ORIGINAL
Research

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Worksite Nutrition: Is a Nutrient-Dense Diet the Answer for a Healthier Workforce?

There are several key settings and locations that provide excellent opportunities for conducting health promotion activities. One such place is the worksite. Since Americans spend nearly 100 000 hours over the course of their lives engaged in employment-related activities, the worksite can potentially provide an excellent setting to conduct interventions for health promotion and disease prevention in an attempt to enhance overall health and reduce the risks related to chronic risk factors for disease. Worksite health promotion can also be an effective means of improving employee morale, employment satisfaction, productivity, and presenteeism, as well as reducing absenteeism, employee turnover, and medical costs.¹

The 6-Week Pilot Intervention

In early 2015, we conducted our first nutrition intervention as a means of developing a model for effective outcomes by assisting our Northern Arizona University Employee Assistance and Wellness Department (NAU: EAW) in achieving their mission to “promote and enhance organizational and individual well-being for NAU faculty and staff.”²

Our evidenced-based microNutrient-Dense Plant-Rich (mNDPR) dietary protocol has been published earlier³ and is designed to be (1) micronutrient rich (ie, especially high in plant-derived phytochemicals, antioxidants, vitamins, and minerals); (2) nutritionally adequate and diverse; (3) hormonally favorable, avoiding carbohydrates with a high glycemic index that could elevate levels of serum insulin and minimizing animal

Our methodological approach was also published earlier³ and describes how the participants were provided with the acronym GBOMBS+T to provide a guide for a portion of their food selection. The acronym represents Greens, Beans, Onions, Mushrooms, Berries, Seeds and Nuts plus Tomatoes. The use of a multivitamin containing B₁₂, iodine, zinc, and vitamin D was also encouraged as well as the consumption of a relatively

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protein that may invoke an inflammatory response; and (4) encouraging of regular intake, with an emphasis on meals and not snacks, with an overnight “fast” of at least 12 hours. In addition, our approach does not generally emphasize macronutrient percentages, portion sizes, or calorie counting.

small amount of eicosapentaenoic docosahexaenoic acid from algae to assure consumption of comprehensive and adequate nutrients, given the small amount of animal products recommended by the program. Participants were encouraged to continue their current exercise habits and not to alter their

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physical activity dramatically during the period of the intervention. Participants were provided contact information for providers of health services at the worksite in the event that they needed services. The protocol and study design were approved by the NAU Institutional Review Board, and all participants provided written informed consent.³

Key outcomes reported included significant clinical and statistical improvements in weight, body mass index, waist and hip measurements, total cholesterol, low-density lipoproteins, and estimated average glucose. Additionally, wellness findings, yet to be published, included significant improvements in depressive symptoms (Beck Depression Inventory–II), sleep quality (Pittsburgh Sleep Quality Index), and quality of life (Quality of Life Index). This 6-week study revealed no correlation between level of physical activity and changes in the anthropometric measurements, blood pressure, triglycerides, or any of the variables related to cholesterol.³

The Expanded 12-Week Pilot Intervention

After realizing these positive outcomes in the initial 6-week pilot project,³ we sought to develop a broader approach and reach with an expanded team, with a desire of assisting employees in making long-term and sustainable changes. To date, our most effective employee intervention has been our intervention that focused on how the overall health and wellness of working adult employees of 3 worksites in Arizona—Northern Arizona University (NAU), Flagstaff Medical Center (FMC), and Verde Valley Medical Center (VVMC)—was affected by a 12-week nutrition education.

Methods

Participants who met the following criteria were eligible to participate in this intervention: employee, spouse, or adult dependent of an employee at NAU, FMC, or VVMC; 18 to 80 years of age; self-reported body mass index of 28 kg/m²

or greater self-reported waist circumference >35 inches for females and >40 inches for males; ready and willing to make a lifestyle change; not currently participating in a weight loss program; and not taking any medications that could increase medical risk or that had weight loss as a primary side effect. Participants were recruited through electronic messaging, fliers, and website promotion by the NAU: EAW, as well as through Northern Arizona Healthcare (NAH). The protocol and study design were approved by the NAH Institutional Review Board, and all participants provided written informed consent.

A total of 77 employees participated in the full study. The mean age was 50.39 (median = 51.5, mode = 51) years, with a range of 28 to 69 years; 88.3% were female. With respect to ethnicity, participants identified as 75.3% Caucasian, 9.1% Hispanic, 2.6% Native American, 1.3% Asian, 3.9% “other,” 5.2% declined to state, and 2.6% “no response.” Of the 9 male participants, all had an initial waist circumference of 42 inches or more. Of the 68 female participants, all but one had a waist circumference of more than 35 inches.

Participants did not receive financial compensation but were eligible for incentives through their respective worksite wellness program that could potentially offset the cost of their personal health insurance premiums. Compensation was prorated, and to earn full credit participants were required to successfully complete the entire intervention.

Intervention Design

The study design was similar to that of our 6-week intervention³ (including identical dietary protocol), with the following slight alterations: During week 0 (the week prior to the commencement of the intervention), participants participated in preintervention blood draws and filled out wellness questionnaires. In week 1, preintervention anthropometric measurements were made, and participants attended 6 hours of lectures over 2 nights in a seminar-style

format. Participants then attended twelve 1-hour weekly group meetings (weeks 2–13) to receive instruction, support, encouragement, a cooking demo, food tasting, and to interact with other volunteers and the research team. Nine of the 12 sessions were in-person (weeks 2–7, 9, 11, and 13), and 3 were online (weeks 8, 10, and 12). Postintervention anthropometric, biometric, and wellness measurements were made the week following the intervention (ie, during week 14). Finally, participants were encouraged to participate in a minimum of 150 minutes per week of moderate physical activity.

Outcome measures were also similar to those in the 6-week intervention, including a medical history and lifestyle questionnaire, the Pittsburgh Sleep Quality Index⁴ (PSQI), the Quality of Life Index⁵ (QLI), and anthropometric measurements of height, weight, waist circumference, hip circumference, and blood pressure. Additional outcome measures included an assessment for gastroesophageal reflux disease⁶ (GerdQ); questionnaires for depression⁷ (Patient Health Questionnaire [PHQ-9]), and for work productivity and activity impairment⁸ (Work Productivity and Activity Impairment questionnaire; WPAI-GHA, WPAI-GHB, WPAI-GHC, and WPAI-GHD); physiological measures of blood lipids, including triglycerides (TG), total cholesterol (TC), high-density lipoprotein (HDL), low-density lipoprotein (LDL), very low density lipoprotein (VLDL); serum glucose (HbA1c and glucose); high-sensitivity C-reactive protein (hs-CRP); and fructosamine. Attendance was measured in total number of sessions attended. Compliance was measured at the weekly meetings by having participants complete a self-reported survey that recorded the percentage of the food and meals consumed that adhered to this intervention's dietary guidelines. Self-reported weekly activity trackers were also utilized to monitor physical activity.

All of our interventions are based on the Health Belief Model, a

psychological model that attempts to explain and predict health behaviors. The Health Belief Model is rooted in the understanding that a person will take a health-related action if that person (1) feels that a negative health condition can be avoided; (2) has a positive expectation that by taking a recommended action, he/she will avoid a negative health condition; and (3) believes that he/she can successfully take a recommended health action.⁹

Statistical Methods

The Shapiro-Wilk statistical test determined that the outcome measures were not normally distributed for the outcome measures prior to the intervention, after the intervention, or at both time periods; therefore, in most cases the Wilcoxon signed ranks statistical test was used to determine whether there were changes in median scores.

Spearman correlation analysis was used to examine the relationship between attendance and various outcome measures. All analyses were conducted using IBM SPSS statistical software version 24.0 (SPSS, Chicago, IL). All statistical tests were considered significant at $P < .05$.

Results

Anthropometric and Biometric Measures

Measurements were assessed pre and post intervention of the following: weight, waist, hips, blood pressure, GerdQ, fructosamine, lipids (TC, TG, HDL, LDL, VLDL, and HDL:TC), blood glucose and HbA1c, and hs-CRP (Table 1).

There was a significant median weight loss of 21 pounds ($Z = -7.025$, $P < .001$). In addition, participants significantly reduced waist measurements by 1.88 inches ($Z = -6.864$, $P > .001$) and hip measurements by 1.50 inches ($Z = -6.209$, $P < .001$). Median systolic blood pressure significantly decreased by 6.00 mm Hg ($Z = -3.983$, $P < .001$), and median diastolic blood pressure (DBP)

significantly decreased by 10.00 mm Hg ($Z = -5.294$, $P < .001$). For DBP, for which the Shapiro-Wilk test was not significant either pre- or postintervention, a parametric test showed the mean DBP significantly decreased by 9.81 mm Hg ($t = 6.45$, $P = .000$). Median scores on the GerdQ decreased by 2.00 points, and this change was significant ($Z = -5.387$, $P < .001$). Median TC level significantly decreased by 26 mg/dL ($Z = -4.761$, $P < .001$). There was also a significant reduction in LDL of 19.5 mg/dL ($Z = -3.896$, $P < .001$) and in HDL of 3.0 mg/dL ($Z = -3.86$, $P < .001$). Median glucose levels significantly decreased by 3.00 mg/dL ($Z = -3.276$, $P = .001$), and median hs-CRP significantly decreased by an average of 1.2 mg/L ($Z = -2.635$, $P = .047$). Median fructosamine levels decreased by 3 mmol/L ($Z = -2.549$, $P = .011$). There was no significant change in the following: HDL:TC ratio ($Z = -0.868$, $P = .385$), VLDL ($Z = -0.171$, $P = .865$), TC ($Z = -0.719$, $P = .472$), and HbA1c ($Z = -0.737$, $P = .461$).

Correlation Between Attendance at Weekly Meetings and Anthropometric/Biometric Changes

Attendance was measured as a percentage. On average, participants attended 84.45% of weekly meetings (median = 82, mode = 100). The mode of 100 indicates that there is a ceiling effect with this variable, and the Shapiro-Wilk test indicates deviation from normality. Thus, we utilized the nonparametric Spearman correlation to examine the relationship between change in outcome measures and attendance. Change variables were computed for all anthropometric and physiological measures by subtracting the postintervention score from the preintervention score. Within this set of measures, there were significant correlations between attendance and change in GerdQ scores (Spearman's $\rho = -.390$, $P = .001$, $n = 67$), between attendance and change in waist measurement (Spearman's $\rho = .236$, $P = .041$, $n = 76$), and between attendance

and change in weight (Spearman's $\rho = .312$, $P = .006$, $n = 76$). No other correlations were significant (all P values $> .05$).

Well-Being Measures

There was a significant improvement of -3.24 points/items in the QLI ($Z = -6.514$, $P < .001$). There was also a significant improvement in the PHQ-9 of 4.00 points/items ($Z = -6.13$, $P < .001$). There was not a significant change in PSQI scores ($Z = -0.643$, $P = .520$). For the WPAI, only GHA showed a significant improvement of 0.2 ($Z = -4.748$, $P < .001$).

Changes in the PHQ-9 were significantly correlated with attendance (Spearman's $\rho = -.267$, $P = .024$, $n = 71$). No other well-being measures were correlated with attendance at the weekly meetings.

Prescription Medication-Related Measures

Pre- and post prescription medication usage were self-reported by participants. Medication categories were categorized as diabetes, cardiac, blood pressure, depression, pain, thyroid, anxiety, multiple sclerosis, and GERD. Prior to the intervention, 32.1% of participants (25 participants) were not taking any medications, and 53 participants (67.9%) reported being on 1 to 4 types of medications. Postintervention, of the 53 participants who had been taking medications at the start, 47.2% reported a reduction in medication usage. For those who started the program on at least one medication, the mean change in number of medications was 0.604, SD = 0.716 (Table 2).

Health Care Costs-Related Measures

For participants who were associated with NAH, we were able to track changes in health care utilization. The average NAH participant health care cost prior to the intervention (January to December 2015) was \$673.16/month. The average NAH participant health care expenditures during and after the

Table 1.

Pre- and Postintervention Outcome Measures.

Measure	n	Shapiro-Wilk Significant at Either Time	Median Time 1	Median Time 2	Z (Wilcoxon Statistic)	Significance Based on Wilcoxon (P Level)
<i>Anthropometric and biometric measures</i>						
Weight	75	Both	212.75	191.75	−7.025	<.001
Waist	76	Pre	42.88	41.00	−6.864	<.001
Hips	76	Both	46.00	44.50	−6.209	<.001
SBP	75	Both	132	126	−3.983	<.001
DBP	75	Neither	84.00	74.00	−5.294	<.001
Fructosamine	77	Both	228.00	225.00	−2.549	.011
Total cholesterol	77	Post	213	187	−4.761	<.001
Triglycerides	77	Both	148	144	−0.719	.472 <i>ns</i>
HDL/TC ratio	77	Both	4.00	4.00	−0.868	.385 <i>ns</i>
HDL	77	Pre	51.00	48.00	−3.860	<.001
LDL	74	Post	126.5	107.00	−3.896	<.001
VLDL	74	Both	28.5	29.00	−0.171	.865 <i>ns</i>
Glucose	77	Both	98.00	95.00	−3.276	.001
hs-CRP	77	Both	3.5	2.3	−2.635	.008
HbA1c	75	Both	5.8	5.8	−0.737	.461 <i>ns</i>
<i>Well-being measures</i>						
GerdQ	67	Both	2.00	0.00	−5.387	<.001
QLI	68	Both	21.14	24.38	−6.514	<.001
PSQI	72	Both	8.00	10.00	−0.643	.520 <i>ns</i>
WPAI-GHA	71	Both	0.20	0.00	−4.748	<.001
WPAI-GHB	71	Both	0.00	0.00	−1.606	.108 <i>ns</i>
WPAI-GHC	71	Both	0.00	0.00	−0.415	.678 <i>ns</i>
WPAI-GHD	71	Both	0.00	0.00	−0.267	.790 <i>ns</i>
PHQ-9	71	Both	6.00	2.00	−6.130	<.001

Abbreviations: SBP, systolic blood pressure; DBP, diastolic blood pressure; HDL, high-density lipoprotein; TC, total cholesterol; LDL, low-density lipoprotein; VLDL, very low density lipoprotein; hs-CRP, high-sensitivity C-reactive protein; QLI, Quality of Life Index; PSQI, Pittsburgh Sleep Quality Index; WPAI, Work Productivity and Activity Impairment questionnaire; PHQ, Patient Health Questionnaire.

intervention was \$393.39/month. Financial savings achieved from January 2016 to May 2017 reflect a savings of more than \$232 000.

Discussion

This intervention has proven to be effective at reducing cardiovascular

disease risk factors as well as improving participants' quality of life. Particularly impressive are the results drawn from the PHQ-9 as shown through a reduction in

Table 2.

Changes in Number of Medications Taken by Participants Who Started With at Least One Medication.

Decrease in Number of Medications	n	%
0 (no change)	28	52.8
−1	18	34.0
−2	7	13.2

depressive symptoms by 60%, reclassifying the participants from mild depression to minimal depression. In addition, gastroesophageal reflux disease symptoms were reduced by 70.8%. These results are consistent with the findings found in our 6-week intervention.

Based on the outcomes from the 6- and 12-week interventions, we subsequently conducted 9-week and 6-month interventions to measure optimum intervention length in relation to outcomes, compliance, and adherence. Both of the subsequent interventions followed the same protocol with slight variations. The 6-month intervention included measuring body composition using a phase-sensitive multifrequency BIA (SECA Medical Body Composition Analyzer 514) and a dual X-ray absorptiometry (Hologic QDR-2000 plus, Hologic Inc, Waltham, MA) scan for a random selection of the study population. Additionally, participants recorded their food intake using electronic forms, utilizing REDCap.¹⁰ Data from these studies will be published elsewhere.

In review of the 4 interventions we have conducted so far, we must note that for ideal long-term glycemic control (ie, serum glucose, HbA1c, and TG), we recommend an increased emphasis on consuming low glycemic foods. Also, we recommend a longer period of time for measuring HbA1c. Additionally, the initial reduction in HDL is not a concern and is possibly because of a significant reduction in TC and LDL.¹¹ Surprisingly, physical activity has shown little influence on

outcomes of these interventions, suggesting the potency of this dietary approach. However, we continue to examine the specific role of physical activity in our lifestyle interventions as we do not want to minimize the importance of physical activity for general health.

At the conclusion of each of our intensive interventions, we have provided additional supporting activities including monthly meetings with education, food demos, and inspiration; CookWell Flagstaff—a once a week food demo focusing on breakfast, lunch, dinner, and dessert recipes; and have hosted a Forward Food training for food service personnel at NAU and NAH.

Future planning is in progress for developing a mNDPR intervention that is culturally relevant to Native American populations and a randomized control trial comparing the effectiveness of our mNDPR protocol to the standard Diabetes Prevention Program.

Our mNDPR interventions have proven to be effective at reducing chronic disease risk factors and improving employee well-being. Widespread worksite implementation of mNDPR interventions should be considered for increasing work productivity and the overall wellness of employees.

Authors' Note

This work was presented at Lifestyle Medicine 2017; Tucson, Arizona; October 22-25, 2017. For further information please consult the following website: www.prandiallab.com or contact the primary author.

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Declaration of Conflicting Interests

The author(s) declared the following potential conflicts of interest with respect to the research, authorship, and/or publication of this article: Joel Fuhrman, MD serves as President of the Nutritional Research Foundation.

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Ethical Approval

(6-week) IRB #691930-4
(12-week) IRB #977309-4

Informed Consent

Informed Consent was obtained for the interventions cited.

Trial Registration

Not applicable, because this article does not contain any clinical trials. **AJLM**

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