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Differential effect by chronic disease risk: A secondary analysis of the ChooseWell 365 randomized controlled trial

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ABSTRACT

Objective: Whether employees' health status is associated with the effectiveness of workplace health promotion programs is unknown. The objective of this study was to determine if the effect of a workplace healthy eating intervention differed by baseline chronic disease status.

Methods: This was a secondary analysis of a randomized controlled trial conducted September 2016 to February 2018 among US hospital employees to test the effect of a 12-month behavioral intervention (personalized feedback, peer comparisons, and financial incentives) on diet and weight. Participants were classified as having chronic disease (yes/no) based on self-reported hypertension, hyperlipidemia, heart disease, stroke, pre-diabetes, diabetes, cancer or another serious illness. BMI was measured at study visits and calories purchased were measured from cafeteria sales data over 24 months. Mixed models with random effects assessed heterogeneity of treatment effects by chronic disease.

Results: Participants (N = 548) were mostly female (79.7 %) and white (81.2 %); 224 (40.9 %) had chronic disease. Among those with chronic disease, intervention participants reduced caloric intake by 74.4 [22.3] kcal more than control, with a smaller difference between intervention and control (−1.9 [18.7] kcal) (three-way p-interaction = 0.02). The effect on BMI for those with chronic disease (0.47 [0.21] kg/m^2) indicated weight stability among intervention participants and weight gain among controls while the effect (−0.56 [0.18] kg/m^2) for those without chronic disease was the opposite (three-way p-interaction < 0.01).

Conclusions: Those with chronic diseases had greater reductions in calories purchased and gained less weight. Employers with limited resources for health promotion might consider tailoring programs to employees at highest risk.

1. Introduction

Food environments, including at the workplace, influence employee's dietary choices, diet quality, and therefore, their cardiovascular risk (Vadiveloo et al., 2021). Employers may be motivated to implement lifestyle interventions to prevent and manage chronic diseases, including obesity, hypertension, hyperlipidemia, and diabetes to improve the health of their workforce and to increase return-on-investment opportunities (Horstman et al., 2021). For example, obesity is associated with more missed work, disability, and workers' compensation claims, and is thus associated with higher employer costs from these sources (Van Nuys et al., 2014). Workplace dietary interventions can influence the dietary quality and health of employees with particular effectiveness in altering fruit and vegetable intake, fat intake, and reducing weight and cholesterol (Schliemann and Woodside, 2019). Intervening on dietary factors is projected to reduce employer healthcare costs and productivity spending (e.g., costs due to absenteeism) (Basu et al., 2020). However, for many employers with limited resources, particularly small employers, spending on health promotion may not yield returns because of variability in outcomes achieved by wellness programs (Mattke et al., 2015), and improvements in self-reported health that do not always translate to better job performance (Song and Baicker, 2019).

Employees, especially those with worse self-rated health, support the

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idea of offering workplace health promotion initiatives (Sears et al., 2022; Lee-Kwan et al., 2017). This may be because those with worse health perceive more personal benefit from these offerings. The health belief model has 6 constructs: perceived susceptibility (to disease), perceived severity (of disease), perceived benefits (of strategies to prevent/treat disease), perceived barriers (to adoption of those strategies), cue to action (stimulus to trigger a decision to adopt the strategy), and self-efficacy (to perform the strategy). This model suggests that a person's assessment of their own personal risk of disease along with other beliefs, such as in the potential effectiveness of an intervention, influences their engagement with an intervention and subsequent health outcomes (Becker, 1974; Rosenstock, 1966). However, in one large study from the UK, employees with the highest health risk were the least likely to know of, engage in, and perceive benefit from relevant workplace wellness programs (Mulaney et al., 2021).

Therefore, for both the employer and employees, it is important to understand if the benefit of workplace health programs is attained by all employees or only a subset of employees. Such an understanding may influence if and how employers with limited resources implement and promote interventions and how employees engage with interventions. Ideally, such interventions would work as well, or better, among employees with the highest disease burden.

The purpose of this secondary analysis was to assess the differential effect of a behavioral workplace intervention on the caloric content and healthfulness of cafeteria purchases, overall diet quality, and weight by employees' baseline chronic disease risk. The ChooseWell 365 workplace healthy eating intervention was designed to address employees' motivation and beliefs about healthy eating and cue them to action through improvements to the cafeteria food environment and personalized feedback (Levy et al., 2018; Ewart, 1991; Fishbein and Yzer, 2003). Based on the health belief theory, we hypothesized that the effect of the intervention would be stronger among employees with chronic disease.

2. Methods

The ChooseWell 365 randomized controlled trial (RCT) tested the effectiveness of a 12-month behavioral intervention on increasing healthy food choices and preventing weight gain of employees at a large hospital. The study design and main results have been reported previously (ClinicalTrials.gov Identifier: NCT02660086) (Levy et al., 2018; Thorndike et al., 2021). Briefly, eligible participants were Massachusetts General Hospital (Boston, MA, USA) employees aged 20–75 years who regularly purchased items from the hospital's cafeterias. Exclusion criteria included plans to leave hospital employment, pregnancy, desire to gain weight, prior eating disorder, recent or planned weight loss surgery, concurrent participation in a weight loss program, and employment in the Massachusetts General Hospital cafeteria or Translational and Clinical Research Center, where study follow-up visits took place. Eligible employees were enrolled and data collected from September 2016 to February 2018. The research was approved by the Mass General Brigham Institutional Review Board (IRB) and participants provided written informed consent.

Participants were block randomized (block size 6) using a computer-generated scheme with equal allocation in this parallel group RCT. Randomization was stratified by the participant's response to the survey question asking if they wanted to lose weight or maintain their current weight in the next year; this was done to ensure balance on weight loss intentions between arms.

The intervention was implemented in the workplace and utilized behavioral economic approaches to promote healthy food choices among participating employees. All employees were exposed to traffic light labelling that had been implemented in all 7 on-site hospital cafeterias since at least 2015 (Thorndike et al., 2012; Thorndike et al., 2014). Items were classified as green = healthy, yellow = less healthy, red = unhealthy based on an algorithm developed by MGH dietitians to align with dietary guidelines (Thorndike et al., 2012). Criteria for assigning labels included balancing the calorie and saturated fat content of a food item with its nutrient density (i.e. inclusion of fruit, vegetables, whole grains, and lean or plant-based protein).

The study intervention lasted 12 months with follow-up through 24 months. During the active phase, intervention group participants received two automated weekly emails with 1) individualized nutritional feedback on cafeteria purchases and 2) personalized tips on healthy eating, physical activity, or disease prevention along with a healthy recipe. Monthly letters compared the healthfulness of their cafeteria purchases to those of their peers. Intervention participants could receive financial incentives of up to $115 for achieving healthy purchasing goals. Control group participants received monthly letters with general nutrition advice during the 12-month intervention period.

In the full sample, no intervention effects were observed on body mass index (BMI) or diet quality. However, participants assigned to the intervention purchased fewer calories over 12 months and had greater improvements in the healthfulness of cafeteria purchases over 24 months than those assigned to control (Thorndike et al., 2021).

3. Measures

Participants self-reported demographic characteristics (e.g., age, race) and pre-existing chronic conditions (i.e., hypertension, hyperlipidemia, heart disease, stroke, pre-diabetes, diabetes, cancer or another serious illness) at baseline. Participants having 0 pre-existing conditions were categorized as having 'no chronic disease' while those having ≥ 1 pre-existing condition were categorized as having 'chronic disease'. Because of small numbers, individuals who identified as Asian, Native Hawaiian/Pacific Islander, more than one racial category, and those who did not respond were collapsed into 'Additional racial categories'. Job categorization was obtained through human resources records, and job categories were collapsed into the following: administrative & service, craft & technicians, physicians & PhD-level clinicians or researchers, and management & professionals.

Body mass index (BMI) (kg/m^2) was calculated from height and weight measured by Translational and Clinical Research Center staff at baseline, 12 months, and 24 months. Staff conducting follow-up visits were blinded to treatment assignment.

The Healthy Eating Index-2020 (HEI-2020) (Shams-White et al., 2023) is a valid and reliabile (Reedy et al., 2018) measure of diet quality aligned with the Dietary Guidelines for Americans (U.S. Department of Agriculture and U.S. Department of Health and Human Services, 2020). The HEI-2020 includes 9 adequacy and 4 moderation sub-components which are summed to create a total score. A total score of 100 represents the best diet quality (Krebs-Smith et al., 2018). HEI-2020 scores at baseline, 6, 12, and 24 months were calculated for participants with one to two dietary recalls captured using the Automated Self-Administered recall system (ASA-24) developed by the National Cancer Institute. Scores were calculated using the Simple Scoring Algorithm (Kirkpatrick et al., 2018).

Participants' food and beverage purchases were collected over 36 months (i.e., 12 months prior to enrollment and 24 months after enrollment) via the cafeteria cash register data system. A participant's average purchased calories per day were calculated for days on which the employee made at least one purchase. Each food item was coded using a traffic-light label. The Healthy Purchasing Score (HPS) (McCurley et al., 2019; McCurley et al., 2022) was calculated as the percentage of purchased items labeled green, yellow, and red multiplied by 100, 50, and 0, respectively over the given timeframe. HPS ranged from zero (100 % red items) to 100 (100 % green items). Average purchased calories per day and HPS scores were calculated for each time period: baseline (i.e., 12 months pre-intervention), intervention (i.e., months 1 to 12), and follow-up (i.e., months 13 to 24).

4. Analysis

Wilcoxon rank sums tests and the Kolmogorov–Smirnov tests were used to describe differences in non-normally distributed continuous variables by baseline chronic disease risk categorization with chi-square tests used to test differences for categorical variables at baseline.

Mixed models were used to assess the heterogeneity of treatment effect by chronic disease categorization on changes in HEI scores, HPS scores, purchased calories, and BMI over 24 months. Fixed effects included study arm, time (baseline, 6, 12, and 24 months), and chronic disease categorization as well as their two- and three-way interactions (the latter was the effect of interest). Models also included fixed effects for age, race, job categorization, and BMI (except in the model where BMI was the outcome). Random intercepts and slopes were considered, as were categorical and continuous, and linear and quadratic time terms. Models were compared using Bayesian Information Criterion (BIC) leading to selection of a categorical time term, full adjustment, and the inclusion of subject-level random intercepts for all outcomes. Statistical significance was set at $p < 0.05$. We present the mean differences-in-differences and standard error separately for those with and without chronic disease. No imputation of missing values was conducted. Analyses were run using SAS 9.4 (Cary, NC).

5. Results

In this secondary, intention-to-treat analysis, we included 548 (91.0 %) of the 602 RCT participants after excluding: women who became pregnant (N = 18), individuals who underwent weight loss surgery during the study period (N = 13), and those who could not be categorized by baseline chronic disease categorization (N = 23).

There were 224 participants (40.9 %) with chronic diseases. The most commonly reported conditions were hypercholesterolemia (49.8 %) and hypertension (42.6 %) and the least commonly reported was history of stroke (1.8 %). Those with chronic diseases were older, had a higher BMI, and a higher percentage had less than a high school education compared to those without chronic diseases ($p < 0.05$) (Table 1). There was no difference in baseline characteristics between intervention and control arms within levels of chronic disease, and about half of those with and without chronic diseases had been assigned to the intervention.

HEI scores did not change significantly over 24 months. The intervention effect on HEI scores over 24 months was −0.59 (1.89) for those with chronic disease and −1.82 (1.59) for those without chronic disease. There was no evidence of a differential effect of the intervention (three-way interaction: F = 0.37, p = 0.77) (Fig. 1). Detailed results of the mixed models (Appendix Table 1) as well as regression-adjusted means at each timepoint for HEI and the other outcomes by study arm and chronic disease classification are presented (Table 2).

Similarly, there was no evidence of a differential effect of the intervention on HPS (three-way interaction: F = 1.49, p = 0.23) (Fig. 1, Table 2, Appendix Table 1). Intervention participants had greater improvements in HPS scores over 24 months compared to control; however, this intervention effect was similar for both those with chronic disease (−5.46 [1.12]) and without chronic disease (−3.13 [0.93]).

There was a statistically significant differential effect of the intervention on Kcal by chronic disease status. Over 24 months, among those with chronic disease, intervention participants reduced caloric intake by 74.4 [22.3] kcal more than control; among those with no chronic disease, there was a smaller difference between intervention and control

Table 1
Baseline Characteristics among US-based Hospital Employees by Study Arm and Chronic Disease Categorization, September 2016 to February 2018.

		No Chronic Disease			Chronic Disease			Both Study Arms		
		Control N = 160	Intervention N = 164	P-Value	Control N = 109	Intervention N = 115	P-Value	No Chronic Disease N = 324	Chronic Disease N = 224	P-value
Age, years, median (p25, p75)		39 (31, 51.5)	39 (32, 47.5)	0.65	54 (41, 59)	49 (39, 60)	0.57	39 (32, 48.5)	53 (39.5, 59.5)	**<.001**
Race, n (%)	Additional racial categories[a]	25 (15.63)	18 (10.98)	0.10	8 (7.34)	5 (4.35)	0.35	43 (13.27)	13 (5.80)	**<0.01**
	Black	7 (4.38)	16 (9.76)		14 (12.84)	10 (8.70)		23 (7.10)	24 (10.71)	
	White	128 (80.00)	130 (79.27)		87 (79.82)	100 (86.96)		258 (79.63)	187 (83.48)	
Education, n (%)	Less than College	16 (10.00)	16 (9.76)	0.90	18 (16.51)	19 (16.52)	0.24	32 (9.88)	37 (16.52)	0.05
	College	66 (41.25)	64 (39.02)		38 (34.86)	52 (45.22)		130 (40.12)	90 (40.18)	
	Grad School	78 (48.75)	84 (51.22)		53 (48.62)	44 (38.26)		162 (50.00)	97 (43.30)	
Job Category, n (%)	Administrative & Service	20 (12.50)	14 (8.54)	0.63	21 (19.27)	19 (16.52)	0.74	34 (10.49)	40 (17.86)	0.06
	Craft & Technicians	15 (9.38)	19 (11.59)		12 (11.01)	16 (13.91)		34 (10.49)	28 (12.50)	
	MD/PhD	20 (12.50)	19 (11.59)		14 (12.84)	11 (9.57)		39 (12.04)	25 (11.16)	
	Management & Professionals	105 (65.63)	112 (68.29)		62 (56.88)	69 (60.00)		217 (66.98)	131 (58.48)	
Gender, n (%)	Female	131 (81.88)	126 (76.83)	0.26	91 (83.49)	89 (77.39)	0.25	257 (79.32)	180 (80.36)	0.77
Physical Activity Level, n (%)	Low/Medium	48 (30.00)	50 (30.49)	0.92	40 (36.70)	42 (36.52)	0.98	98 (30.25)	82 (36.61)	0.12
	High	112 (70.00)	114 (69.51)		69 (63.30)	73 (63.48)		226 (69.75)	142 (63.39)	
Body mass index, kg/m^2, median (p25, p75)		24.81 (22.52, 29.17)	25.76 (23.17, 29.31)	0.16	28.31 (25.45, 31.50)	29.91 (24.92, 34.60)	0.08	25.39 (22.75, 29.27)	28.90 (25.13, 33.15)	**<.001**
Weight Loss Goal, n (%)	Lose weight	122 (76.25)	132 (80.49)	0.35	100 (91.74)	97 (84.35)	0.09	254 (78.40)	197 (87.95)	**0.004**
	Maintain weight	38 (23.75)	32 (19.51)		9 (8.26)	18 (15.65)		70 (21.60)	27 (12.05)	

Abbreviations: BMI, body mass index (kg/m^2): HEI, Healthy Eating Index-2020; HPS, Healthy Purchasing Score; kcal, kilocalories.

[a] Additional race categories includes individuals who identified as 'Asian', 'Native Hawaiian/Pacific Islander', more than one racial category, and those who did not respond.

Note: P-values come from the Kolmogorov–Smirnov test for 1) the difference in BMI between intervention and control among those with chronic disease and 2) the difference in BMI between no chronic disease and chronic disease overall for both study arms. P-values for all other continuous variables come from the Wilcoxon rank sums test. For all categorical variables, p-values come from chi-square tests.

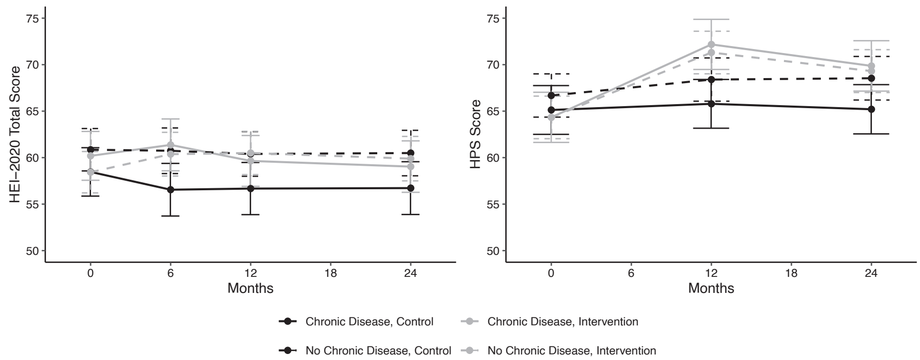

Fig. 1. Adjusted Mean HEI and HPS Scores by Study Arm and Chronic Disease over 24 Months among US-based Hospital Employees, September 2016 to February 2018 Abbreviations: HEI, Healthy Eating Index-2020; HPS, Healthy Purchasing Score; kcal, kilocalories. Three-way interaction p-value > 0.5.

Table 2
Least Square Means and 95 % Confidence Intervals over 24 Months among US-based Hospital Employees, September 2016 to February 2018.

	Study Arm	Chronic Disease Classification	Baseline Mean (95 % CI)	6 Months Mean (95 % CI)	12 Months Mean (95 % CI)	24 Months Mean (95 % CI)
HEI	Control	No Chronic Disease	60.85 (58.57, 63.13)	60.74 (58.29, 63.19)	60.40 (58.00, 62.79)	60.49 (58.05, 62.94)
(Range: 0 to 100)	Control	Chronic Disease	58.47 (55.86, 61.07)	56.55 (53.72, 59.38)	56.67 (53.87, 59.48)	56.72 (53.89, 59.56)
	Intervention	No Chronic Disease	58.43 (56.21, 60.66)	60.37 (58.02, 62.72)	60.50 (58.17, 62.83)	59.89 (57.50, 62.28)
	Intervention	Chronic Disease	60.19 (57.57, 62.82)	61.37 (58.58, 64.16)	59.64 (56.91, 62.38)	59.04 (56.27, 61.80)
HPS	Control	No Chronic Disease	66.68 (64.36, 69.01)	–	68.40 (66.07, 70.72)	68.54 (66.19, 70.88)
(Range: 0 to 100)	Control	Chronic Disease	65.13 (62.50, 67.75)	–	65.78 (63.16, 68.41)	65.20 (62.55, 67.85)
	Intervention	No Chronic Disease	64.33 (62.04, 66.62)	–	71.30 (69.01, 73.59)	69.31 (67.00, 71.61)
	Intervention	Chronic Disease	64.33 (61.64, 67.03)	–	72.18 (69.48, 74.87)	69.87 (67.15, 72.58)
BMI (kg/m^2)	Control	No Chronic Disease	28.33 (27.14, 29.53)	–	28.49 (27.30, 29.69)	28.58 (27.38, 29.78)
	Control	Chronic Disease	30.47 (29.15, 31.79)	–	30.59 (29.26, 31.92)	31.08 (29.75, 32.41)
	Intervention	No Chronic Disease	28.81 (27.63, 29.98)	–	29.15 (27.97, 30.32)	29.62 (28.44, 30.80)
	Intervention	Chronic Disease	32.11 (30.77, 33.45)	–	32.14 (30.80, 33.48)	32.25 (30.91, 33.59)
Kcal	Control	No Chronic Disease	619.1 (572.2, 666.0)	–	615.1 (567.0, 663.3)	563.5 (514.9, 612.0)
	Control	Chronic Disease	675.1 (622.3, 727.9)	–	685.8 (631.0, 740.5)	652.2 (597.1, 707.4)
	Intervention	No Chronic Disease	635.0 (588.8, 681.2)	–	591.1 (543.9, 638.4)	581.3 (533.6, 629.0)
	Intervention	Chronic Disease	714.4 (660.0, 768.8)	–	626.2 (570.7, 681.6)	617.1 (561.4, 672.8)

Abbreviations: BMI, body mass index (kg/m^2): HEI, Healthy Eating Index-2020; HPS, Healthy Purchasing Score; kcal, kilocalories.

(−1.9 [18.7] kcal) (three-way interaction: $F = 3.91$, $p = 0.02$) (Fig. 2, Table 2, Appendix Table 1).

Intervention participants with chronic disease were better able to maintain their BMI over 24 months. The intervention effect on BMI over 24 months was 0.47 (0.21) kg/m^2 for those with chronic disease. This was statistically different from the intervention effect among those without chronic disease (−0.56 [0.18] kg/m^2) (three-way interaction: $F = 7.35$, $p < 0.01$) (Fig. 3, Table 2, Appendix Table 1). A sensitivity analysis was run removing participants with high BMI values, but results did not differ.

6. Discussion

This secondary analysis showed that a workplace healthy eating and weight gain prevention intervention had a stronger effect on some health-related outcomes for employees with chronic diseases compared to employees who had no chronic diseases. Although no clinically meaningful improvements were noted in overall diet quality for any subgroup, as measured by the HEI, all employees in the intervention group increased healthy purchases at work during the study period: on a 100-point scale, improvements were about 5–6 points. Intervention effects on reducing caloric intake and preventing weight gain were larger for employees reporting a chronic disease than for those with no chronic diseases. These results suggest that employees with chronic diseases may have had larger health benefits from the workplace healthy eating intervention than employees without any chronic diseases.

The differential effect of the intervention on caloric intake by chronic disease status may have driven the observed differential effect on weight gain prevention. Intervention participants' caloric goals were personalized based on whether they wanted to maintain or lose weight. Compared to participants without chronic disease, participants with chronic disease had a higher average BMI at baseline, and 88 % of participants with chronic diseases desired to lose weight compared to 78 % of participants without chronic disease. Since the intervention feedback on cafeteria purchases showed purchased calories in relation to the participant's calorie goal, the differential effect on caloric intake would be expected. This is in line with the health belief model; those with higher health risk (i.e., higher BMI) would perceive higher need to change their health behaviors (i.e., lose weight) and thus engage more with the intervention to help them change eating habits.

The approximately 100-calorie difference pre/post intervention we observed among those with chronic disease assigned to the intervention represents a nearly 14 % reduction in purchased calories which could be clinically meaningful. This reduction is in line with other evidence suggesting that a 100-calorie deficit may be sufficient for weight gain prevention (Wing et al., 2016), and indeed, we observed weight stability among those with chronic disease who received the intervention (i.e., less than a 0.2 kg/m^2 increase over 2 years). This is important as adults gradually gain weight through early and middle adulthood, and preventing weight gain is recommended for health (Hutfless et al., 2013).

Similar results were observed in a study of approximately 250 employees of a large healthcare company. Those exposed to traffic light calorie labelling and/or numerical caloric information had larger reductions in purchased calories compared to those not exposed to caloric information, with a trend towards larger relative reductions with increasing BMI (VanEpps et al., 2016).

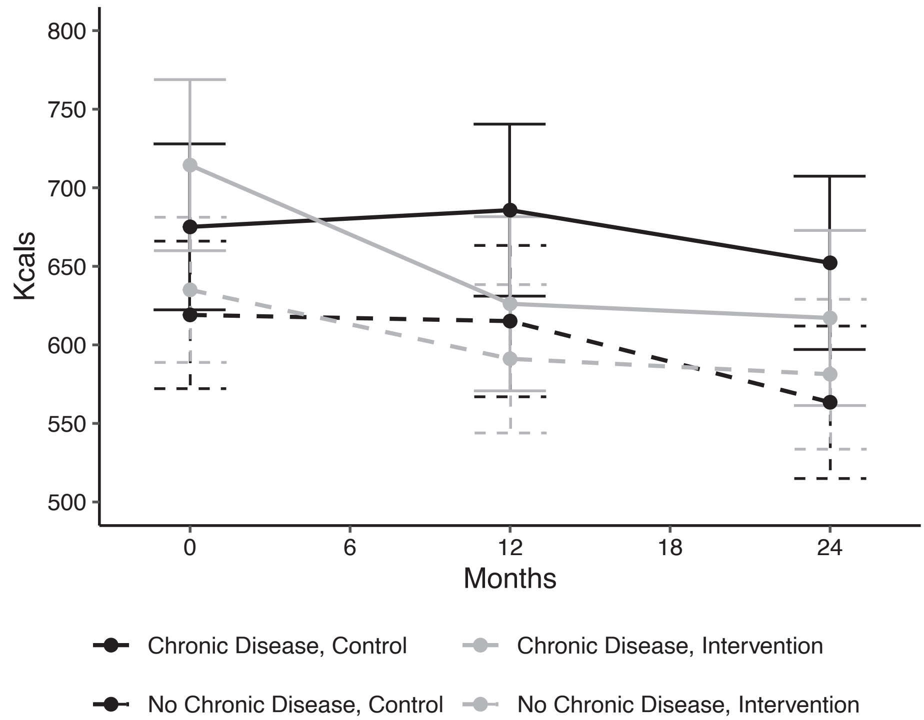

Fig. 2. Adjusted Mean Calories Purchased by Study Arm and Chronic Disease over 24 Months among US-based Hospital Employees, September 2016 to February 2018 Abbreviations: kcal, kilocalories. Three-way interaction p = 0.02.

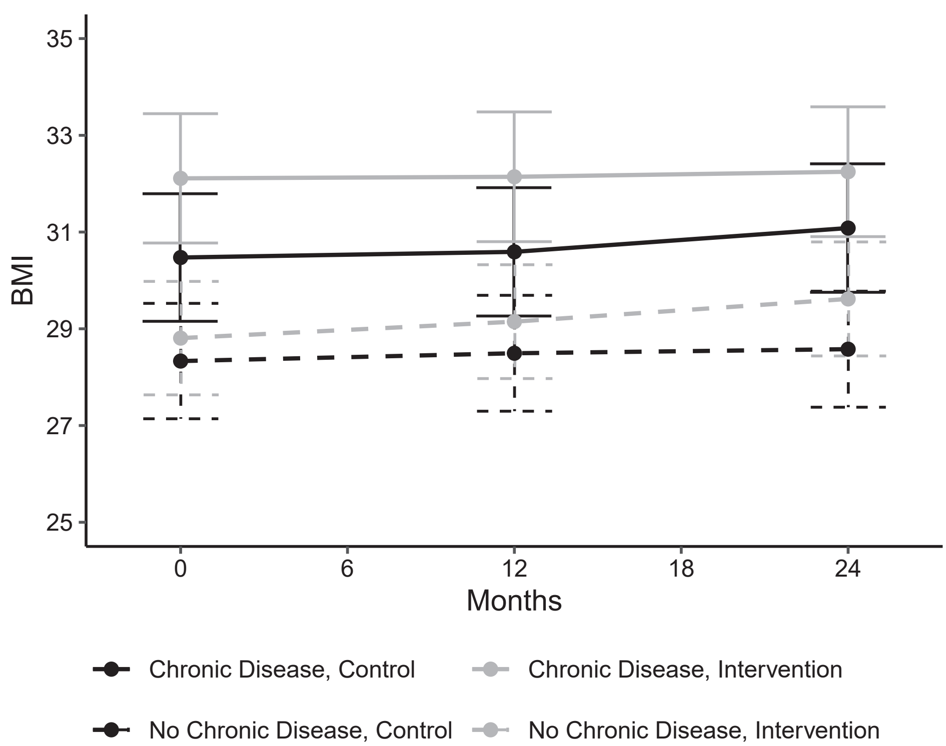

Fig. 3. Adjusted Mean BMI by Study Arm and Chronic Disease over 24 Months among US-based Hospital Employees, September 2016 to February 2018 Abbreviations: BMI, body mass index (kg/m^2). Three-way interaction $p < 0.01$.

Other studies have also shown that tailoring of intervention components may be a useful strategy for helping participants with high disease burden. For example, a study of a personalized grocery purchasing intervention showed higher effectiveness at improving the quality of purchases among participants with diet-related medical conditions (i.e., type 2 diabetes mellitus, hypertension, high cholesterol, heart disease, kidney disease, or gastric bypass) although improvements in purchases were smaller than in our study, and changes in calories were not assessed (Vadiveloo et al., 2023).

A systematic review of workplace wellness programs showed positive effects for multiple dietary intake and physiological measures; however, heterogeneity in effects across studies was not explained by study design, type of workplace, number or type of intervention components, age, gender, or duration of the intervention, suggesting a need to consider other reasons for heterogeneity of treatment effects (Peñalvo et al., 2021). In a similarly sized study (N = 657) to ChooseWell, employees with elevated BMI or waist circumference showed larger reductions in sugar-sweetened beverage (SSB) consumption when an SSB ban was instituted (Schmidt et al., 2023). Along with our results, this suggests that baseline health risk may explain part of the heterogeneity of treatment effects. In another study at an academic medical center, a workplace wellness program was associated with improvements in pain interference, fatigue, and sleep quality, decreases in hip circumference, and improvements in functional movement outcomes, job satisfaction, and self-reported productivity (Rubery et al., 2022). Although heterogeneity of treatment effects were not assessed, the sample was likely high-risk: over 60 % of employees reported at least one comorbidity and employees were enrolled in the program if they were deemed likely to benefit based on quality of life, biometric, and functional movement screenings (Rubery et al., 2022).

Strengths of the current analysis include the long duration of follow-up, minimal loss to follow-up, and objective assessment of cafeteria purchases and BMI. As previously reported, 92 % of participants rated at least one component of the intervention as helpful in making healthy dietary choices with the traffic-light labels and weekly personalized feedback rated the most helpful (Thorndike et al., 2021). Another strength is the assessment of heterogeneity of treatment effects using a formal test of interaction, as recommended (Wang et al., 2007). However, this study has limitations. The analysis was not pre-specified and therefore was not necessarily powered to detect heterogeneity of treatment effects. Future work assessing similar interventions in the workplace setting could be powered for confirmatory subgroup analyses. Additionally, it may be useful to consider predictive approaches to heterogeneity of treatment effects analysis which have the benefit of being able to consider multiple factors that may simultaneously affect the outcomes of interest and treatment effect (Kent et al., 2020). Finally, results may not generalize to non-hospital workplaces or workplaces with more limited cafeteria offerings. Our sample was mostly female, White, and college-educated; future studies including a more diverse sample in hospital and non-hospital settings may be warranted.

7. Conclusion

The results of this analysis suggest that receiving the behavioral intervention was more effective in reducing calories purchased and preventing weight gain for hospital employees with chronic diseases compared to those without. Importantly, the intervention resulted in significant increases in healthy purchases for both employees with and without chronic disease. Ideally, workplace health promotion interventions should be offered to all employees and if so, may reach employees with or at risk for chronic diseases. However, if employers have limited resources, they might consider marketing workplace wellness programs only to employees at highest risk.

8. Conflict of interest/financial disclosure

This study was funded by grant No. R01HL125486 (Thorndike) from the NIH. The project was also supported in part by NIH grants R01DK114735 (Thorndike), 1UL1TR001102 (Nadler), K24 HL163073 (Thorndike), and T32HL098048 (Cheng). The sponsor had no role in the conduct or reporting of this research. No authors have financial disclosures to report.

CRediT authorship contribution statement

J. Cheng: Writing – review & editing, Writing – original draft, Methodology, Investigation, Formal analysis, Conceptualization. **D.E. Levy:** Writing – review & editing, Supervision, Methodology, Investigation, Conceptualization. **J.L. McCurley:** Writing – review & editing, Investigation. **E.B. Rimm:** Writing – review & editing, Investigation. **E. D. Gelsomin:** Writing – review & editing, Investigation. **A.N. Thorndike:** Writing – review & editing, Supervision, Methodology, Investigation, Funding acquisition, Data curation, Conceptualization.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: This study was funded by grant No. R01HL125486 (Thorndike) from the NIH. The project was also supported in part by NIH grants R01DK114735 (Thorndike), 1UL1TR001102 (Nadler), K24 HL163073 (Thorndike), and T32HL098048 (Cheng). The sponsor had no role in the conduct or reporting of this research. No authors have financial disclosures to report.

Data availability

Data will be made available on request.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.pmedr.2024.102736.

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