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RESEARCH ARTICLE

Association of Worksite Food Purchases and Employees' Overall Dietary Quality and Health

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Introduction: Most Americans spend half their waking hours at work and consume food acquired there. The hypothesis was that the healthfulness of worksite food purchases was associated with employees' overall diet and health.

Methods: Participants were 602 hospital employees who regularly used worksite cafeterias and enrolled in a health promotion study in 2016–2018. All cafeterias used traffic-light labels (green=healthy, yellow=less healthy, red=unhealthy). A Healthy Purchasing Score was calculated for each participant by summing weighted proportions of cafeteria items purchased over a 3-month observation period (red=0, yellow=0.5, green=1; range, 0–1). Healthy Eating Index scores (range, 0–100) were calculated based on two 24-hour dietary recalls. BMI, blood pressure, and HbA1c were measured. Hypertension and prediabetes/diabetes diagnoses were determined by self-reported and clinical data. Regression analyses examined dietary quality and diagnoses by tertile of Healthy Purchasing Score (T1=least healthy purchases, T3=most healthy), adjusting for demographics. All data were collected before the start of the intervention and were analyzed in 2018.

Results: Mean age was 43.6 years (SD=12.2), 79% were female, and 81% were white. Mean BMI was 28.3 kg/m^2 (SD=6.5); 21% had hypertension, and 27% had prediabetes/diabetes. Mean Healthy Eating Index was 60.4 (SD=12.5); mean Healthy Purchasing Score was 0.66 (SD=0.15). Healthier purchases were associated with healthier Healthy Eating Index scores (T1=55.6, T2=61.0, T3=64.5, $p<0.001$) and lower obesity prevalence (T1=38%, T2=29%, T3=24%, $p<0.001$); similar patterns were observed for hypertension and prediabetes/diabetes.

Conclusions: Worksite food purchases were associated with overall dietary quality and cardiometabolic risk. Interventions to increase healthfulness of food choices at work may improve employees' health.

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INTRODUCTION

Most Americans spend half of their waking hours at work[1] and many consume food and beverages acquired at the work site.[2] The prevalence of obesity has been increasing in all employment industry categories, and nearly one-third of workers in the U.S. are obese.[3,4] Obesity among employees contributes to higher absenteeism, lower productivity, and higher healthcare costs for employers.[5,6] A recent population-based study found that food and beverages obtained at work are often high in saturated fat, sodium, and added sugars, and do

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not align with national dietary recommendations.[2] Poor diet quality is a major modifiable risk factor for obesity and other costly cardiometabolic conditions, such as cardiovascular disease and type 2 diabetes.[7] Improving diet quality, regardless of weight change, can reduce the risk of chronic disease.[8]

Interventions in the worksite food environment to promote healthy choices have the potential to reach a large population of employees, particularly those with poor diet quality and cardiometabolic risk. Simple behavioral nudges in the worksite food environment, such as product placement (choice architecture) and traffic-light food labeling (green label=healthy, yellow label=less healthy, red label=unhealthy) increase employees' healthy purchases.[9–11] However, most work sites do not provide support to help employees make healthier choices. In a 2013 national consumer survey, only 20% of respondents who worked outside the home reported that their employer provided an opportunity to eat a healthy diet, and 17% reported having signs or labels in the cafeteria or vending area to help employees make healthy food and beverage choices.[12]

Despite employers' rising healthcare expenses from diet-related diseases,[5,13] little is known about employees' food choices at work. Understanding the relationship between employees' food choices and cardiometabolic risk will help inform efforts to provide worksite wellness interventions that improve long-term health outcomes and decrease healthcare costs. This study is a cross-sectional analysis of worksite food purchases, dietary quality (food consumed over 24 hours), and cardiometabolic risk factors of 602 employees who enrolled in a health promotion study at a large urban hospital. Data analyzed in this study are baseline data collected before the initiation of the intervention. The hypothesis was that the healthfulness of worksite food purchases is associated with employees' overall dietary quality and cardiometabolic health.

METHODS

Study Sample

Participants were employees of the Massachusetts General Hospital (MGH) that enrolled between September 2016 and February 2018 in an RCT of a worksite healthy eating intervention (ChooseWell 365; Clinicaltrials.gov NCT02660086). The MGH is a 999-bed teaching hospital in Boston (MA) with >27,000 employees, 70% of whom are female and 81% white, and have a mean age of 41 years. The hospital campus has five onsite food service locations including three full-service cafeterias and two smaller cafes (hereafter, all referred to as cafeterias). The MGH employees may purchase cafeteria items by payroll deduction using their employee identification badge, and these purchases can be tracked by employee number. This study analyzed purchase data collected for each participant at baseline before the start of intervention procedures.

A full description of the methodology for the RCT, ChooseWell 365, has been previously published,[14] and outcome data from that intervention will be analyzed when the trial is complete. In brief, employees were eligible if they were between ages 20 and 75 years and used their employee badge to purchase cafeteria items at least four times per week for >6 weeks during a 12-week period before recruitment. Exclusion criteria included pregnancy, desire to gain weight, participation in a weight-loss study, weight-loss surgery in the prior 6 months, history of an eating disorder, employment as cafeteria staff, or plan to leave MGH employment in the upcoming year. Study participants completed an online survey, two online 24-hour dietary recalls, and an in-person clinical visit. All participants provided informed consent and all study procedures were approved by the Partners IRB on October 2, 2015.

Traffic-light food labeling was implemented in the largest cafeteria in 2010 and in the four additional cafeterias in 2015 to inform employees of healthfulness of food and drink items (green label=healthy, yellow label=less healthy, red label=unhealthy). The MGH nutrition staff developed the labeling algorithm based on the 2010 U.S. Department of Agriculture (USDA) dietary guidelines,[9,15] and updated it to align with 2015 guidelines.[16] All items available for purchase were categorized into four types (food entrée, other food item, food condiment, beverage) and were assessed for positive and negative nutritional criteria. Negative criteria were: (1) saturated fat content ≥5 grams per entrée or ≥2 grams per non-entrée item; and (2) caloric content of ≥500 kilocalories per entrée, ≥200 kilocalories per non-entrée food item, or ≥100 kilocalories per condiment or beverage. Positive criteria were assigned if the main ingredient of the item was a fruit or vegetable, a whole grain, or a lean protein or low-fat dairy. Items with more positive than negative criteria were labeled green. Items were labeled yellow if they had equal positive and negative criteria, had only one negative criterion, or had no positive or negative criteria. Items with two or more negative criteria and no positive criteria were labeled red. The average costs of red, yellow, and green items were comparable for beverages, entrées, and snacks/side items, and items across a range of prices were available in each color category. Permanent, highly visible signage was installed in cafeterias at the time of implementation to explain the labeling system.

Choice architecture modifications were also implemented in cafeterias to make green-labeled items more visible and convenient to purchase.[9] Specifically, some refrigerators with beverages, premade sandwiches, and snack displays were arranged such that green items were located at eye level, whereas yellow and red items were placed below or above eye level. Both the traffic-light labels and choice architecture interventions have been described in detail previously.[9,10]

Measures

Participants completed an online survey that collected information on demographic variables, medical history, medication use, and health behaviors.

Job type for each participant was obtained from the hospital's human resources office. Specific job types were combined into four categories that roughly correlated with increasing educational attainment: (1) service workers (manual or unskilled laborers)/

administrative assistants; (2) craft/technicians (e.g., radiology technicians, respiratory therapists); (3) management/professionals (e.g., hospital managers, nurses, social workers); and (4) MDs/PhDs (e.g., physicians, researchers).

Participants were asked to fast 8 hours before their clinic visit, which included measurement of weight, height, blood pressure, lipid panel, glucose, and HbA1c. BMI was calculated and used to categorize weight status (i.e., normal weight, overweight, obese). Hypertension was defined as self-reported hypertension/high blood pressure diagnosis or self-reported prescription of antihypertensive medication or systolic blood pressure ≥150 millimeters of mercury or diastolic blood pressure ≥90 millimeters of mercury. Prediabetes/diabetes was defined as self-reported diabetes or prediabetes diagnosis or self-reported prescription medication for diabetes or HbA1c ≥5.7%. Hyperlipidemia was defined as self-reported high cholesterol/hyperlipidemia diagnosis or self-reported prescription medication for high cholesterol or fasting total cholesterol ≥220 mg/dL, low-density lipoprotein ≥160 mg/dL, or triglycerides ≥180 mg/dL. Physical activity was measured by the International Physical Activity Questionnaire–Long Form[17] and participants were categorized into low, moderate, or high physical activity according to the standard International Physical Activity Questionnaire scoring protocol.[18]

The Automated Self-Administered 24-hour dietary recall (ASA24) is a free web-based tool for dietary intake assessment developed by the National Cancer Institute.[19] Modeled after the USDA interview-administered dietary recall method, the ASA24 uses multilevel probes to guide respondents through a 24-hour recall period and is a valid measure of dietary intake in adults.[20,21] Most participants completed two ASA24 recalls on non-consecutive days; 38 participants (6.3%) completed only one recall. ASA24 recall scores were combined and used to calculate a Healthy Eating Index (HEI)-2015 score for each participant[22,23] using the National Cancer Institute scoring algorithm.[21] If only one ASA24 was completed, HEI was based on that recall alone. The HEI-2015 is a measure of dietary quality that assesses compliance with the dietary recommendations for the USDA Guidelines for Americans.[22,24] Scores range from 0 to 100; higher scores indicate higher compliance with USDA dietary recommendations. The most recent estimate of the average HEI-2015 score for Americans, based on data from the National Health and Nutrition Examination Study in 2013–2014, is 59 of 100.[25]

Cafeteria purchases of participants during the 3 months before enrollment in the RCT were extracted retrospectively from the MGH cafeteria cash register data system. Purchasing data included item type, time and date of purchase, and the traffic-light label color (i.e., red, yellow, green). Three months of data were used to represent typical recent purchases and avoid abnormalities because of short-term vacations or work schedule changes.

A Healthy Purchasing Score (HPS) was created to reflect the overall healthfulness of an employee's baseline (3-month) purchases. For each employee, the percentage of the items purchased during the baseline period that were red, yellow, or green was determined. Then, the percentage of red items was multiplied by 0, the percentage of yellow items by 0.5, and the percentage of green items by 1. The sum of these values was the HPS, which ranged from 0 (least healthy, 100% red items) to 1 (most healthy, 100% green items). For example, if an employee's 3-month baseline purchases were 20% red-labeled items, 50% yellow items, and 30% green items, the HPS would be calculated as follows: (0.2 red × 0) + (0.5 yellow × 0.5) + (0.3 green × 1) = 0.55.

Statistical Analysis

All analyses were conducted using Stata statistical software, version 15.1. Participants were divided into tertiles based on the proportion of red, yellow, and green items they purchased. Participants were also divided into tertiles based on their HPS; the first tertile (T1) included individuals with the lowest scores (i.e., least healthy purchases at work), and the third tertile (T3) included individuals with the highest scores (i.e., healthiest purchases at work). Demographic characteristics were assessed for the full sample and by tertiles of HPS. To explore how overall dietary quality varied with worksite food purchases, regression models of HEI-2015 scores were estimated as a function of purchasing tertiles (HPS or proportions green, yellow, or red items) adjusted for age, sex, race, ethnicity, education, physical activity, and number of purchases. The *p*-values for trend were generated for each set of tertiles. A scatterplot of HEI-2015 scores and HPS was generated to examine the unadjusted relationship between these variables. Logistic regression analyses were conducted to estimate prevalence of cardiometabolic conditions (obesity, prediabetes/diabetes, hypertension, hyperlipidemia) by tertiles of HPS.

RESULTS

Characteristics of the full sample and by tertile of HPS are presented in Table 1. The mean age of participants was 43.6 years (SD=12.2), 79.4% of whom were female, 81.1% were white, and 87.5% had a college degree. The mean BMI was 28.3 kg/m^2 (SD=6.5), and 62.6% of the participants were overweight or obese. The prevalence of hypertension, prediabetes/diabetes, and hyperlipidemia were 20.6%, 26.6%, and 32.1%, respectively. Among those with prediabetes/diabetes, 10.6% (*n*=17) had HbA1c ≥6.5 (data not shown). Average number of food and beverage items purchased during the 3-month baseline observation period was 112 items (SD=21). The mean HEI-2015 score was 60.4 (SD=12.5) and the mean HPS was 0.66 (SD=0.15). Tertiles of HPS had the following ranges: T1 (least healthy tertile), 0.13–0.61; T2, 0.62–0.72; and T3 (most healthy tertile), 0.73–0.98.

The Table 2 shows adjusted mean HEI-2015 scores by tertile of proportion of green, yellow, and red purchases, and by tertile of HPS. There were statistically significant trends in HEI-2015 score by tertile of proportion of red and green purchases, but of not yellow purchases. Employees who purchased the highest proportion of green-labeled items and those who purchased the lowest proportion of red-labeled items had the highest (i.e., healthiest) overall dietary quality, as measured by the HEI-2015. There was a statistically significant trend for increase in HEI-2015 scores by tertile of HPS; employees with the healthiest purchases at work (the upper tertile of HPS) had the healthiest overall dietary quality. The

Table 1. Characteristics of Employees by Tertile of Healthy Purchasing Score[a]

Variable	Total[b] (N=602)	Healthy Purchasing Score tertiles[c]		
		T1 (least healthy) (n=201)	T2 (n=201)	T3 (most healthy) (n=200)
Age, years, mean (SD)	43.6 (12.2)	41.5 (11.4)	44.1 (12.3)	45.4 (12.8)
BMI, kg/m^2, mean (SD)	28.3 (6.5)	29.7 (7.5)	28.3 (6.4)	26.8 (5.1)
Healthy Purchasing Score mean (SD)	0.66 (0.15)	0.50 (0.10)	0.67 (0.03)	0.82 (0.07)
Sex, *n* (%)				
Male	124 (20.6)	57 (28.4)	37 (18.4)	30 (15.0)
Female	478 (79.4)	144 (71.6)	164 (81.6)	170 (85.0)
Race, *n* (%)				
White	488 (81.1)	141 (70.1)	169 (84.1)	178 (89.0)
Black	54 (9.0)	32 (15.9)	12 (6.0)	10 (5.0)
Asian	27 (4.5)	10 (5.0)	11 (5.5)	6 (3.0)
Other/Not reported	33 (5.5)	18 (9.0)	9 (4.5)	6 (3.0)
Ethnicity, *n* (%)				
Non-Hispanic/Latino/a	556 (94.2)	174 (90.2)	193 (97.0)	189 (95.5)
Hispanic/Latino/a	34 (5.8)	19 (9.8)	6 (3.0)	9 (4.5)
Job type, *n* (%)				
Administrative/service	84 (14.0)	43 (21.4)	28 (13.9)	13 (6.5)
Craft/Technicians	67 (11.1)	33 (16.4)	15 (7.5)	19 (9.5)
Management/professionals	377 (62.6)	100 (49.8)	134 (66.7)	143 (71.5)
MDs/PhDs	74 (12.3)	25 (12.4)	24 (11.9)	25 (12.5)
Education level, *n* (%)				
High school/Some college	75 (12.5)	36 (18.1)	25 (12.5)	14 (7.0)
College degree	240 (40.1)	83 (41.7)	83 (41.5)	74 (37.0)
Graduate degree	284 (47.4)	80 (40.2)	92 (46.0)	112 (56.0)
Current smoker, *n* (%)	17 (2.8)	6 (3.0)	8 (4.0)	3 (1.5)
Physical activity,[d] *n* (%)				
Low	18 (3.0)	7 (3.5)	5 (2.5)	6 (3.0)
Moderate	177 (29.4)	63 (31.3)	64 (31.8)	50 (25.0)
High	407 (67.6)	131 (65.2)	132 (65.7)	144 (72.0)

[a]Score based on weighted proportion of green, yellow, and red cafeteria items purchased; higher score=healthier purchases.
[b]*n*=602.
[c]T1 (least healthy), *n*=201; T2, *n*=201; and T3 (most healthy), *n*=200.
[d]Measured by the International Physical Activity Questionnaire (IPAQ)—Long Form version; High=Vigorous—intensity activity on ≥3 days and total of ≥1,500 MET-minutes/week OR ≥ 7 days of any combination of walking, moderate intensity, or vigorous intensity activities and total of ≥3,000 MET-minutes/week; Moderate= ≥3 days of vigorous activity of ≥30 minutes per day OR ≥5 days of moderate intensity activity or walking of ≥30 minutes per day OR ≥5 days of any combination of walking, moderate intensity, or vigorous intensity activities and total of ≥600 MET-minutes/week; Low=individuals who not meet criteria for Moderate or High categories.

Figure 1 presents a scatterplot showing the positive linear association of HEI-2015 score and HPS with few outliers (Pearson's r =0.33, p<0.001).

The prevalence of cardiometabolic risk factors was significantly lower for the tertiles of participants with healthier purchases. Figure 2 shows the prevalence of each cardiometabolic condition by HPS tertile, adjusting for age, sex, race, ethnicity, education, physical activity, and number of purchases. Individuals in the healthiest tertile of HPS (T3) had the lowest prevalence of obesity, hypertension, prediabetes/diabetes, and hyperlipidemia compared with the employees in the least healthy (T1) and middle (T2) tertiles. For all conditions except hyperlipidemia, these trends were statistically significant across tertiles. The differences in prevalence rates between T1 (least healthy purchasers) and T3 (healthiest purchasers) were highest for obesity (38% vs 24%) and prediabetes/diabetes (34% vs 21%).

DISCUSSION

The healthfulness of worksite food purchases was significantly associated with employees' overall diet quality and cardiometabolic risk factors. This is the first study to the

Table 2. Adjusted Mean Healthy Eating Index-2015 (HEI-2015) Scores by Tertiles of Cafeteria Purchases and Healthy Purchasing Score[a]

Variable	HEI score	*p*-value for trend
Proportion of green items purchased		
T1 (0–41%, least green)	56.4	—
T2 (41%–59%)	61.5	—
T3 (59%–97%, most green)	63.3	**<0.001**
Proportion of yellow items purchased		
T1 (0–24%, least yellow)	60.7	—
T2 (24%–38%)	60.3	—
T3 (38%–93%, most yellow)	60.4	0.83
Proportion of red items purchased		
T1 (0%–9%, least red)	64.4	—
T2 (9%–20%)	61.0	—
T3 (21%–85%, most red)	55.7	**0.001**
Healthy Purchasing Score		
T1 (0.13–0.61, least healthy)	55.6	—
T2 (0.62–0.72)	61.0	—
T3 (0.73–0.98, most healthy)	64.4	**<0.001**

Note: Boldface indicates statistical significance ($p<0.05$).
[a]Adjusted for age, sex, race, ethnicity, education, physical activity, and number of cafeteria purchases. Higher score=healthier purchases.

authors' knowledge to evaluate the association of employees' worksite food purchases with their diet quality outside of work. Despite a high average education level and a healthcare occupational setting, employees in this study were similar to the U.S. population in having a high prevalence of overweight/obesity and relatively low dietary quality (HEI score) that was far from adherent to USDA dietary recommendations. The overall healthfulness of worksite purchases (i.e., HPS) was positively associated with diet quality, and there were clinically meaningful differences[26] in HEI scores between categories of HPS. The significant linear association between the HPS and the HEI-2015 scores in this sample provides initial evidence for the validity of the HPS as a measure of employees' dietary quality. Further, worksite purchases were associated with cardiometabolic risk factors. Individuals with the least healthy purchases had the highest prevalence of obesity, prediabetes/diabetes, hypertension, and hyperlipidemia. The implication of these findings is that effective worksite food environment and nutrition interventions may be able to improve employees' health.

Workplace environments are particularly well suited for implementation of interventions to support lifestyle change and improve population health. The U.S. workforce comprises more than 150 million individuals representing 60% of the total population.[27] In addition to high costs related to disability and lost productivity, insurance claims related to obesity and cardiometabolic conditions cost employers US$200 billion per year.[13] Worksite-based health promotion strategies have the unique ability to nurture social norms around healthy lifestyle choices, influence shared health behavior environments (e.g., food purchasing settings), and reach individuals across demographic strata. A previous study examined the effectiveness of traffic-light labeling and product placement

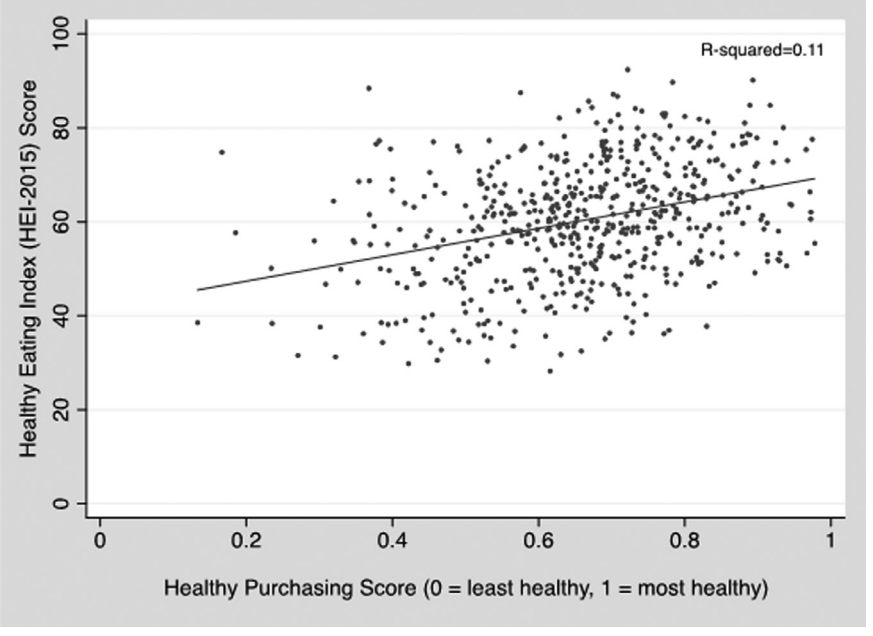

Figure 1. Healthy Purchasing Score and Health Eating Index-2015.

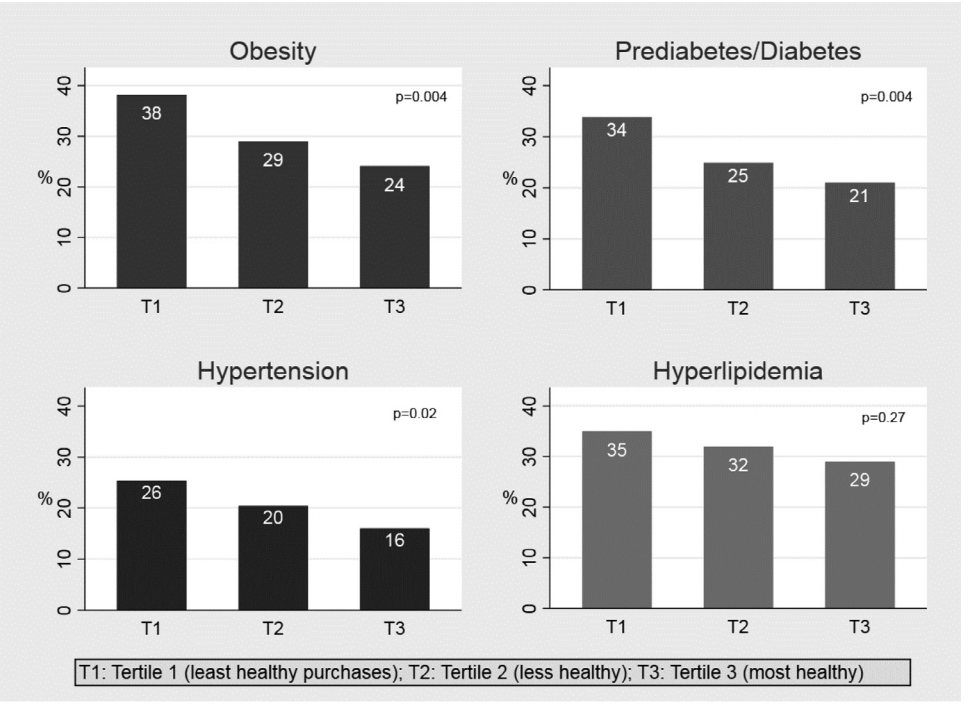

Figure 2. Prevalence of Cardiometabolic Risk Factors by Tertile of Healthy Purchasing Score.

interventions by employee race, ethnicity, and job type in 4,642 hospital employees. Although the proportion of healthy to unhealthy purchases differed across groups at baseline, all groups increased purchases of healthy items and decreased purchases of unhealthy items in response to the intervention.[28]

Worksite wellness programs have shown promise in reducing healthcare costs and improving employee productivity; a 2010 meta-analysis concluded that medical costs decreased by US$3.27 for every dollar spent on worksite wellness programs, and absenteeism costs decreased by US$2.73.[29] In addition to financial returns on investment, wellness programs may also increase value-based benefits such as employee morale, job satisfaction, and quality of life that boost worker productivity and reduce turnover.[30–33] More research is needed to develop worksite programs that are accessible, scalable, affordable, and feasible to maintain in the long term.

The current results suggest that worksite food and beverage purchases could be used as objective measures of health behavior and are promising tools for personalization and optimization of worksite health promotion efforts. Analyzing employee purchases may be an effective, low-cost strategy for identifying employees that would benefit from healthy eating interventions, without relying on in-person assessments or self-reported dietary intake. Cash register data can be utilized to log purchases in systems where the infrastructure is in place for use of employee badges or loyalty cards for purchases. Traffic-light coding of food and beverages facilitates this assessment, lending simple objective data about the health of items purchased. Although eliminating the sale of unhealthy foods from workplace locations is another option, simplified labeling strategies provide an opportunity to educate employees about the nutritional content of items, without restricting freedom of choice. Purchase data could be incorporated into automated, personalized low-touch interventions (e.g., e-mail or text summaries) to provide immediate feedback and education to employees with lower time and cost burden than with counseling.

Strengths of this study include the objective measurement of worksite food purchases using cafeteria sales data in a large employee population and the comparison of purchases to validate measures of dietary quality and cardiometabolic health. The HPS, a weighted scale of red, yellow, and green purchases, provided an objective summary of worksite purchases, which was associated with cardiometabolic health. In the future, this type of purchasing score could be utilized for personalized, targeted health promotion.

Limitations

This study has several limitations. First, the cross-sectional nature of the data limits conclusions regarding causality. Rather, these findings suggest hypotheses to be

tested in future trials. Second, it is not certain that employees consumed all the items they purchased. However, cafeteria items are sold as single-serve, ready-to-eat items. Employees in the study visited cafeterias frequently and were familiar with typical serving sizes. Therefore, they would be unlikely to consistently pay for items that they were not going to consume. Third, individuals with prior diagnoses of metabolic conditions (e.g., hypertension, diabetes) may have chosen healthier options in response to medical recommendations; this may have weakened relationships between purchasing and health variables. Finally, this sample included employees at a large urban hospital with a relatively high education level, and results may not be fully generalizable to smaller businesses, working populations with lower education levels, or rural or non-employed people.

CONCLUSIONS

Worksite food choices were associated with overall dietary quality and health of employees who regularly purchased food at work. These results suggest that improving the healthfulness of worksite food choices could improve dietary quality, reduce cardiometabolic risk factors, and slow or prevent weight gain. Worksite food and beverage purchases are novel objective measures of health that may be useful in personalization and targeting of healthy eating interventions.

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