Sociodemographic and social contextual predictors of multiple health behavior change: data from the Healthy Directions–Small Business study

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ABSTRACT

Multiple modifiable health behaviors contribute to the chronic diseases that are the leading causes of death in the USA. Disparities for meeting recommended health behavior guidelines exist across occupational classes and socioeconomic levels. The purpose of this paper was to investigate sociodemographic and social contextual predictors of multiple health behavior change in a worksite intervention. We analyzed data on four diet and exercise variables from an intervention trial with worksite-level randomization. Eight hundred forty-one employees had complete data from baseline (response rate=84 %) and follow-up surveys (response rate=77 %). Multilevel logistic regression estimated associations between least absolute shrinkage and selection operator-selected sociodemographic and social contextual predictor variables and the multiple health behavior change outcome (changing 2+ versus 0 behaviors). Gender, being married/partnered, and perceived discrimination were significantly associated with multiple health behavior change. Sociodemographic and social contextual factors predict multiple health behavior change and could inform the design and delivery of worksite interventions targeting multiple health behaviors.

KEYWORDS

Behavioral research, Diet, Exercise, Health promotion, Primary prevention, Worksite

BACKGROUND

Heart disease, stroke, cancer, and diabetes kill over one million people annually in the USA and are among the five leading causes of death [1]. Multiple modifiable health behaviors, such as diet and physical activity, are risk factors for these chronic diseases [2, 3]. Disparities exist across US occupational classes and socioeconomic levels for meeting recommended goals for diet and physical activity; for example, blue-collar workers and people with lower socioeconomic position exhibit higher risk [2, 4–8]. While disparities in health behaviors across occupational class are well documented for discrete health behaviors [8], a few studies have also

Implications

Practice: Sociodemographic and social contextual factors predict multiple health behavior change and should be considered when designing and delivering worksite interventions targeting more than one behavior.

Policy: Multiple health behavior change interventions designed for worksites have the potential to reach high-risk populations of workers; incorporating sociodemographic and social contextual factors into workplace health risk assessments would allow for tailoring of interventions to characteristics of worksite populations.

Research: Researchers studying multiple health behavior change should collect data that enable examination of the mechanisms explaining the relationships between sociodemographic and social contextual factors and multiple health behavior change.

suggested that there may be disparities in clustering of health behaviors among people of different occupational classes and socioeconomic and education levels [9, 10]. Since both chronic disease burden and clusters of unhealthy behaviors have been shown to be disproportionately high among blue-collar workers; examining contextually relevant programs that address multiple health behaviors is an important public health endeavor.

Multiple health behavior change interventions might have numerous advantages over the single-behavior approach for worksites. The research documenting the clustering of risk behaviors suggests that addressing multiple behaviors in a single intervention could be an efficient method of improving multiple health behaviors concurrently [11, 12]. Some research has shown that successfully changing one behavior might promote change in another behavior [13]. Additionally, working to address multiple health behaviors in interventions could realize healthcare cost savings [14]. By offering more behavioral options to participants,

multiple health behavior change interventions could appeal to more employees with a broader range of risk factors.

Blue-collar worksites are important settings for health promotion efforts for various reasons, chief among them the ability to reach large populations of high-risk individuals who share a daily occupational context and working class social position [6, 15]. While worksite programs already play an important role in addressing disparities in health-promoting behaviors by occupational class [15, 16], many research-based worksite programs adopt a single-behavior approach or do not report analyses across the targeted behaviors [10, 17]. While these data yield important information about effective worksite interventions, behavior by behavior, a gap remains in understanding how multiple health behavior change could be used to optimize overall intervention impact. A key limitation of the existing multiple health behavior change literature involves understanding what predicts participants' success in changing more than one behavior within a single intervention [18].

The primary objective of this investigation was to conduct an exploratory examination of sociodemographic and social contextual predictors of multiple health behavior change in a worksite intervention for manufacturing businesses.

METHODS

Study overview

We conducted a secondary analysis of baseline and follow-up data from the Healthy Directions–Small Business study, a multiple health behavior change intervention implemented via a randomized controlled trial in 24 small manufacturing businesses. The primary aim of the 18-month intervention was to help workers meet federal guidelines surrounding three health behaviors—fruit and vegetable consumption (5+ servings/day) [19]; red meat intake (≤ 3 servings/week) [20]; and physical activity (30 min of moderate activity on most days) [2]—and to encourage daily multivitamin use [21]. The focus on multivitamin use was in response to epidemiologic evidence at the time of the study highlighting the need for adequate folate intake [21]. The Healthy Directions–Small Business study showed greater improvements for the intervention group compared to the control group for each behavior, with multivitamin use and physical activity reaching statistical significance [15].

Healthy Directions–Small Business study intervention

The Healthy Directions–Small Business study was guided by the social contextual framework, developed by Sorensen and colleagues, that explicates the role of social context in behavior change [6]. This framework identifies a set of multilevel (i.e., individual, interpersonal, organizational, and societal) mod-

ifying conditions. These factors are hypothesized to independently affect outcomes, but are unlikely to be influenced by the intervention. Examples include material circumstances, family roles and responsibilities, social ties, social capital at work, job strain, and perceived discrimination. This framework also identifies mediating mechanisms that are posited to be modifiable by the intervention. Examples include self-efficacy, motivation to change, perceived workplace norms, and social support.

Intervention strategies in the Healthy Directions–Small Business study were based on this social contextual framework and principles of employee participation [22]. Over an 18-month period, we employed intervention strategies at both worksite and individual levels. Examples of worksite-level strategies included monthly contacts with management to encourage environmental support and organizational change; monthly meetings of the employee advisory board to plan intervention elements; and collaboration with management to adopt healthy food policies at the workplace. Examples of individual-level strategies included small discussion groups, health fairs, and risk factor self-assessments with feedback. Participation in all of the activities was voluntary.

Accessibility for people with low literacy was addressed by delivering messages through photographs instead of words, where possible. Written materials were translated into Spanish, Portuguese, and Vietnamese to accommodate non-native English speakers. Specific intervention process and protocol details beyond the focus of this paper—predictors of multiple health behavior change—have been published previously [6, 15, 23].

Sample

Small manufacturing firms in Massachusetts were identified using the Dun and Bradstreet database [24]. Criteria for worksite eligibility beyond manufacturing included (1) employing a multicultural population (25 % of workers being first or second generation immigrants or people of color); (2) employing between 50 and 150 employees; (3) having a turnover rate of less than 20 % in the previous year; and (4) being autonomous in decision-making power to participate in the study. Of the 131 worksites that met eligibility criteria for the study, 26 worksites consented to participate in the trial. Worksites were pair-matched on whether they were unionized or nonunionized. Within each pair, worksites were randomized to condition with 13 worksites in the intervention group and 13 in the minimal-intervention control group. Two sites—one from each condition—dropped out between baseline and follow-up, citing lack of time. Within each worksite, workers were eligible to participate if they (1) were permanent employees, (2) worked 20 h or more per week, (3) worked on site, and (4) spoke either English, Spanish, Portuguese, or Vietnamese.

Data collection

Data were collected by interviewer-administered surveys at baseline and follow-up (18 months later). The surveys measured health behaviors, sociodemographic characteristics, and the modifying conditions and mediating mechanisms specified in the social contextual conceptual model [6]. Both the intervention and control worksites provided support for the study, in part by providing work time to complete the surveys. Following standard procedures for the protection of human subjects, steps were taken to ensure that no undue pressure to participate was exerted. The Harvard School of Public Health IRB approved the study, and written informed consent was obtained from each worker.

Based on the worksite level randomization, surveys were administered at the two time points using an independent cross-sectional design. At baseline, the survey response rate was 84 % (range=70 to 98 %; 1,740 employees in 26 worksites); at follow-up, the response rate was 77 % (range=54 to 93 %; 1,408 employees in 24 worksites).

An embedded cohort of 974 participants in 24 worksites completed both baseline and follow-up surveys. Complete survey data on all four behaviors, as required by our outcome variable, were provided by 841 of the 974 embedded cohort participants. We present analyses on these 841 respondents to track individuals' multiple health behavior change.

Measures

Health behaviors

Health behaviors were measured at baseline and follow-up. Fruit and vegetable consumption was assessed with a seven-item screener developed for the National Cancer Institute's 5-A-Day for Better Health research studies [25]. Red meat consumption was assessed with an abbreviated form (six items) of the semiquantitative food frequency questionnaire [26]. Responses were re-coded to equivalent servings and summed to obtain total daily servings of fruits and vegetables and total weekly servings of red meat. The physical activity assessment was based on the questionnaire used in the Nurses' Health Study [27], adapting items to specific activities that were found to be more common among the intended population through our formative work. The responses were coded in metabolic equivalents (METs) and re-coded to hours of physical activity per week. Walking was included if usual walking pace was reported to be faster than "easy, casual." Multivitamin use was assessed with a single question asking workers how many days per week on average they took a multivitamin.

Multiple health behavior change outcomes

We re-coded the four health behavior variables at both time points to indicate whether or not the

participant met the guidelines described in the Section "Study overview" above for that behavior. We then summed these variables to calculate two scores for each participant, one at baseline and one at follow-up, to indicate how many of the participant's four health behaviors met guidelines at each time point. To assess behavior change from baseline to follow-up, we created a multiple health behavior change (MHBC) score by subtracting the baseline score from the follow-up score. An MHBC score of zero indicates the participant had the same number of healthy behaviors meeting guidelines at baseline and follow-up (hereafter referred to as *changing zero behaviors*). A positive MHBC score indicates the participant had more healthy behaviors meeting guidelines at follow-up than they did at baseline (hereafter referred to as *changing one behavior* or *changing two or more behaviors* depending on number of net behaviors meeting guidelines at follow-up). A negative MHBC score indicates the participant had fewer healthy behaviors meeting guidelines at follow-up than they did at baseline. We did not include participants with negative MHBC scores in our analyses because our study examined predictors of positive health behavior change.

To create our multiple health behavior change outcome variable, we dichotomized the MHBC score to indicate those who had changed two or more behaviors and those who had changed zero behaviors. We created an additional outcome variable replacing the reference group (those who changed zero behaviors) to those who changed one behavior. We did not combine these two reference groups for our analyses due to the potential that non-behavior changers were qualitatively different than those who changed one behavior.

Sociodemographic characteristics

Respondents were asked for their date of birth, gender, and race/ethnicity. Respondents reported their highest level of education completed. We used annual household income and household size to create a poverty variable based on the US Census Bureau definitions for 2001 [28]. We used a two-category measure of nativity: both participant and parents born in the USA versus one of those parties born outside of the USA [29]. Language acculturation was computed from variables asking participants to indicate native language, language spoken at home, and preferred language for reading. Occupational class, defined as manager versus non-manager [30], was provided by the worksite.

Social contextual predictors: modifying conditions

In our analyses, we used six modifying conditions from the social contextual framework that were measured in the baseline survey: material circumstances, family roles and responsibilities, social ties, job strain, social capital at work, and perceived

discrimination. We measured four elements of material circumstances: financial hardship, food security, car ownership, and household crowding. Financial hardship included four categories (comfortable with some extras, enough but no extras, have to cut back, cannot make ends meet). Food security was assessed by asking whether they had run out of food in the past year with no money to buy more [31]. Car ownership was based on whether the participant owned a car or whether a car was available on a regular basis. Household crowding was measured by number of rooms in the house (excluding bathrooms, porches, halls and entries) and number of residents. Family roles and responsibilities was measured across five roles (earning money, childcare, food shopping/cooking, care of the home, care of another household). For each role, the response was coded as 0 (little or no responsibility), 0.5 (half the responsibility), or 1 (most or all of the responsibility). We averaged the responses into three categories (low=0–0.33, medium=0.34–0.66, high=0.67–1.0). Social ties were operationalized by four items: whether the participant had a spouse or live-in partner, number of close friends, number of close relatives, and voluntary participation in groups or clubs [32]. We measured job strain using seven items adapted from the Job Content Questionnaire [33]. These items assessed psychological demands of the job, job control, decision authority, and skill discretion. We measured social capital at work by averaging agreement with three items (coworkers are willing to help each other; I trust my coworkers; and management looks out for employees) [34]. Using a global discrimination question, “Have you ever been discriminated against, kept from doing something, or made to feel inferior?” [35, 36], we measured whether participants had perceived being discriminated against (never, a few times, sometimes, or often). For this variable, we set the reference group as “a few times” per recommendations in the literature [37].

Social contextual predictors: mediating mechanisms

In our analyses, we used four mediating mechanisms from the social contextual framework that were measured in the baseline survey: self-efficacy, motivation to change, perceived workplace norms and social support. Self-efficacy for change was measured by a single item asking, “If you thought you needed to improve at least one of these health habits, how sure are you that you could do something about it in the next 30 days?” Motivation to change was measured with two items asking about intention to improve any of the four health behaviors. Responses to these items were categorized as not seriously thinking about changing in the next 6 months (precontemplation), thinking about changing in the next 6 months but not planning on taking action in the next 30 days (contemplation), and planning to do something to change in the next 30 days (preparation) [38]. We measured perceived workplace norms surrounding health behaviors by

asking participants how many fellow workers were getting recommended amounts of fruits and vegetables and leisure-time physical activity [39, 40]. We assessed social support in three domains from the Inventory of Social Supportive Behaviors [41]: emotional, instrumental, and financial support.

Statistical analysis

Due to concern that the large number of predictor variables in our study would likely result in unstable models, we performed least absolute shrinkage and selection operator (LASSO) selection [42] to determine our working model. This method allows for simultaneous variable selection and parameter estimation, thereby avoiding problems associated with multiple testing. LASSO optimizes model parameters based on a loss function subject to the absolute value of the model parameters being constrained.

We performed the LASSO analysis in three stages. First, we performed LASSO to select significant sociodemographic predictors. Second, we performed LASSO to select significant social contextual predictors in models adjusted for sociodemographic predictors chosen in the first stage (statistically significant at $\alpha \leq 0.10$). Typically, model building approaches use a preset p value cutoff to select variables in a model. It is customary to set this value above the conventional 0.05 level, often to a 0.10 or even a 0.20 level. We set ours at a 0.10 level to avoid eliminating potentially meaningful variables too early in the model building process. Third, we adjusted the LASSO model built in the second stage for baseline multiple health behavior score. We performed cross-validation to determine the tuning parameter, based on the highest area under the curve, for each model selection. The LASSO procedure was performed in R using the `glm` command [43].

Based on the results from the three LASSO models, we built three multilevel logistic regression models with random intercepts to account for potential clustering of observations by worksite. Models were based on a logit link function [44] with predictive/penalized quasi likelihood approximation and a second-order Taylor linearization procedure [45]. Models were built using MLwiN (version 2.02.0000) and `gllamm` procedure in Stata (version 11). Statistical significance, for all multilevel regression models, was assessed at a level of 0.05 (two-tailed). Individuals with missing observations for predictor variables were excluded from those models containing the variable(s) for which the information was missing. We compared participants with missing versus non-missing values for differences in mean MHBC score.

RESULTS

The sample was predominately male (65.4 %) and White (69.9 %) (Table 1). Participants' mean age was 44 years (SD=11, range=18–82). About 80 % of

Table 1 | Frequency and mean multiple health behavior score of selected sample characteristics at baseline and follow-up ($N=841$)

Sample characteristics	Frequency		Mean multiple health behavior score at...		
	No.	%	Baseline	Follow-up	Follow-up, adjusted ^a
Age					
18–34 years	198	23.8	2.58	2.54	2.41
35–49 years	474	57	2.60	2.43	2.28
50–64 years	138	16.6	2.44	2.16	2.03
65+ years	21	2.5	2.10	2.14	2.01
Gender					
Men	550	65.4	2.61	2.51	2.37
Women	291	34.6	2.39	2.19	2.09
Race/ethnicity					
White	588	69.9	2.54	2.40	2.25
Racial/ethnic minority ^b	253	30.1	2.55	2.40	2.26
Education					
High school or less	374	45.1	2.60	2.46	2.32
Some post-high school	289	34.8	2.55	2.36	2.22
Undergraduate degree or greater	167	20.1	2.43	2.33	2.15
Nativity					
Respondent and parents USA-born	575	68.7	2.55	2.40	2.26
Respondent or ≥ 1 parent not USA-born	262	31.3	2.51	2.39	2.24
English language acculturation					
Complete	501	67.6	2.60	2.39	4.50
Low or moderate	240	32.4	2.51	2.40	2.26
Occupational position					
Non-manager	693	82.4	2.56	2.43	2.29
Manager	148	17.6	2.45	2.24	2.09
Poverty status					
> 185 % of poverty line	728	87.5	2.52	2.38	2.23
≤ 185 % of poverty line	104	12.5	2.73	2.51	2.40
Married or living with partner					
No	226	27	2.43	2.41	2.28
Yes	612	73	2.57	2.61	2.25
Experienced discrimination					
Never	523	62.9	2.56	2.46	2.23
Only a few times in life	214	25.8	2.50	2.78	2.33
Sometimes, often, or all the time	94	11.3	2.48	2.76	2.24
Intervention status					
Minimal intervention (control) group	451	53.6	2.52	2.50	n/a
Intervention group	390	46.4	2.54	2.27	n/a

n/a Not Applicable

^a Adjusted for intervention status^b Due to small numbers in some categories, Blacks, Native Americans, Hispanics and those of mixed heritage were collapsed into a single category—racial/ethnic minority

participants had not obtained a college degree and 82.4 % held non-managerial positions. In a test for differences between individuals with missing versus non-missing outcome data, mean MHBC scores for instrumental and economic support were significantly higher among those with at least one missing response. However, the magnitude of difference was small—about 3 % for each variable.

In terms of behavior change at follow-up, of the 841 participants, 562 changed zero behaviors or had a negative MHBC score. For participants with positive health behavior change, 215 changed one behavior and 64 changed two or more behaviors.

Predictors of multiple health behavior change

We report the results from the regression models, which tested for associations between LASSO-selected sociodemographic and social contextual predictor variables and multiple health behavior change (changing two or more behaviors compared to changing zero behaviors).

The first model contained the LASSO-selected sociodemographic predictors of multiple health behavior change, which were gender, education, language acculturation, and occupational status. Of these, only gender ($p=0.04$) and language acculturation ($p=0.05$) reached statistical significance at the

$p \leq 0.10$ level, and were thus included in subsequent models.

The second model contained LASSO-selected social contextual predictors of multiple health behavior change, which included family roles and responsibilities, spouse or live-in partner (one of the social ties items), emotional support, and perceived discrimination (Table 2). After adjusting for gender, language acculturation, and intervention group, the only statistically significant social contextual predictor of the outcome variable was having a spouse or live-in partner, with multiple health behavior change more likely among those with a spouse or live-in partner compared to those without.

The third and final model adjusted the second model for baseline multiple health behavior score (Table 3). This model resulted in two social contextual variables, having a spouse or live-in partner and perceived discrimination, remaining as significant social contextual predictors of multiple health behavior change. Multiple health behavior change was more likely among married/partnered individuals compared to singles. Multiple health behavior change was also more likely among individuals who reported experiencing discrimination never or

Table 2 | Associations of LASSO-selected social contextual predictors with multiple health behavior change, adjusted for sociodemographics and intervention ($N=841$)

Predictor variables	Change in 2+ vs. 0 behaviors		
	OR	<i>p</i>	95 % CI
Gender			
Men ^a	1.00		
Women	2.23	0.05	0.99, 4.99
Marital/partner status			
Not married/partnered ^a	1.00		
Married or live with partner	3.96	0.02	1.22, 12.8
Family roles			
Low ^a	1.00		
Medium	0.91	0.79	0.45, 1.81
High	0.89	0.83	0.31, 2.52
Emotional support			
None ^a	1.00		
Some	1.32	0.63	0.42, 4.17
A lot	0.90	0.84	0.33, 2.42
Experienced discrimination			
Never	1.32	0.45	0.62, 2.81
A few times ^a	1.00		
Sometimes or often	2.51	0.05	0.98, 6.41
English language acculturation			
Complete or moderate ^a	1.00		
Low	1.46	0.26	0.74, 2.85

Sociodemographic characteristics significant at $p \leq 0.10$ in Table 1 (gender and language acculturation)

OR Odds Ratio, CI Confidence Interval

^a Reference category

Table 3 | Associations of LASSO-selected social contextual predictors with multiple health behavior change, adjusted for baseline multiple health behavior score, sociodemographics and intervention ($N=841$)

Predictor variables	Change in 2+ vs. 0 behaviors		
	OR	<i>p</i>	95 % CI
Gender			
Men ^a	1.00		
Women	4.61	<0.01	2.00, 10.64
Marital/partner status			
Not married/partnered ^a	1.00		
Married or live with partner	3.10	0.01	1.38, 6.96
Family roles			
Low ^a	1.00		
Medium	0.50	0.05	0.24, 0.99
High	0.86	0.79	0.28, 2.56
Emotional support			
None ^a	1.00		
Some	1.02	0.97	0.28, 3.66
A lot	1.23	0.69	0.44, 3.43
Experienced discrimination			
Never	2.59	0.02	1.17, 5.67
A few times ^a	1.00		
Sometimes or often	3.75	0.01	1.33, 10.5
English language acculturation			
Complete or moderate ^a	1.00		
Low	1.41	0.29	0.75, 2.62

Sociodemographic characteristics significant at $p \leq 0.10$ in Table 1 (gender and language acculturation)

OR Odds Ratio, CI Confidence Interval

^a Reference category

sometimes/often compared to those who reported experiencing discrimination a few times. Gender remained a significant sociodemographic predictor of the outcome variable with multiple health behavior change more likely among women. We tested for an interaction between having a spouse or live-in partner and gender, but it was not significant.

Because the association between perceived discrimination and multiple health behavior change was enhanced by the addition of the baseline multiple health behavior score, we further explored the relationship between these variables. In a simple regression model adjusting only for intervention status and worksite, the association between perceived discrimination and multiple health behavior change was not significant. However, this association became significant upon the addition of the baseline multiple health behavior score. In this regression model, as in the final model, reporting discrimination “never” and “sometimes or often” remained associated with increased odds of multiple health behavior change compared to those who reported experiencing discrimination “a few times.” We tested for an interaction between baseline multiple health behavior score and perceived discrimination in simple and fully adjusted models, but did not find evidence for baseline multiple health

behavior score functioning as a mediating variable. When we stratified by baseline multiple health behavior score, we found that the association between having “never” experienced discrimination (compared to having experienced discrimination “a few times”) and multiple health behavior change may be inversely associated with the number of behaviors meeting guidelines at baseline. However, due to low cell counts, we were not able to construct valid models to test for these types of moderating effects.

Results from regression models (not shown) testing our other outcome variable, which compared participants who changed two or more behaviors with those who changed one behavior, showed no significant associations between any LASSO-selected sociodemographic or social contextual predictors and multiple health behavior change.

DISCUSSION

Using data from a worksite intervention focused on four health behaviors; we conducted an exploratory analysis to examine sociodemographic and social contextual predictors of multiple health behavior change using a LASSO procedure to select the most parsimonious model. Gender, having a spouse or live-in partner, and perceived discrimination were significant predictors of changing two or more behaviors compared to changing zero behaviors. Gender was the only sociodemographic variable that remained significant in the final model. Having a spouse or live-in partner and perceived discrimination are both modifying conditions in our social contextual framework at the interpersonal and societal level, respectively. Our findings indicate that there are individual, interpersonal, and societal factors that predict multiple health behavior change. These data can inform intervention design and implementation for research and practice. For example, our findings illustrate the importance of designing intervention strategies specifically to support men and single people to achieve multiple health behavior change. Additionally, our findings suggest that researchers and practitioners should consider the social context of their participants when designing and delivering interventions, including the potential for a social context that includes perceived discrimination to impact multiple health behavior change success.

In our study, women were more likely to change two or more behaviors than men. One explanation for this gender difference might be that women have been shown to be more likely than men to engage in healthy behaviors [46] and to participate in health promotion interventions [47]. In samples like ours that are predominately male, it is particularly striking that women were more likely to show multiple health behavior change. The role of gender in multiple health behavior change needs further examination due to a paucity of evidence and

inconsistent findings. For example, in one recent multiple health behavior change intervention focused on nutrition, gender was not associated with behavior change [11]. An important aspect of addressing the disparities in healthy lifestyle behaviors by occupational class [2, 4–8] is identifying appropriate intervention strategies for worksites that employ substantial proportions of men.

In our data, participants who reported being married or partnered were significantly more likely to change two or more behaviors during the intervention. Of note, this social tie was the only social network factor—including the three types of social support we measured—that was a significant predictor of multiple health behavior change. One hypothesis is that this tie is functioning through one of the other social network pathways such as social influence, social engagement, and/or access to material goods and resources [48]. Literature does suggest that having a spouse or partner engaging in health behavior change concurrently improves one’s potential for success [49, 50]. Practitioners planning worksite multiple health behavior change interventions should consider the social ties of their participants outside of the workplace as possible facilitators or barriers to change. Future research should aim to understand how this particular social tie functions to support multiple health behavior change.

The third significant predictor of multiple health behavior change in our study was perceived discrimination. The literature shows that self-reported, perceived discrimination has been associated with a broad range of physical and mental health outcomes including distress, self-rated health, and hypertension, among others [51–53]. In our study, we found that having experienced discrimination “never” or “sometimes/often” was associated with a higher likelihood of changing two or more behaviors compared to having experienced discrimination “a few times.” One possible interpretation of this relationship is that the experience of infrequent discrimination is different than that of regularly experiencing discrimination in that no resilience or expectation of poor treatment is developed. While the literature on perceived discrimination and health is rich, extant evidence on the role of discrimination in predicting successful health behavior change is very limited. In fact, in their recent review of studies addressing perceived discrimination and health, Williams and Mohammed found 155 papers, only 10 of which were longitudinal and none of which report findings related to perceived discrimination and health promotion intervention success [51]. Our findings begin to fill this important gap on the relationship between perceived discrimination and health behavior change. These findings also highlight the importance of future research that seeks to better understand how a societal factor such as discrimination impacts the success of health promotion interventions and that explores programmatic implications.

We also found that there were no significant predictors of changing two or more behaviors compared to changing one behavior. One interpretation of this finding is that the sociodemographic and social contextual predictors of multiple health behavior change are not significantly different from those predictors of single behavior change. While this might seem a null finding, it is an important contribution to our understanding of the applicability of the substantial empirical evidence about single behavior change interventions to the smaller, though growing body of evidence on multiple health behavior change interventions. These findings raise the question of whether the pace of discovery in the science of multiple health behavior change could be accelerated by drawing on existing single behavior intervention evidence while building empirical evidence for questions only multiple health behavior change research can answer.

Study limitations and strengths

While this study contributes new insights into the multilevel predictors of multiple health behavior change, its limitations should be considered in interpreting the findings. Our analyses were exploratory since a modest number of participants changed multiple health behaviors over the course of the intervention. Our outcome variable required complete data on the four behaviors addressed in the intervention requiring the use of an embedded cohort of the two independent cross-sectional samples, therefore those workers who completed both surveys might have been different than those who only completed one. As with many community interventions, our measures were based on self-report. We used validated measures following a standardized protocol to reduce the potential for reporting bias. Our study also has a number of strengths including utilizing data from a randomized, controlled trial with representation from working class, multiethnic groups. Another important strength is our use of the LASSO technique for model building, which eliminates errors related to multiple testing.

Multiple health behavior change interventions have the potential to reach high-risk populations of workers through programs focused on a constellation of healthy behaviors related to chronic disease. This study contributes to the growing body of evidence on multiple behavior change interventions by focusing on sociodemographic and social contextual predictors of change.

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