


# Evaluating the Full Plate Living lifestyle intervention in low-income monolingual Latinas with and without food insecurity

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## Abstract

**Introduction:** Food insecurity has long been associated with poor physical and mental health, especially among women from underrepresented minorities. Despite efforts to reduce food insecurity, rates continue to rise and remain disproportionately high among Latinx living in the United States, a group reporting worse mental health symptoms than any other ethnic group during the COVID-19 pandemic. The need to reduce the health burden associated with food insecurity among Latinas is urgent and requires a more targeted and innovative approach. Interventions using a popular education approach have proven effective among underserved populations, especially when these are delivered by community health workers. However, food insecurity status of the participants is often unreported and it is not clear whether or not results vary between those with and without food insecurity.

**Objectives:** The aim of this quasi-experimental study was to examine physical and mental health changes among Latinas with, and without, food insecurity following a multicomponent health intervention led by community health workers using a popular education approach.

**Methods:** Enrolled obese Latinas (N=98) with and without food insecurity responded to demographic, health behaviors and mental health surveys and completed biometric measurements at baseline, immediately following the intervention and at 3 months.

**Results:** At baseline, participants with food insecurity reported more anxiety and depression than those without, but average body mass index was comparable. Depression, anxiety and body mass index were lower at 3 months post and no statistically significant differences were seen between the groups. Participants with food insecurity benefited as much from the intervention as those without.

We found that, although community health workers are not licensed healthcare professionals, with proper training and support, they were able to successfully reduce the risk of chronic diseases and improve mental health symptoms among food-insecure Latinas.

**Conclusion:** Given the promising results, similar interventions should be implemented on a larger scale in Latino communities among food insecure women. Long-term sustainability should also be explored.

## Keywords

chronic disease, community health workers, female, food insecurity, Hispanic Americans, social determinants of health

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## Introduction

In the United States, food insecurity (FI)—“a household-level economic and social condition of limited or uncertain access to adequate food”—affects 13.8 million (more than 1 in 10 households) costing billions in excess annual healthcare costs.<sup>1–4</sup> Compared to food secure individuals,

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adults with FI have higher rates of obesity,<sup>5,6</sup> depression, anxiety, diabetes and cardiovascular diseases and are hospitalized more frequently regardless of ethnicity or cultural background.<sup>7</sup>

FI prevalence is unevenly distributed: for example, as of Fall 2021, 17% of Black households and 16% of Hispanic households had FI compared to 6% of non-Hispanic White households.<sup>8</sup> Latinos are 2.5 times more likely to experience FI than non-Hispanic Whites, with Puerto Ricans and those of Mexican origin being most affected.<sup>9</sup> Furthermore, globally, and in the United States, FI is associated with worse health outcomes among women, especially women who are the head of a household.<sup>10</sup>

Smith et al. reported that White and Hispanic women with FI have 41% and 29% higher odds, respectively, of being overweight and obese, while no correlation with obesity was found among men with FI. This correlation was especially significant among Mexican American women.<sup>11</sup> Women (not men) with FI are more likely to have pre-diabetes and a higher risk of diabetes and of cardiovascular diseases.<sup>12–15</sup> Women with FI tend to also engage in more risky behaviors, suffer more depression and overall stress, and have negative pregnancy outcomes (e.g. birth defects) when compared to those who are food secure.<sup>16–18</sup> Given the cost and multiple ramifications of FI, there is an urgent need to provide effective solutions for women, especially for those most affected.

Multiple governmental and non-governmental agencies and programs have attempted to address the problem of FI with food banks, food prescriptions, community gardens and community kitchens and programs (e.g. Supplemental Nutrition Assistance Plan).<sup>19,20</sup> These have been implemented with some degree of success;<sup>21</sup> for example, one study reported that recipients of the Supplemental Nutrition Assistance program (SNAP)—the largest food and nutrition program in the United States—were 30% less likely to be food insecure.<sup>22</sup> Another study reported an increase in fruits and vegetables consumption among SNAP recipients, besides a reduction in FI. However, biometric improvements have not been reported.<sup>23</sup>

While simply expanding programs that supply food may seem ideal to address FI, the complexity of FI requires a multifaceted approach. Based on current policies, more than 25% of those with FI do not qualify for several of the programs offering food;<sup>19,24</sup> some individuals who qualify do not access them for fear of legal repercussions.<sup>25</sup> Others benefit little from food provisions; for example, in one intervention, FI participants lost half the weight as those without FI,<sup>26</sup> a clear success gap. In another study, food donations did not reduce anxiety among FI adults,<sup>27</sup> which is not surprising, considering that most food recipients report stigma and shame.<sup>28,29</sup>

Indeed, FI rates and related health outcomes remain high especially among underserved populations.<sup>15</sup> Several months into the coronavirus disease 2019 (COVID-19)

pandemic, more depression was reported among Latinx than any other ethnic group (40.3% compared to 27.7% among African Americans and 25.3% among non-Hispanic Whites, with four times more suicide ideations compared to African Americans). Among the reasons given, housing instability and inadequate food supply were mentioned more frequently by Latinx than Whites.<sup>30</sup>

FI does not happen in a vacuum. Its root causes are linked to policies and a complex interplay of various social determinants of health (SDOHs)—income, housing cost and location, access to transportation, employment, access to healthy food—resulting in inequities that perpetrate a vicious cycle of barriers.<sup>10</sup> For example, Latinas with FI may be hesitant to accept food donations due to limited knowledge about free resources, lack of transportation or fear of deportation.<sup>31</sup> However, they respond well to the interventions led by community health workers (CHWs), trusted members of their communities familiar with—and trained to help individuals address—SDOHs associated with FI.<sup>32–35</sup>

The literature describes several interventions delivered by CHWs among ethnic minorities—including Latinas—with low income. Results are often categorized by gender, acculturation and income, with worst results being associated with lowest income.<sup>36</sup> However, these reports do not necessarily report on FI status. Indeed, there is a paucity of information about the impact of interventions specifically on Latinas with FI. It is important to identify whether or not programs led by SDOHs experts (CHWs) can effectively reduce the health burden of low-income Latinas with FI, a group with unique realities even within the Latino community.

### *Theoretical framework: popular education*

Popular education, an “empowerment” philosophy and didactic approach to education popularized by Paul Freire, is “a philosophy and methodology that aims to construct a just society by creating settings in which people who have historically lacked power can discover and expand their knowledge and use it to eliminate societal inequities.”

Popular education stipulates that resources and power are *not* distributed fairly; that this can be changed; that every person has unique knowledge to share regardless of “formal education” or socio-economic status; and that trust is a necessary requirement for people to open up and share their thoughts. Furthermore, individuals who “teach” and those “taught” have a bidirectional learning experience, and all participants are encouraged to remain active during the process: identify problems and brainstorm on root causes and then find solutions together—rather than being “spoon-fed” pre-determined solutions. Finally, those who “educate” are expected to have shared circumstances with those being “educated.”<sup>37</sup> This approach has been shown to promote health among disadvantaged

populations.<sup>38</sup> For this reason, the authors chose to use “popular education” as a theoretical framework to guide the implementation of a lifestyle intervention for low-income Latinas.

### Purpose

The aims of this pilot and feasibility study were to explore the results of a culturally sensitive, popular-education-based, CHW-delivered multicomponent lifestyle intervention among low-income Latinas with and without FI. We hypothesized that those with FI would benefit less from the intervention because of the preference for low-cost, calorie-dense, nutrient-poor foods and possibly barriers associated with SDOHs.<sup>39–41</sup>

## Methods

### Study participants and recruitment

Participants (N=98) were low-income, overweight and obese monolingual/bilingual (with the preference for Spanish) Latinx women, self-identifying as “Latina,” who enrolled in a culturally adapted lifestyle intervention. They were recruited through flyers posted at stores, community centers and schools, and through word-of-mouth and personal invitation from CHWs.

Inclusion criteria included being at least 18 years of age, overweight or obese (BMI  $\geq 25$  kg/m<sup>2</sup>), willingness to participate in the study evaluation procedures and attend at least 80% of the *Full Plate Living* (FPL) intervention (see description below). Participants were excluded if they were pregnant, breastfeeding and had a BMI below 25 kg/m<sup>2</sup>, were unable to perform physical activity due to a medical condition, unable to write or read Spanish or English or unable/unwilling to answer the surveys.

### Setting

Participants resided in the Inland Empire of Southern California, a region with multiple food deserts within a county that has the second largest number of Hispanic/Latinx in the United States.<sup>42–45</sup>

### Procedures

For this non-equivalent, quasi-experimental design (pre-test, post-test and 3-month post-test), two rigorously trained CHWs delivered the intervention to four cohorts of less than 30 Latinas each, at either a church or a local elementary school, for eight consecutive weekly sessions. For each cohort, we recorded participants’ biometric measurements and collected self-reported surveys. Respondents gave active written informed consent depending on their preferred language (Spanish or English) before completing

data collection. As an incentive, each participant received a US\$10 gift certificate to a local grocery store at each data collection. Ethical approval for this study was obtained from the Loma Linda University Institutional Review Board (IRB #5180068).

### Data collection and measures

Participants completed self-reported surveys, including basic demographic information (age, relationship status, children, household size, education, employment and annual family income) and relevant behaviors, such as food/beverage consumption and physical activity.<sup>46</sup> Questions pertaining to FI,<sup>47</sup> depression,<sup>48</sup> anxiety<sup>49</sup> and acculturation scales<sup>50</sup> were also included (see Table 1 and supplementary material for details). Biometric measurements included weight, height, waist and hip measurements, body fat percentage and cholesterol levels.

The study lasted 16 weeks during Summer and Fall of 2019. All data were collected before the intervention (baseline), immediately after and at 3 months. To facilitate responses by participants at all literacy levels, we used flip charts depicting measured concepts. Data can be obtained by contacting the project group at Loma Linda University.

### Anthropometric measures

1. *Height (inches) and weight (lbs)*. Measured using a Seca Stadiometer (Seca North America, Chino, CA) and InBody 270 (InBody USA, Cerritos, CA) scale, respectively. Persons were instructed to stand straight and tall without shoes nor headwear or heavy clothing. Level of measurement: interval/ratio (continuous)
2. *Body mass index (BMI; kg/m<sup>2</sup>)*. Calculated based on the following formula:  $\text{weight} \times 703 / (\text{height})^2$ . Level of measurement: interval/ratio (continuous).
3. *Waist measurement (inches)*. With participant having an empty bladder, a measuring tape was wrapped snugly around the narrowest part of the abdomen, approximately 2 inches above the navel, immediately after exhaling. Level of measurement: interval/ratio (continuous).
4. *Hip measurement (inches)*. Measured by wrapping a measuring tape around the widest part of the hips covered with light clothing. Level of measurement: interval/ratio (continuous).
5. *Body fat percentage (%)*. Based on the InBody 270 scale calculations and output. Level of measurement: interval/ratio (continuous)
6. *Cholesterol levels (mg/dL)*. Assessed using the Cholestech LDX Analyzer System (Abbott Rapid Dx North America, San Diego, CA), after finger prick blood sample collection. Level of measurement: interval/ratio (continuous)

### Self-reported measures

1. *Dietary patterns.* After identifying food categories on a flipchart, participants self-reported the quantity and type of food and beverages consumed over the past 2 weeks in response to the question “*How many times did you eat/drink these in the past 2 weeks?*” using a 6-point Likert-type scale where 1 is “*never*” and 6 is “*several times a day*”. The flipchart included pictures and names of locally available foods, such as salads, fruits, vegetables, whole grains, beans/lentils, sugar-sweetened beverages (SSB), juices and unhealthy snacks. Level of measurement: ordinal.
2. *Water consumption.* Based on the response to the 5-point Likert-type scale question “*How many glasses of water do you drink per day on average?*” Level of measurement: ordinal.
3. *Physical activity status.* All activities were assessed using the short version of the International Physical Activity (IPAQ) questionnaire.<sup>46</sup> Time spent engaging in each level of activity was categorized based on the following ranges: less than 30 min, between 30 and 60 min, more than 1 h. Level of measurement: ordinal.
4. *Food insecurity.* Based on responses to the following validated two-question scale: “*Within the past 12 months we worried whether our food would run out before we got money to get more*” and “*Within the past 12 months we didn't have money to get more food.*” Individuals were considered food insecure if they responded “*sometimes true*” or “*often true*” to either question.<sup>47</sup> Level of measurement: categorical.
5. *Depression.* Based on the responses to Patient Health Questionnaire-9 (PHQ-9), a 4-point Likert-type 9-item scale validated among Spanish-speaking Latinx.<sup>48</sup> Level of measurement: interval/ratio (continuous)
6. *Anxiety.* Using responses from the generalized anxiety disorder questionnaire GAD-7, a 4-point Likert-type 7-item scale which has been validated among Spanish-speaking Latinx.<sup>49</sup> Level of measurement: interval/ratio (continuous)

Table 1 (below) includes more details on each measure.

### Statistical analyses

All data were analyzed using version #22 of the Statistical Package for the Social Sciences (SPSS). Data were cleaned and inspected for inconsistencies before analyses. Correlations were analyzed using Spearman's Rho.

This pilot/feasibility study was established as an efficacy study to determine whether or not this culturally adapted intervention works overall, and if results among Latinas with and without FI would be comparable. Our

primary outcomes were weight and waist-hip ratio. Secondary and tertiary outcomes were cholesterol and mental health (depression and anxiety), respectively. Changes in our primary outcomes of interest over time were modeled using linear mixed models (repeated measurements nested within individuals) with an interaction between time and FI, with age, marital status, number of children and education included as covariates. The models are analogous to repeated measures Analysis of Covariance (ANCOVA) models, where time is a within-subjects factor and FI is a between-subjects factor. However, the linear mixed model framework has several advantages over the repeated measures ANCOVA framework, including the ability to include individuals with partially missing data within the analysis. Thus, participants who had missing data on one or more of the time points could still be included within the analysis.

The primary effects of interest are the adjusted mean differences in each of the outcome variables across time. The interaction between time and FI within the models allows for these adjusted mean differences to differ across the two FI groups. Therefore, attention is focused on the (adjusted) conditional effects of time within each of the two groups (i.e. within-group changes over time, after adjusting for the covariates). Conditional effects are sometimes referred to as “simple effects” within the ANOVA literature.

A power analysis—conducted prior to study initiation—using simulation-based methods indicated that a sample size of 75 is large enough to detect within-group adjusted mean differences between pre- and post-assessments that have small-to-medium effect sizes ( $d \approx .27$ – $.38$ , depending on true correlation between repeated measures). Thus, the analyses for our primary outcomes generally had sufficient power, even with the observed missing data (number of non-missing measurements at each of the three time points ranged from 72 to 98).

### The FPL intervention

The FPL lifestyle intervention is a culturally adapted version of the Ardmore Institute of Health *Full Plate Diet* approach<sup>51</sup> delivered by CHWs. It was chosen because of its easy adaptability and the simplicity of its basic concepts. The 8-week intervention was co-created by Loma Linda University research team members, Latino community members and CHWs, and facilitated by two certified bilingual CHWs who went through an additional 60-h intensive content and adult teaching style training. Once trained, these CHWs also helped to culturally adapt the curriculum for delivery, using popular education (the process of adaptation is the subject of a forthcoming article).

During the intervention, and to reinforce the message of the CHW as a facilitator (not necessarily more knowledgeable than participants), chairs were arranged in a large

**Table 1. Variables used for analyses—descriptions and levels of measurement.**

Variable category	Variable name	Unit/ answer choices	Level of measurement	Description
Biometric	Height	Inches (to the closest 1/4 inch)	Interval/ratio	Measured using a Seca portable stadiometer (Seca North America, Chino, CA) and Inbody 270 (InBody USA, Cerritos, CA), with a person standing straight and tall without shoes nor headwear.
	Weight	Pounds (lbs)	Interval/ratio	Measured using a Seca portable stadiometer (Seca North America, Chino, CA) and Inbody 270 scale (InBody USA, Cerritos, CA), with a person standing straight and tall without shoes or heavy clothing.
	Fat percentage	Percentage (%)	Interval/ratio	Based on the InBody 270 calculations. With the minimum amount of clothes and jewelry for best accuracy. <ul style="list-style-type: none"> <li>Healthy range = 31% or less</li> <li>Unhealthy range = more than 31%</li> </ul>
	Body mass index (BMI)	Kg/m <sup>2</sup>	Interval/ratio	Calculated as $\text{weight} \times 703 / (\text{height})^2$ and reported in kg/m <sup>2</sup> . <ul style="list-style-type: none"> <li>Overweight = BMI between 25 and 29.9 kg/m<sup>2</sup></li> <li>Obese = BMI of 30 kg/m<sup>2</sup> or more</li> </ul>
	Waist measurement	Inches (to the nearest 1/4 inch)	Interval/ratio	With participant having an empty bladder, assessed by wrapping a measuring tape snugly around the narrowest part of the abdomen, approximately 2 inches above the navel immediately after exhaling and writing the measurement <ul style="list-style-type: none"> <li>Healthy range = less than 35 inches</li> <li>Unhealthy range = 35 inches or more</li> </ul>
	Hip measurement	Inches (to the nearest 1/4 inch)	Interval/ratio	Measured by wrapping a measuring tape around the widest part of the hips covered with light clothing.
	Waist-hip measurement	N/A	Interval/ratio	Calculated as waist measurement divided by hip measurement. <ul style="list-style-type: none"> <li>Healthy range = less than 0.85</li> <li>Unhealthy range = 0.85 or more</li> </ul>
	Total cholesterol	mg/dL	Interval/ratio	Assessed with Alere analyzers using Cholestech LDX Analyzer System after finger prick blood sample collection. <ul style="list-style-type: none"> <li>Healthy range = less than 200 mg/dL</li> <li>Unhealthy range = 200 mg/dL or more</li> </ul>
	LDL (low-density lipoprotein) cholesterol	mg/dL	Interval/ratio	Assessed with Alere analyzers using Cholestech LDX Analyzer System after finger prick blood sample collection. <ul style="list-style-type: none"> <li>Healthy range = less than 130 mg/dL</li> <li>Unhealthy range = 130 mg/dL or more</li> </ul>
	HDL (high-density lipoprotein) cholesterol	mg/dL	Interval/ratio	Assessed with Alere analyzers using Cholestech LDX Analyzer System after finger prick blood sample collection. <ul style="list-style-type: none"> <li>Healthy range = 60 mg/dL or more</li> <li>Unhealthy range = less than 60 mg/dL</li> </ul>
Self-reported demographics	Age	Years	Interval/ratio	Based on response to the following question: "What is your age?"
	Relationship status	1. Single 2. Married living with partner 3. Divorced/separated 4. Widow	Categorical	Based on response to the following question: "What is your relationship status?" (4 choices)
	Household size	1. Only myself 2. 2 (me and someone else) 3. 3 (me and two other people) 4. 4 (me and three other people) 5. Five or more of us	Ordinal	Based on response to the following question: "How many people live in your house - including yourself?" (5 choices)
	No. of children in the home	0. None (no son or daughter) 1. One child 2. Two children 3. Three children 4. Four children 5. Five or more children	Ordinal	Based on response to the following question: "How many children (sons or daughters) do you have?" (6 choices)
	Education level	1. No schooling 2. Elementary 3. Some high school 4. High school diploma 5. Vocational /Some college 6. University degree 7. Other _____	Ordinal	Based on response to the following question: "What was the last grade that you completed at school?" (7 choices— "Other" was merged with the closest category for analyses)

(Continued)

Table 1. (Continued)

Variable category	Variable name	Unit/ answer choices	Level of measurement	Description
Self-reported behaviors	Employment status	1. Employed for wages 2. Out of work 3. Retired 4. Unable to work due to disability 5. Volunteer 6. Self-employed (working for yourself) 7. Other (please specify): _____	Categorical	Based on response to the following question: "Which of the following describes you or your job situation?" (7 choices). For analyses "employed for wages and "self-employed" were merged to create "employed." All others were merged to create "unemployed."
	Annual family income	0. I don't know 1. less than US\$20,000 2. US\$21,000-US\$50,000 3. US\$51,000-US\$75,000 4. More than US\$75,000	Ordinal (0 counts as missing)	Based on response to the following question: "What is your current family level of income?" (5 choices)
Self-reported behaviors	Health insurance	0. currently do not have any health insurance 1. Medical (IEHP or Molina) 2. Medicare (65 years or above or eligible for SSD or disability) 3. Private insurance 4. Other (please specify): _____	Categorical	Based on response to the following question: "What type of health insurance do you have?" (5 choices) Medical and Medicare were merged as Federal/Government
	Physical activity score	– Vigorous – Moderate – Walking – Sitting	Interval/ratio	Assessed with the aid of a flipchart with pictures of types of physical activity. We assessed all activities using the recommended weekly amount as a guide. See short version of the International Physical Activity (IPAQ) questionnaire. <sup>46</sup>
Self-reported behaviors	Dietary patterns—Consumption of fiber-rich foods	1. Never 2. Once a day 3. 2 to 3 times a week 4. Almost every day 5. Every day 6. Several times a day	Ordinal	Assessed using a flipchart with pictures and names of locally available foods in the area of the following categories: salads, fruits, vegetables, whole grains, beans/lentils. For each one, the score was based on the responses to the question "How many times did you eat these in the past 2 weeks?" (6 choices) Weekly frequency of these five food categories were averaged for a "fiber consumption score"
	Dietary patterns—consumption of unhealthy foods	1. Never 2. Once a day 3. 2 to 3 times a week 4. Almost every day 5. Every day 6. Several times a day	Ordinal	Assessed using a flipchart with pictures and names of locally available unhealthy foods eaten by this population, such as cakes, candies, chocolate bars, pizza, donuts, French fries, chips, cookies (all under the "unhealthy foods" category). A score was based on responses to the question "How many times did you eat these in the past 2 weeks?" (6 choices)
Self-reported behaviors	Drinking patterns—Juices	1. Never 2. Once a day 3. 2 to 3 times a week 4. Almost every day 5. Every day 6. Several times a day	Ordinal	Assessed using a flipchart with pictures of locally available beverages (all under the "juices" category). Question asked: "Over the last 2 weeks, how often did you drink fruit juices (e.g. apple juice or orange juice)?" (6 choices)
	Drinking patterns—SSB	1. Never 2. Once a day 3. 2 to 3 times a week 4. Almost every day 5. Every day 6. Several times a day	Ordinal	Assessed using a flipchart with pictures of locally available SSB (all under "unhealthy beverages" category). Question asked: "Over the last 2 weeks, how often did you drink the following sugary beverages (e.g. soda, sports drinks, juice)?" (6 choices)
Self-reported behaviors	Drinking patterns—Water intake	1. Less than 1 cup of water 2. 1–3 cups of water 3. 4–6 cups of water 4. 7 or 8 cups of water 5. Over 8 cups of water	Ordinal	Based on response to the question "How many glasses of water do you drink per day on average?" (5 choices)

(Continued)

**Table 1. (Continued)**

Variable category	Variable name	Unit/ answer choices	Level of measurement	Description
Scales	Depression	0. Not at all 1. Several days 2. More than half of the days 3. Nearly every day	Interval/ratio	Using PHQ-9, a 9-items validated scale which has also been validated in Spanish among Latinx. <sup>46</sup>
	Anxiety	0. Not at all 1. Several days 2. More than half of the days 3. Nearly every day	Interval/ratio	Using GAD-7, a 7-items validated scale which has also been validated in Spanish among Latinx. <sup>49</sup>
	Food insecurity	0. Never true 1. Sometimes true 2. Often true	Categorical	Based on responses to a validated set of two statements: – “Within the past 12 months we worried whether our food would run out before we got money to get more” – “Within the past 12 months we didn’t have money to get more food.” (3 choices) Individuals were considered food insecure if they responded “sometimes true” or “often true” to either one of the questions. <sup>47</sup>
	Acculturation	1. Spanish only 2. More Spanish than English 3. Both Spanish and English equally 4. More English than Spanish 5. English only	Categorical	Based on the validated Brief Acculturation scale for Hispanics (BASH) which includes four questions about language, such as “what language do you read/speak? . . . do you think in? . . . do you speak at home? . . . do you speak with friends?” (5 choices) Once averaged, those with a score above 3 were categorized as having higher acculturation. All others were considered as having low acculturation level. <sup>50</sup>

circle for each of the 2-h weekly sessions. Topics included preparing meals with food readily available at participants’ homes, shopping at favorite local stores and eating out while on a small budget. To avoid eliminating foods associated with positive emotions or cultural traditions, no food category was prohibited. Instead, participants were encouraged to fill three-fourth of their plates with low-glycemic index fiber-rich foods (clearly color-coded in a booklet) to create or complement favorite dishes. Drinking water was available at each session and suggested as a replacement for juices and SSB during and outside of the sessions, and simple physical activities (mostly walking) was promoted. At the end of each session, CHWs encouraged participants to set personal goals for the following week. Instead of “homework,” participants could devise a “personal project” to be “shared” with fellow participants at the next session. Information about food banks, appropriate locations for physical activity and healthcare resources was regularly shared.

To facilitate the participation of women with poor eyesight, and low literacy and numeracy, colorful printed material was mostly pictorial with few words, all written in large font for hands-on adult learning. Neither calorie-counting nor reading of food labels were emphasized. Pictures were carefully selected to reflect the context and living conditions of participants. Everyone was given a measuring tape to self-monitor progress (assess one’s own waist circumference).

Early on, it became clear that mental health was a significant issue, leading us to include stress management skills of the Community Resiliency Model (CRM)—a layperson-friendly model from the Trauma Research Institute<sup>52</sup>—in the curriculum. The goal of the CHWs would be to assist participants—as they learned to become more self-aware about their health behaviors—to make realistic adaptations and practice CRM stress management skills. As experts in resource navigation, throughout the intervention, CHWs shared resources, such as lists of locations where certain foods were available, and discussed price differences and saving tips for grocery shopping. To promote self-empowerment, they encouraged participants to identify their personal and community resources and take action to influence local food availability. They also encouraged the formation of small support groups that would continue to help support newly formed healthy habits after program completion.

At one of the sessions, a mental health specialist and a healthcare professional joined the group to support CHWs and help participants to problem-solve the most challenging situations and provide physical and mental health education and resources. On the last day, participants had the opportunity to prepare favorite Latino dishes using principles learned and shared during the program. Finally, during the month following the 8-week program delivery phase, weekly telephone coaching and two “booster” sessions on desired topics were provided.

**Table 2.** Baseline characteristics of the study population.

Measures	Overall group		No FI		Yes FI		<i>p</i>
	N	M (SD) or %	N	M (SD) or %	N	M (SD) or %	
<b>Demographic</b>							
Age	99	50.03 (12.75)	56	51.55 (14.47)	43	48.05 (9.91)	.18
Marital status	99		56		43		.75
Single	8	8.1	4	7.1	4	9.3	
Married/with partner	75	75.8	41	73.2	34	79.1	
Divorced/separated	13	13.1	9	16.0	4	9.3	
Widow	3	3.0	2	3.6	1	2.3	
Educational level	99		56		43		.88
No formal education	4	4	3	5.4	1	2.3	
Elementary	26	26.3	16	28.6	10	23.3	
Secondary	16	16.2	8	14.3	8	18.6	
High school	17	17.2	10	17.9	7	16.3	
Vocational or some college	28	28.3	14	25	14	32.5	
University	8	8.1	5	8.9	3	7.0	
Acculturation	97		55		42		.46
Low	85	87.6	47	85.5	38	90.5	
High	12	12.4	8	14.5	4	9.5	
Income (yearly)	95		54		41		.24
Unknown or no income	18	18.9	12	22.2	6	14.6	
Less than US\$21,000/year	30	31.6	16	29.6	14	34.1	
Between US\$21,000 and US\$50,000	39	41.1	19	35.2	20	48.8	
Between US\$51,000 and US\$75,000	4	4.2	3	5.6	1	2.4	
More than US\$75,000/year	4	4.2	4	7.4	—	—	
<b>Biometric</b>							
BMI (kg/m <sup>2</sup> )	93	31.14 (5.30)	54	31.46 (5.67)	39	30.68 (4.78)	.49
Overweight	25		10	18.5	15	38.5	
Obese	58		36	66.7	22	56.4	
Weight (lbs)	95	167.43 (30.64)	54	168.91 (32.75)	41	165.49 (27.89)	.59
<b>Mental health</b>							
Depression scores	86	6.92 (5.1)	51	6.04 (4.80)	35	8.20 (5.32)	.05 <sup>†</sup>
Anxiety scores	87	5.54 (5.21)	53	4.64 (5.22)	34	6.94 (4.94)	.04 <sup>*</sup>

<sup>†</sup>Marginally statistically significant.

<sup>\*</sup>Significant differences between "no FI" and "yes FI" groups, *p* < .05.

## Results

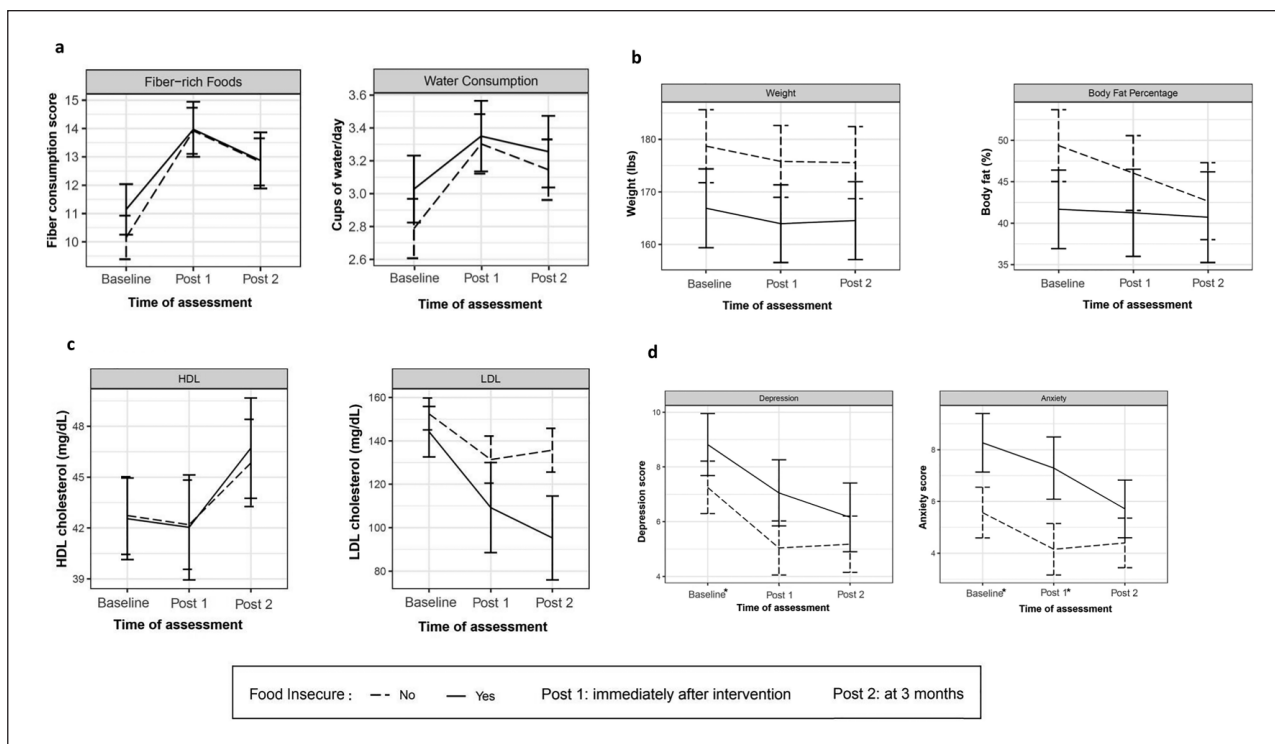
### Participant baseline characteristics

Table 2 describes baseline participant characteristics of this low-income group, overall and by FI. Most of these were Latinas of Mexican descent and average age was around 50.03 ( $\pm 12.75$ ) years. Most were married, obese (70%) and had low educational and acculturation levels; none of these group characteristics differed by food security. Not reported in the table, participants had an average of three children, lived with four or more individuals, one-third worked outside of home and 39% reported not having health insurance; again, no differences were found by food security status. Participants who attended less than three sessions or did not attend any of the last two sessions were assumed to have dropped out. Based on these criteria,

program retention was 79.6%. For the analyses, baseline measurements for all participants were used, whereas post-test measurements were only used for participants who had attended at least one session. Not all participants had measurements at all three time points. Specifically, 98 (100%) of the individuals had all measurements at baseline, 74 (75.5%) at program completion and 72 (73.5%) at the 3-month post-assessment.

Although 62% reported some level of depression and 43% reported mild-to-severe anxiety, baseline depression and anxiety scores differed significantly between the two groups: those with FI reported statistically significantly more anxiety than those with no FI (*p* < .05). After controlling for covariates (age, marital status, number of children and education), the FI group also had more baseline depression and anxiety than those without FI (*p* = .04 and





**Figure 1.** Major results of FPL intervention. (a) Food and water consumption. (b) Biometric measurements. (c) Cholesterol. (d) Mental health.

Note: Bars represent 1 standard error above and below mean. Results after controlling for age, marital status, education and number of children.

\*Statistically significant difference between “no FI” and “yes FI” groups,  $p < .05$ .

$p = .02$ , respectively). Furthermore, the rank order of baseline anxiety ( $r_s = 0.29$ ,  $p = .006$ ) and depression scores ( $r_s = 0.28$ ,  $p = .010$ ) was each positively correlated with FI.

### Intervention effects

Figure 1 provides visual depictions of demographically adjusted (age, marital status, education and number of children) changes in the biometric measures, cholesterol levels, behaviors and mental health measures across time (at baseline, at program completion and at 3 months post) for each group. Table 3 shows the estimated adjusted means and standard errors for each of the two groups across the three time points. These estimates were obtained through linear mixed models that included a time by FI interaction, again with age, marital status, number of children and education as covariates. The 95% confidence intervals for the adjusted mean differences—comparing the baseline-adjusted measurements to measurements immediately after completion and 3 months post (i.e. conditional mean differences across time within each of the groups, comparing each post-test to the baseline measurements)—are displayed for each group.

**Behaviors.** On average, both groups consumed significantly more fiber-rich foods at program completion compared to baseline. Although fiber-rich food consumption

decreased in both groups between program completion and 3 months measurement, consumption at 3 months remained significantly higher compared to baseline ( $p < .001$  and  $p = .03$  for no FI and FI groups, respectively). Consumption of SSB was reduced for both groups from baseline to immediate follow-up ( $p = .002$  and  $p = .01$  for no FI and FI groups, respectively); again, while it increased some by the 3-month point, the pre-post differences remained statistically significant. There were no statistically significant differences in food consumption between groups at the end of the intervention or at 3 months.

In both groups, participants drank less juices and SSB immediately after program completion. However, by 3 months, the difference was no longer statistically significant. Both groups had a statistically significant increase in water consumption between baseline and program completion ( $p = .002$  and  $p = .01$  for no FI and FI groups, respectively); this persisted to 3 months post for those with no FI. However, among those with FI, water consumption dropped somewhat and lost statistical significance after program completion ( $p = .16$ ).

Physical activity levels also improved significantly for follow-ups (immediately post-completion and at 3 months) among both groups ( $p = .003$ ,  $p = .01$  for no FI and FI groups, respectively), with no statistically significant differences between groups.

**Table 3.** Estimated and adjusted<sup>a</sup> pre–post group differences immediately after FPL intervention (8 weeks) and at 3 months.

Variable	N	Baseline mean (SE) <sup>b</sup>	8 weeks mean (SE)	95% CI <sup>c</sup> for difference	3 months mean (SE)	95% CI for difference
<b>Behaviors</b>						
Water consumption	98					
No FI <sup>d</sup>	56	2.79 (.18)	3.30 (.18)	0.26, 0.77**	3.15 (.18)	0.08, 0.63*
Yes FI	42	3.03 (.20)	3.35 (.22)	-0.00, 0.65	3.26 (.22)	-0.11, 0.57
Drinking juices and unhealthy beverages	97					
No FI	55	1.90 (.30)	1.21 (.31)	-1.13, -0.26**	1.51 (.33)	-0.83, 0.05
Yes FI	42	1.90 (.35)	1.15 (.37)	-1.33, -0.17*	1.48 (.39)	-1.01, 0.17
Consumption of fiber-rich foods	97					
No FI	55	10.16 (.77)	13.92 (.82)	2.52, 5.01**	12.82 (.83)	1.48, 3.85**
Yes FI	42	11.15 (.89)	13.97 (.97)	1.21, 4.44**	12.87 (.99)	0.14, 3.32*
Eating unhealthy foods	98					
No FI	56	1.40 (.17)	1.08 (.17)	-0.60, -0.04*	1.21 (.16)	-0.46, 0.08
Yes FI	42	1.41 (.19)	.94 (.21)	-0.84, -0.11*	1.00 (.19)	-0.76, -0.07*
Physical activity level	93					
No FI	54	19.11 (3.52)	27.48 (4.1)	3.07, 13.69**	25.91 (4.17)	0.71, 12.90*
Yes FI	39	18.69 (4.14)	27.92 (4.80)	2.05, 16.41*	34.03 (4.81)	7.37, 23.31**
<b>Mental health</b>						
Depression score	94					
No FI	54	7.10 (1.00)	4.94 (1.02)	-3.37, -0.95**	5.32 (1.06)	-2.94, -0.61**
Yes FI	40	9.27 (1.15)	7.41 (1.21)	-3.46, -0.26*	6.34 (1.27)	-4.49, -1.37**
Anxiety score	97					
No FI	56	5.57 (.98)	4.15 (1.00)	-2.89, 0.06	4.40 (.96)	-2.20, -0.14*
Yes FI	41	8.27 (1.13)	7.29 (1.20)	-2.94, 0.99	5.71 (1.12)	-3.97, -1.14**
<b>Biometric measurements<sup>c</sup></b>						
Weight (BMI $\geq$ 25 kg/m <sup>2</sup> )	83					
No FI	47	178.71 (6.95)	175.81 (6.85)	-4.22, -1.57**	175.57 (6.86)	-4.79, -1.48**
Yes FI	36	166.89 (7.50)	163.95 (7.39)	-4.62, -1.25**	164.54 (7.41)	-4.41, -0.28*
Body fat% (only > 31%)						
No FI	53	49.36 (4.34)	46.05 (4.51)	-8.57, 1.94	42.66 (4.65)	-13.39, -0.02 <sup>†</sup>
Yes FI	38	41.68 (4.74)	41.26 (5.26)	-7.46, 6.62	40.72 (5.47)	-9.64, 7.73
Waist circumference (>35 inches)	62					
No FI	34	41.59 (1.07)	39.98 (1.07)	-2.32, -0.90**	40.46 (1.13)	-1.92, -0.34**
Yes FI	28	41.03 (1.10)	38.97 (1.16)	-3.11, -1.00**	39.20 (1.20)	-2.80, -0.86**
Waist–hip ratio ( $\geq$ .85)	53					
No FI	29	.92 (.01)	.89 (.02)	-0.05, -0.02**	.89 (.02)	-0.04, -0.00*
Yes FI	24	.93 (.02)	.90 (.02)	-0.05, -0.01**	.90 (.02)	-0.06, -0.01*
Total cholesterol ( $\geq$ 200 mg/dL)	47					
No FI	28	220.63 (7.43)	200.83 (9.35)	-34.01, -5.60*	209.70 (9.72)	-26.00, 4.14
Yes FI	19	216.35 (8.56)	207.63 (12.31)	-29.36, 11.91	184.82 (12.99)	-53.68, -9.39*
HDL cholesterol (<60 mg/dL)	80					
No FI	47	42.74 (2.29)	42.20 (2.63)	-4.08, 3.00	45.84 (2.57)	-0.06, 6.26
Yes FI	33	42.55 (2.41)	42.04 (3.10)	-5.23, 4.22	46.72 (2.96)	-0.04, 8.37
LDL cholesterol ( $\geq$ 130 mg/dL)	27					
No FI	19	152.44 (7.36)	131.38 (10.82)	-37.72, -4.39*	135.70 (10.05)	-30.61, -2.86*
Yes FI	8	144.22 (11.62)	109.23 (20.74)	-71.50, 1.52	95.26 (19.30)	-80.97, -16.95**

<sup>a</sup>Adjusted for age, marital status, number of children and educational level.<sup>b</sup>SE = standard error.<sup>c</sup>CI = confidence interval.<sup>d</sup>FI = food insecurity.\*Statistically significant differences between pre-test and post-test within group,  $p < .05$ .\*\*Statistically significant differences between pre-test and post-test within group,  $p < .005$ .<sup>†</sup>Marginally statistically significant differences pre-test and post-test within groups.

### Biometric measurements

Sensitivity analyses revealed statistically significant improvements for several biometric measurements. On average, overweight and obese participants lost weight and reduced waist circumference and waist-hip ratio at both follow-up measurements:  $p < .001$  for all measures immediately after program and  $p < .001$ ,  $p = .006$  and  $p = .02$ , respectively, at 3 months for those with no FI;  $p = .001$ ,  $p < .001$  and  $p = .002$  immediately after program completion and  $p = .03$ ,  $p = .001$  and  $p = .006$ , respectively, at 3 months for those with FI. However, no statistically significant reduction in body fat percentage was detected among those who enrolled with higher than desirable (above 31%) body fat percentages ( $p = .08$  and  $p = .16$  for those with no FI and those with FI, respectively).

**Cholesterol.** Within both groups, those with low initial high-density lipoprotein (HDL) cholesterol showed an increase by 3 months, although the changes only approached statistical significance ( $p = .054$  and  $p = .052$  for no FI and FI groups, respectively). However, low-density lipoprotein (LDL) cholesterol levels significantly decreased from baseline to the 3 months follow-up with those reporting FI having more improvement at 3 months (from  $152.44 \pm 7.36$  to  $135.70 \pm 10.05$ ,  $p = .005$ ) compared to those with no FI (from  $144.22 \pm 11.62$  to  $95.26 \pm 19.30$ ,  $p = .02$ ).

**Mental health.** For both groups, depression scores at both follow-up measurements were significantly lower than at baseline:  $p = .001$  immediately after program and  $p = .003$  at 3 months for those with no FI;  $p = .02$  immediately after program completion and  $p < .001$  at 3 months for those with FI. Anxiety scores in both groups were lower at immediate follow-up, though not significantly so ( $p = .06$  and  $p = .33$  for the no FI and FI groups, respectively). However, by 3 months post, anxiety scores for both groups were significantly less than the corresponding baseline measurements and the FI group experienced more improvement than those without FI (estimates and standard error being  $-2.55 \pm 0.71$ ,  $p = .03$  versus  $-1.17 \pm 0.51$ ,  $p = .001$ , respectively). Furthermore, among those with baseline and multiple data points, there was a positive correlation between weight loss and depression scores ( $r_s = 0.34$ ,  $p = .04$ ).

### Discussion

This pilot study was an initial exploration of the effect of FPL, a culturally adapted intervention delivered by CHWs to Latinas with and without FI using popular education principles. The purpose was to assess whether or not women with FI could benefit equally from the intervention as those with no FI.

At baseline, after controlling for covariates, we found that participants with FI had higher depression and anxiety scores than those without FI, a phenomenon consistent with the conclusions of other studies,<sup>53-55</sup> which found a positive correlation between depression, anxiety and FI, regardless of ethnic background.

Our results also confirm the findings of a meta-analysis reporting a positive correlation between dietary fiber consumption and weight reduction, healthy changes in lipids and mental health,<sup>56</sup> though we are the first to report this effect in mono- and bilingual Latinas of varying FI status. At the end of the program and at 3 months, food insecure participants in our study experienced changes known to improve mental health and reduce the risk of diabetes type II and cardiovascular diseases and these improvements were at least comparable to those seen among those with no FI. Moreover, weight loss was positively correlated with mental health improvement, a phenomenon also described elsewhere.<sup>57</sup> Thus, besides reducing their risk of chronic diseases, weight loss in these women was also associated with improved mental health, a correlation seen in another study among pregnant Latinas. Participants in that study showed a reduction in depression levels following the adoption of healthy habits—high fiber consumption, increased consumption of fruits and vegetables, less fat consumption and more physical activity.<sup>58</sup> Although we could not and did not control for social support, we suspect that the social support from fellow participants and from CHWs also played a major role in improving mental health. The effect of social network has been reported in other studies<sup>59</sup> and was evident in our qualitative analyses to be published separately.

Water intake has been shown to help sustain weight loss and lifestyle changes.<sup>60</sup> While both groups in this study reported increased water intake by the end of this program, this behavior was not sustained at the 3-month post data collection among those with FI. At the same time, opposite changes were seen in the consumption of SSB and juices which increased at the 3-month mark after an initial decrease. Because both SSB and juice consumption were merged for purpose of analyses, we did not determine which beverages were most responsible for this increase. However, an inverse correlation between SSB and water consumption has been reported among those who feel that fruits and vegetables are expensive and among adolescents and women with FI.<sup>61,62</sup> We suspect factors, such as quality of available water at home and/or the inability to purchase drinking water, may have played a role, especially in light of the promotion of eating fruits—possibly leading them to invest in one versus the other.

The partial reversal in healthy food consumption from the end of the program to 3 months post indicates an often-observed trend toward relaxing healthy behavioral modification after the completion of intensive program phase.<sup>63</sup> It would seem to suggest that extending the weekly sessions

could help avoid a digression in old patterns of behavior. Indeed, the obesity taskforce recommends that programs last 14 weeks,<sup>64</sup> and the National Diabetes Prevention Program suggests 16 weeks of consecutive sessions.<sup>65</sup> However, attendance among low-income Latinos in the latter program has been an issue. In our program development, participants made it clear that they preferred a shorter program. Moreover, in a previous pilot study, we noticed that interest started to wane after Session 6, leading us to merge Sessions 7 and 8 and replace Session 8 with a cooking class. Thus, simply offering more formal class sessions seemed unrealistic. It is for this reason that we offered flexible follow-up booster sessions, though we should perhaps consider offering these more often as a mix of group discussions and individualized self-help information.

A better solution to this softening of effects may be related to observations by program participants who noted that those engaged in support groups better maintained their healthy behaviors and that short motivational calls and a booster session helped. Therefore, more strongly encouraging support group activities after program completion may be more critical to retaining healthy behaviors.

Considering that participants with FI in general tend to benefit less from interventions, our results are encouraging and offer the promise of reducing the physical and mental health disparities associated with FI. Similar programs could even help to somewhat compensate for the shortage of bilingual or linguistically trained mental health professionals.<sup>66,67</sup>

Limitations to this pilot study include the lack of a standardized social support measure and the inability to distinguish between beverages other than water and to address all SDOHs related to FI. Furthermore, because participants self-selected into the study, this study may be subject to selection bias. Since there was not a control group within the study design (i.e. all participants received the intervention), any changes over time we find may be due to the actual intervention or other external circumstances. Future studies should be randomized and explore longer term results of the measures presented. However, these limitations are far outweighed by the consistency of the results, and the fact that we used validated scales for mental health screening and objective biometric measurements.

### *Implications for practice, policy and research*

Programs that provide food to households with FI neither reach all of them nor prevent its adverse health effects among the most vulnerable. As a costly and complex SDOH, FI should be approached by a partnership between policymakers, trusted SDOHs experts (i.e. CHWs) and

healthcare providers. As demonstrated in this study, even prior to such much needed efforts, however, implementing a culturally relevant intervention adapted for Latinas with low literacy using the principles of popular education which is delivered by CHWs can accomplish much to reduce the health burden in low-income Latinas, regardless of FI status. Placing a stronger emphasis on support groups following weekly sessions is also critical in obtaining more sustainable results.

Policies that sustain programs, such as FPL, ensuring that food insecure Latinas are given a voice, should be given a priority if we are serious about eliminating health disparities in this population. Finally, we developed and piloted this intervention as an efficacy study/intervention to see if applying our theoretical framework would produce results and because we felt it was necessary before moving forward with a more rigorous study. Future research should attempt to identify barriers to water consumption among Latinas with FI and include a longer randomized controlled trial (at least one year) to assess how results compare with established evidence-based lifestyle interventions, such as the National Diabetes Prevention program.

While a key approach to our intervention lies in its cultural adaptation to needs, we believe that the principles of our study could be generalizable to low-income, mono- and bilingual Latinas, especially those of Mexican heritage, living in Southern California. If extended to low-income women of other cultural backgrounds in other communities of the United States, we suggest an initial brief adaptation phase to explore what specific issues should be taken into account. Nevertheless, we feel that this type of intervention approach would be useful to improve the health of food insecure men and women, irrespective of their cultural or ethnic background and thus reduce the national and global health and financial burdens of FI.

### *Conclusion*

Even within a group of low-income Latinas, our results indicate that it is possible to increase healthy behaviors and improve the overall health of FI Latinas, and thus eliminate some of their physical and mental health disadvantages. Reducing FI disparities and ensuring that those with FI benefit as much as those without FI entails more than providing individuals with food. A comprehensive approach must involve trusted CHWs or lay workers familiar with SDOHs, able to facilitate customized comprehensive programs that involve behavior modification. Challenges may still remain, but a strong coalition between policymakers, healthcare practitioners, CHWs and the recipient community has the potential to dramatically reduce the staggering cost of FI and health disparities in the United States.

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## Author contribution(s)

**Maud Joachim-Célestin:** Conceptualization; Formal analysis; Investigation; Project administration; Resources; Software; Supervision; Writing—original draft; Writing—review & editing.

**Nicholas J Rockwood:** Data curation; Formal analysis; Methodology; Software; Validation; Writing—original draft; Writing—review & editing.

**Camille Clarke:** Funding acquisition; Investigation; Project administration; Resources; Supervision; Validation; Writing—review & editing.

**Susanne B Montgomery:** Conceptualization; Funding acquisition; Investigation; Methodology; Project administration; Resources; Supervision; Validation; Writing—original draft; Writing—review & editing.

## Compliance with ethical standards

This article is an original work and is being submitted for the first publication in this journal. No part of it has been published elsewhere or is any part of it under consideration for publication in another journal.

## Declaration of conflicting interests

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## Supplemental material

Supplemental material for this article is available online.

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