Hispanic/Latina or a group considered Hispanic or Latina by the US Census Bureau. A telephone screening process ensured that participants were under-active (participating in less than 60 min of MVPA per week) but free of any health conditions that could make unsupervised PA unsafe, as determined by the Physical Activity Readiness Questionnaire (PAR-Q) [40]. A full description of inclusion criteria, recruitment efforts, and data collection procedures for the parent study has been published previously [38, 39]. The current study received institutional review board approval from Brown University.

### Measures

At baseline, participants provided demographic information including age, education, income, occupation, race/ethnicity, marital status, and generation status via standard questionnaires. First-generation Latinas were considered foreign-born, US immigrants; second-generation Latinas were born in the USA to first-generation parents; and third-generation Latinas were born in the USA to parents also born in the USA, but whose grandparents were foreign-born US immigrants. Health literacy was assessed at baseline using the Newest Vital Sign (NVS) [41], a frequently used measure that is valid and reliable in English and Spanish [45, 46]. The NVS has a score of 0 to 6 and classifies health literacy status as high likelihood of limited health literacy (0–1), possibility of limited literacy (2–3), and adequate literacy (4–6) [41]. Strengths of the NVS include its brevity to administer (approximately 3 min), its emphasis on a practical health skill (i.e., interpreting an ice cream nutrition label) which reflects both reading and quantitative comprehension (numeracy), and requires participants to process and utilize only relevant information [37, 41].

Physical activity was measured at baseline and 6 months with the 7-day physical activity recall (7-day PAR) [42, 43]. The 7-day PAR is an interview-administered assessment that estimates weekly minutes of self-reported MVPA across various activity contexts (e.g., leisure, occupation) in a minimum of 10-min bouts. The 7-day PAR has demonstrated consistent

reliability, internal consistency, and validity with objective measures of PA [44–46] including with Latinos [46, 47] and has good test-retest reliability among Latino participants [47].

### Theoretical Approach

The intervention was guided by social cognitive theory [48] and transtheoretical model [49]. Behavior change strategies targeted theoretical constructs including cognitive and behavioral processes of change and self-efficacy which are known to influence PA [37, 50]. Intervention participants received monthly mailings that included individually tailored messages specifically matched to a participant's current stage of motivational readiness for PA. The rationale for using tailored approaches that target key predictors of PA is supported in the literature [36–38, 51–53]; however, few studies to date have used these approaches within a Latina-only sample [36, 38].

### Analysis

Participant characteristics at baseline, including PA level and health literacy, were summarized between and across treatment conditions using means where appropriate, standard deviations for continuous variables, and percentages for categorical variables. NVS scores were compared at baseline using Spearman rank order correlations, which are less subject to the effect of outlying values. This study used continuous scores of health literacy, whereby the mean score reflects the overall health literacy status within the study sample.

Using analysis of variance (ANOVA), baseline health literacy scores were compared between treatment arms (intervention vs. control). Rank order correlations were used to assess linear association between health literacy score and MVPA at baseline. Previous analysis has shown significant effects of intervention versus control on change in mean minutes/week of MVPA from baseline to 6 months, controlling for baseline [36, 38]. At baseline, mean self-reported minutes/week of MVPA for treatment ( $n=132$ ) and control ( $n=134$ ) participants were not statistically different ( $1.87\pm 6.86$  vs.  $3.02\pm 10.30$  min/week, respectively). At 6 months, a significant treatment effect was found in which intervention participants reported an average of 41.36 (SE=7.93) minutes more MVPA compared to control participants, after controlling for baseline values and significant covariates ( $p<0.01$ ). Using generalized linear models (GLMs), we assessed whether the effects of the intervention on MVPA outcomes at 6 months were moderated by health literacy at baseline (NVS scores, measured continuously). Specifically, MVPA at 6 months was regressed on baseline value, main effect of treatment assigned (intervention vs. control), main effect of health literacy (NVS score), and the interaction between treatment condition and health literacy. In considering generation status as an independent predictor of PA at follow-up, results did not suggest a significant

main effect ( $p=0.57$ ). Furthermore, when examined as a potential moderator of intervention effects on PA outcomes, the interaction was also not significant ( $p=0.84$ ). As generation status and blood pressure were not balanced by randomization, both were retained as covariates in the models assessing effects of health literacy (HL) on PA outcomes. Models were interpreted for key values of health literacy (low=1 and high=5) for comparison purposes. GLMs use a likelihood-based approach to estimation and thus make use of all available data without directly imputing missing values.

A sensitivity analysis was subsequently performed to explore whether the moderating effects of health literacy on the association between treatment and MVPA outcomes were different for generation status. As described earlier, the same set of models were run among the subset of participants who identified themselves as first-generation US immigrants and separately for those who reported being second- or third-generation Latinas. Data were analyzed in 2014 using SAS 9.3; significance level was set a priori at 0.05.

### Results

A total of 196 participants with complete NVS data were included in this study (Table 1). Mean participant age was  $40.95\pm 10.8$  years. Most identified themselves as first-generation Latinas (90.5 %), primarily of Dominican or Columbian origin (65 %). Nearly half reported attending at least some college (44 %). At baseline, mean self-reported MVPA was  $2.73\pm 9.06$  min/week.

NVS scores for the entire study sample ranged between 0 and 6. The distribution of scores by NVS classification included high likelihood of limited health literacy, 0–1 ( $n=59$ , 30.0 %), possibility of limited health literacy, 2–3 ( $n=92$ , 47.0 %), and adequate health literacy, 4–6 ( $n=45$ , 23.0 %). Overall, mean NVS score was  $2.38\pm 1.59$ , suggesting limited or marginal health literacy overall. Mean NVS scores were not statistically different between intervention ( $2.40\pm 1.55$ ) and control ( $2.36\pm 1.65$ ). There was no significant correlation between NVS scores and MVPA at baseline ( $\rho=-0.12$ ,  $p>0.05$ ). Among first-generation participants ( $n=181$ ), mean NVS score was  $2.29\pm 1.53$  and 75 % of scores ranged between 0 and 3, suggesting that most first-generation Latinas likely had limited health literacy. Second- and third-generation participants ( $n=15$ ) had a mean NVS score of  $3.47\pm 1.96$  with 50 % of scores ranging between 3 and 5, suggesting that participants who were born in the USA were more likely to have higher health literacy.

Results showed a significant moderating effect of health literacy on the association between treatment assigned and self-reported MVPA at 6 months, such that the greatest intervention effect on MVPA at 6 months was seen in those with

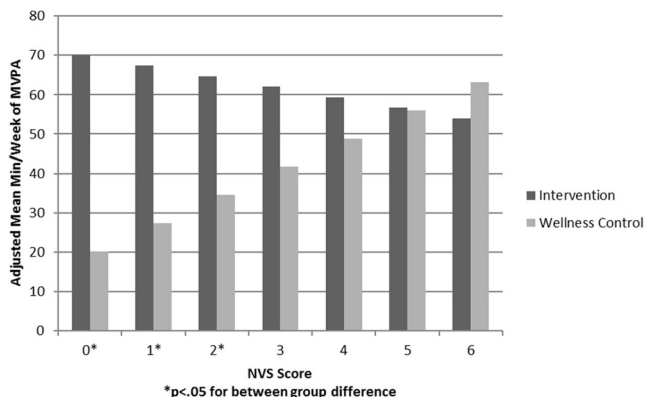
**Table 1** Baseline characteristics of study sample (N=196)

	Intervention (N=91)	Wellness contact control (N=105)
Age, years	41.65 (10.10)	40.15 (10.05)
BMI	29.69 (4.35)	29.75 (5.06)
Generation status*		
First	90.5 %	94.5 %
Second	7.6 %	5.5 %
Third	1.9 %	0 %
Speak only Spanish or more Spanish than English at home (%)	77.1 %	83.5 %
Country of origin		
Columbia	37.1 %	47.3 %
Dominican Republic	27.6 %	17.6 %
Guatemala	5.7 %	13.2 %
Mexico	5.7 %	2.2 %
Puerto Rico	10.5 %	12.1 %
Education, % at least some college	46.7 %	41.8 %
Employment, % unemployed	49.0 %	51.1 %
Income, <\$20,000 <sup>a</sup>	56.4 %	58.6 %
Marital status, % married/partnered	56.2 %	52.8 %
Systolic blood pressure*	115.58 (10.75)	119.41 (11.07)
Diastolic blood pressure*	72.68 (8.63)	75.52 (8.11)
Health literacy, mean NVS score	2.40 (1.55)	2.36 (1.65)

\*p<0.05 for between group differences

<sup>a</sup>N=108

lower health literacy scores (after controlling for baseline MVPA and key confounders). As shown in Fig. 1, the difference in MVPA at 6 months between intervention and control participants decreased with each increase in NVS score. Specifically, among those with the lowest health literacy (NVS=1), mean differences in MVPA at 6 months between intervention and control was 40.13±17.38 min/week (p=0.02), whereas no group differences were found among Latinas with



**Fig. 1** Health literacy as a moderator of the intervention effect on self-reported MVPA at 6 months. \*p<0.05, adjusted for education, income, generation status, and blood pressure

higher health literacy scores (NVS=5) at 6 months (0.62 min/week ± 25.79 (p=0.98)). Figure 1 depicts this relationship.

Among first-generation Latinas, a significant moderating effect was found for health literacy on the association between treatment and self-reported MVPA at 6 months, such that there was a more pronounced effect of the intervention on 6-month MVPA among first-generation Latinas with lower health literacy scores (NVS=1). Specifically, mean differences in MVPA at 6-months between intervention and control groups were significantly greater (43.81±17.94 min/week, p=0.01) for first-generation participants with lower health literacy scores (NVS=1). No differences between intervention and control were found for MVPA at 6-months among first-generation Latinas with higher health literacy scores (NVS=5) (-8.47±27.86 min/week, p=0.76).

**Discussion**

The present study showed the moderating effect of health literacy on the amount of change in MVPA outcomes and differences in change between intervention and control conditions. Specifically, results indicated that the culturally and linguistically adapted PA intervention was more effective among Latina participants with the lowest NVS scores than those with higher NVS scores. These results support previous findings that interventions can have different effects on outcomes among individuals with varying health literacy levels [32–35]. For example, in a 12-month, randomized clinical trial of a primary care-based diabetes management program, the intervention was more successful in improving hemoglobin A1C levels and reducing systolic blood pressure among patients with lower health literacy [34]. In another study examining the efficacy of a tailored nutrition intervention with low-income adults (55 % Latino), those with less education significantly increased fruit and vegetable consumption to a greater extent than more educated participants [54]. This interaction may be partly due to the low literate nature of the educational materials [34, 35], but it also may be that tailored materials are particularly more effective for less literate individuals because they are more personally relevant [54]; thus highlighting the importance of developing health education and behavior programs that meet the needs of all participants [54]. Moreover, tailored messages are more likely to be read and attended to by the recipients, resulting in greater message recall [55].

It is possible that the intervention indirectly improved participants functional health literacy skills (ability to read, understand, and act on health information) [56] by providing tailored resources and activities that mostly low-literate Latinas could easily understand and successfully utilize. To examine this further, we performed a post hoc ANOVA to compare NVS scores with responses from two Consumer Satisfaction Questionnaire items, administered to intervention



participants ( $N=68$ ) at 12-months (“Overall, how helpful did you find the print materials” and “How enjoyable did you find the print materials”). Response format included a 4-point Likert scale ranging from 1 (not at all helpful/enjoyable) to 4 (extremely helpful/enjoyable). Results indicated that those with lower NVS scores (0–3) more positively endorsed the helpfulness and enjoyment of the print materials compared to participants with higher NVS scores. The differences were borderline significant for helpfulness (3.68 vs. 2.35,  $p=0.05$ ) and nearly significant for enjoyment (3.64 vs. 2.47,  $p=0.07$ ). However, because changes in health literacy were not assessed after baseline, we cannot presume health literacy was improved. Future research should examine the extent to which tailored behavioral interventions impact changes in functional health literacy skills.

It has been suggested that improving self-efficacy may attenuate the adverse influence of limited health literacy [30]. The intervention did produce significant group-level differences in PA self-efficacy scores compared to baseline values [38]; however, results from a post hoc analysis determined that health literacy was not significantly associated with changes in PA self-efficacy ( $p=0.30$ ). Previous research has speculated that factors other than self-efficacy may be more strongly associated with health literacy and health behaviors for some population subgroups [30]. Future research is therefore needed to explore the potential relationship between health literacy, self-efficacy and other psychosocial mediators, and PA behavior.

Consistent with the literature [1, 5, 20, 57], it is not surprising that most of the Latina participants had limited health literacy and low levels of PA at baseline. A national survey among US adults found that 66 % of Latinos had basic or below basic health literacy compared to just 28 % among whites [57]. In a recent systematic review of interventions for individuals with low health literacy, Sheridan and colleagues [32] reported that few studies include a sufficient number of low health literacy participants to determine intervention effects among this high-risk subgroup. While such a sample was recruited in the current study, our intervention was not designed to improve participants’ health literacy; rather, it was tailored to provide resources and activities that these mostly low-literate participants could easily understand and successfully utilize. Interestingly, our data showed that Latinas in the control group with high health literacy showed large improvements in MVPA. This could suggest that control participants with higher health literacy may be capable of accessing and utilizing PA resources and support for PA. This also emphasizes the importance of targeting populations with low health literacy, and who may be less likely to improve MVPA on their own without intervention.

Targeting health information to accommodate for literacy and education level, along with individual-level tailoring, may enhance comprehension and self-efficacy and ultimately

improve self-care and health outcomes [30, 31, 58, 59]. In Seamos Saludables, extensive formative research was done to confirm the appropriateness of materials and intervention activities, in which text was reduced and messages were simplified to ensure that study materials did not require a high reading level and/or English proficiency, with the goal of maximizing the potential efficacy of the intervention and meeting the needs and interests of the Latina participants. These formative efforts appear to have been successful as findings indicate that the program was particularly well-suited and beneficial for first-generation Latinas with low health literacy [39].

This study has some limitations. Participants were screened for existing illness or disease and thus results are not generalizable to the larger Latina population. In addition, the interpretation regarding the influence of generation status was limited to first-generation Latinas only. Research has shown that US born Latinas are more likely to engage in more purposeful PA than first-generation Latinas [4, 5]. However, PA varies within Hispanic subgroups [60], and rates of insufficient PA and inactivity remain high even among the most acculturated Latinas [4, 5]. Future research should include larger studies specifically powered to examine differences in MVPA between first and later generation Latinas. Another limitation is that while data from Latina focus groups identified print as their preferred method of intervention delivery, such an approach may not be adequate for illiterate Latinas, who may be at greatest risk for inactivity. Finally, there are measurement challenges in that health literacy is so broadly defined that no single health literacy measure completely captures the complexity of the construct. The NVS was selected because of the short time it takes to administer, its appropriateness with both English and Spanish speakers, and its ability to assess reading comprehension and numeracy, applied to health-related skill (e.g., reading a nutrition label). However, the NVS is more likely to overestimate the percentage of individuals with limited health literacy [41].

Strengths of this study include the prospective, randomized design and a study sample of mostly first-generation Latinas with limited-to-marginal health literacy and who are at greatest risk for inactivity and poor health outcomes. This study emphasizes the importance of considering health literacy level when developing a culturally and linguistically appropriate PA intervention. To date, few studies have examined health literacy in the context of PA behavior within a Latina sample [31]. To our knowledge, this is the first study to demonstrate the moderating influence of health literacy on the efficacy of a PA intervention.

Due to the formative work used to inform the development of Seamos Saludables, the intervention was able to improve MVPA among previously inactive Latinas with limited health literacy. Future research is needed to understand the underlying mechanisms that explain why effects may be different for

Latinas with varying health literacy levels. As the US Latino population grows, research must continue to identify optimal PA programs that can be implemented within communities to meet the needs of those at all literacy levels.

**Acknowledgments** The authors would like to thank Maddison Noble of the University of California, San Diego for her valuable assistance communicating between collaborators and editing. We also thank the participants for their time.

**Funding** This study was funded by the National Institute of Nursing Research at the NIH (NR011295).

**Conflict of Interest** The authors declare that they have no conflict of interest.

**Statement of Human Rights** In accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards, this study was approved by the institutional review board of Brown University.

**Informed Consent** Informed consent was obtained from all individual participants included in the study.

**Statement on the Welfare of Animals** This article does not contain any studies with animals performed by any of the authors.

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