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Evaluation Of Yale New Haven Health System Employee Wellness Program

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Abstract

Objective: To assess the effectiveness of the Yale New Haven Health System (YNHHS) Employee Wellness Program.

Methods: A pre- and post- study design of wellness-enrolled employees from YNHHS was conducted. Biometric screening, Health Risk Assessment, one-on-one counseling and other wellness interventions were made available to 20,630 employees across the health system. There were 8,164 individuals who participated in both 2013 and 2014. Analysis was performed on the biometric measurement data obtained at initial screening in 2013 and follow up screening in 2014.

Results: Clinically and statistically significant improvements were seen after one year in biometric measures: BMI, systolic blood pressures (SBP), diastolic blood pressures (DBP), high-density lipoprotein (HDL), low-density lipoprotein (LDL), and triglyceride levels. Shifts from high-risk categories into intermediate and normal risk categories were seen for blood pressure measurements and HDL levels. Age was a significant predictor of negative changes in SBP, DBP, glucose (fasting and non-fasting), total cholesterol, LDL, and triglyceride levels. Gender significantly predicted improved change in SBP, DBP, HDL, and triglycerides levels. Marital status significantly predicted change in SBP and DBP. Race was a significant predictor of change in BMI, SBP, DBP, total cholesterol, and triglyceride levels. Job classification was a significant predictor of change in SBP, DBP, non-fasting glucose, and total cholesterol levels.

Conclusion: The Yale New Haven Health System Employee Wellness program significantly improved biometric markers of health.

Table Of Contents

Tables

Background

Healthcare reform by the Affordable Care Act (ACA) in the United States of America initiated a series of steps to improve the overall health and health behavior of the U.S. population. To address the growing prevalence of chronic diseases (e.g. hypertension, diabetes mellitus, obesity, cardiovascular disease, etc.), the ACA ensured basic preventive medical care and counseling for individuals in clinical settings, but also ensured that institutions would make efforts to promote better health based on evidence-based guidelines and protocols. Considering that a large proportion of the American population works, it is conceivable that time spent at the occupation has a great weight on daily activities affecting health.[1] With this in mind, Section 4303 of the Affordable Care Act of 2010 contained directives for employers to "adopt health promotion and risk reduction programs, also known as employee wellness programs," to reduce modifiable health risks. These noted risks contribute to employee absenteeism, reductions in productivity, and increased health care costs.[2] The Centers for Disease Control and Prevention's Community Guide Task Force performed a systematic review of such wellness programs and noted that well designed, multicomponent programs did "exert a positive influence on health behaviors, biometric measures, and financial outcomes important to employers."[3] Short et al., evaluated the Prudential Financial Inc.'s health promotion program and found "statistically significant decreases in total cholesterol, LDL, and triglycerides."[4] Considering these outcomes, wellness program initiatives such as the Surgeon General 's Vision for a Healthy and Fit Nation (program to address obesity) have proliferated, and Healthy People 2020 set objectives to increase employee health-promotion programs, nutrition/weight-management counseling, exercise programs, and availability of exercise facilities. As these programs gained popularity among large employers, expanding this concept to smaller business has been a keen interest, especially with the Prevention and Public Health Fund of the ACA providing $200 million in wellness grants for small businesses.[2] According to one study, the implementation of primary, secondary, and tertiary prevention in homes and workplaces may save up to “$1.1 trillion annually by 2023 and reducing cases of chronic disease by 40 million.”[5]

The expansion of wellness programs has been executed in a variety of ways. Presently, sets of recommended criteria and goals guide employers in formulating better-designed programs. Wellness programs should demonstrate that employees improve in their health and their heath behaviors (lose weight, stop smoking, eat healthier, increase in exercise, etc.), reduce medical claim cost, and have a positive return on investment (“return on investment, ROI, is a financial metric that calculates the amount of money gained or costs averted relative to the amount spent on any given investment”) through reductions in absenteeism and increases in productivity. Further benefits could be far reaching with time with potential reductions in workplace turnover and reduced costs of “disability insurance and Medicare.” [6] These goals would typically be accomplished with employee awareness of their baseline health via assessments, health education, modifying the social and physical workplace environments, and essentially integrating the program into the human resource and employee benefit infrastructure. [7-10]

Health Assessments include the use and/or the combination of health risk assessments (self-report survey of medical conditions and health behaviors) and biometric screenings (either self-reported or objectively measured body mass indexes, blood pressures, blood cholesterol and glucose levels, etc.) to establish baseline data and provide for longitudinal comparisons. Health education has been accomplished via health coaches, workplace health fairs/seminars, and online resources that provide counseling and management techniques for smoking cessation, weight management, exercise, stress relief, etc. Examples of social and physical workplace environment include workplace tobacco bans and healthier food options in cafeterias and/or vending machines. [8, 11] To be a truly successful program, incorporating participation and wellness culture should be shared between leadership and management, hopefully leading to positive influences on health behaviors, medication compliance, chronic disease prevention, improvements in biometric measures, "… appropriate utilization of health care services, (reducing) the probability of costly hospital admissions and emergency room visits", and avoiding/reducing the progression of individuals into worse health categories. [7, 12, 13]

Thus far, the current literature and evidence indicate that effectively designed wellness programs are promising and can ultimately reduce cardiovascular risk factors, especially if they capture health risk assessments and biometric measures.[8] Further, Bolnick et al estimated that the total healthcare expense per working adult was $3,534 and theoretically up to 20% of these direct costs could be eliminated if biometric values of modifiable health risk factors were reduced. Currently a wealth of literature shows wellness programs to be cost-effective (studies have their own associated strengths and weaknesses). Note-worthy within this body of evidence is the Baicker et al report that wellness programs can have "medical and absenteeism ROI amounting to $3.27 and $2.73, respectively, saved on every $1.00 invested over three years". Of the various programs cited in the literature, the Citibank Health Management program was noted to have a ROI of $4.50 in medical expenditures and other studies have demonstrated 25% lower medical and absenteeism expenditures amongst wellness program participants compared to nonparticipants. [3, 6-9, 12]

Although wellness program effectiveness is documented in multiple industries, there remains a limited evaluation of these programs in the healthcare workplace and their effects across job categories. The Berkshire Healthcare System Cardiovascular Health Risk Reduction Program is but one evaluation of wellness program outcomes in a hospital system. It evaluated CVD risk scores based on HRA and biometric data offered to over 3,000 hospital-based employees after health coaching interventions. It had reported clinically and statistically significant improvements in biometric measures, concluding improved cardiovascular health.

The purpose of our study was to evaluate the effectiveness of the multifaceted wellness initiative of the Yale New Haven Health System (YNHHS), specifically in the time frame when the program was opened to all employees of the network. The program has multiple components available to employees, but it primarily provided health coaching to participants based upon screening data. Further, we evaluated the wellness program's effects by occupational categories that have been narrowly reviewed in the literature.

Methods

Study Design and Population

We performed a Pre- and Post- Intervention Study of the YNHHS employee wellness program that was open to all its employees in 2013. Data measures for evaluation were collected at baseline in 2013 and again 1 year later in 2014. Of over 20,000 potential employees of YNHHS, the study population who enrolled into the wellness program during both years consisted of over 8,000 employees working across three hospitals, outpatient clinics, and research areas. The job locations include the acute care 1,541-bed primary teaching Yale New Haven Hospital, the 383-bed Bridgeport hospital, and the 206-bed Greenwich Hospital. Employees in the study population had various specific job titles that were grouped accordingly into job categories based on human resource classifications. Job categories were organized as follows:

- Administrative/Clerical—billing analysts, administrative positions, billing, registrars, clerks, schedulers, secretaries, coordinators, etc.
- Management—managers, directors, associate directors, executive directors, etc.
- Nursing—nurse practitioners, clinical nurses, all non-direct patient care nurses, nurse managers, clinical resource nurses, etc.
- Patient Care Support—medical assistants, patient care associates, nursing assistants, etc.
- Professional-Clinical—physicians, pharmacists, mental health professionals, physician assistants, occupational therapists, etc.

- Professional-Nonclinical—accountants, information technology specialists, executives, financial professionals, legal professionals, etc.
- Service Support Trade—food services, laundry, environmental services, maintenance, patient transporters, etc.
- Technical—support technician, surgical technician, clinical technician, radiology technician, lab technician, medical technician, patient care technician, etc.

The YNHHS wellness initiative was operated by a third party subcontractor that collected employee HRA and biometric data along with employee consents and confidentiality agreements. The program was not mandated for employees but was offered to employees on a voluntary enrollment basis. The initiative was communicated to the employees across the sites via newsletters, information tables, and staff meetings to raise awareness and invite self-referrals. Incentives to join the program included a $500 credit off the employer-based medical plan premiums for those enrolled in the YNHHS health plan. Prior to this specific program becoming available, YNHHS had instituted social and physical environment changes that include but not limited to: tobacco free zones, healthy food options, redesign of cafeterias and vending machines, onsite vaccinations, onsite fitness centers, employee assistance programs, and occupational health services.

Study Intervention

The YNHHS Wellness Initiative utilized employee health-screening data in combination with health coaches. Every employee who enrolled into the wellness initiative completed an online health risk assessment (HRA) profile. Aside from self-reported HRA, objective biometric measurements were taken that include blood pressure, height and weight (to calculate body mass index), fasting and non-fasting blood glucose levels, total cholesterol levels, high-density lipoprotein (HDL) levels, low-density lipoprotein (LDL) levels, and triglyceride levels. Study participants were grouped into categories of normal glucose level, impaired glucose level, and high glucose level based upon their fasting and/or non-fasting glucose level. We did not differentiate fasting status for lipid panel measures (Total Cholesterol, HDL, LDL, and Triglyceride) based on medical literature.[14]

Every employee who completed both HRA and Biometric measurements also met individually in person with a wellness health coach who reviewed and discussed the results of laboratory biometric measures. Discussions could include, but were not limited to, health areas for improvement, strategies to address specific health problems, health behaviors, medication and treatment adherence, and providing sources of primary care to those employees who did not have a primary medical provider at time of screening. Employees were also provided their results to share with their medical care providers. Each individual was given further information about the various multifaceted programs available, including follow up with in-person and/or telephone health coaches, smoking cessation, exercise tracking, participation in recommended screening exams (dermatological screening for skin cancers, colonoscopy), preventive dental visits, and chronic disease management.

Data

Baseline data on all employees across the YNHHS was obtained for baseline description of the workforce. The third party subcontractor handling the wellness initiative for YNHHS provided the data that included: demographic information (age, gender, marital status, race), job titles, and biometric measurements on the employees who enrolled since 2013 and followed up a year later for repeat screening and health coaching. HRA assessment information was not available for analysis at this time. Employee information was de-identified by this company prior to analysis. Biometric measurements were additionally grouped into categories to differentiate higher risk groups from lower ones. BMI (kg/m^2) was categorized into normal, overweight, and obese (<25, 25-29, and ≥30 respectively). Systolic blood pressure (mm Hg) was categorized into normal, pre-hypertensive, and high (<120, 120-139, and ≥140 respectively). Diastolic blood pressure (mm Hg) was categorized into normal, pre-hypertensive, and high (<80, 80-89, and ≥90 respectively). Glucose levels were categorized into normal, impaired, and high based upon participants providing fasting versus non-fasting blood glucose samples. Fasting Glucose levels categorized into normal, impaired, and high were based on the following blood glucose measures: <100, 100-125, ≥126, respectively. Non-fasting glucose levels categorized into normal, impaired and high were based on the following measures: <140, 140-199, ≥200, respectively. Total cholesterol (mg/dL) levels were categorized into normal, borderline high, and high (<200, 200-239, and ≥240 respectively). HDL levels (mg/dL) were categorized into low, intermediate, and normal (<40, 40-59, ≥60 respectively). LDL levels (mg/dL) were categorized into normal, intermediate, and high (<100, 100-159, ≥160 respectively). Triglyceride levels (mg/dL) were categorized into normal, intermediate, and high (<150, 150-199, ≥200 respectively).

Univariate analysis of the study population was performed through the calculation of frequency distributions, means, and mean changes. Comparisons of employee characteristics between all YNHHS employees and those who enrolled into the wellness initiative were conducted using the Chi Square test of association. Comparisons were also made between categorical biometric measures between years 2013 and 2014. Mean biometric changes between 2013 and 2014 data were calculated as a function of age, gender, marital status, and occupational category and were evaluated using the paired t-test statistic. Parsimonious modeling using backward elimination (where only significant variables are retained) was performed to determine predictors of biometric measure changes amongst the study population. Tests of significance were based on an alpha level of 0.05. Analysis was performed with the use of SAS version 9.3. Approval to perform this wellness initiative evaluation was approved by the Yale University Institutional Review Board.

Results

A description of baseline characteristics of all employees of YNHHS is represented in Table 1. 20,630 individuals work across the health system. The average age is 43 years, ranging from 18 to 91 years. Over 86% of employees are distributed almost evenly within the 10-year interval age groups of 20 to 60 years. Employees are primarily women (75.7%) and the majority of the population (86%) was enrolled into the YNHHS medical plan prior to the wellness initiative. 44.2% of them are grouped into the professional job category that include all nursing, clinical professionals, and non-clinical professionals. 60% of employees work at the Yale New Haven Hospital.

A description of the baseline 2013 characteristics of the employees who enrolled into the wellness initiative is represented in Table 2 with comparative demographic data as Table 1. Additional information on race, marital status, and having a primary care provider (PCP) was available on the wellness subjects and was included into Table 2. A total of 8,164 employees enrolled in the wellness program, representing a 39.6% participation rate. The average age of the study participants is 45 years, ranging from 23 to 89 years. Participants are primarily women (78.7%), similar to the baseline total YNHHS population. They are primary Caucasian (66.7%) followed by African Americans (17.5%). 37.5% of the study group are married and 22.5% are single, but 33% did not report on marital status. Interestingly, 97.2% of study participants were enrolled into the YNHHS medical plan prior to the wellness initiative. 42.1% of the study group employees fall within the large “professional” category. This group is further detailed with 24.9% of employees as nursing, 8.5% as clinical professionals, and 8.7% as non-clinical professionals. 19% work in administrative/clerical positions and 15.5% work in technical positions. Similar to the YNHHS baseline, the majority of wellness enrollees are from New Haven Hospital (54.8%).

Table 1
Description of All YNHSS Employees

	N=20630 Mean (Range)
Age (years)	43 (18-91)
	No. (%)
Age Group	
20-30	4799 (23.3)
31-40	4768 (23.1)
41-50	4494 (21.8)
51-60	4471 (21.7)
61-70	1913 (9.3)
>70	185 (0.9)
Gender	
Female	15626 (75.7)
Male	5004 (24.3)
Enrolled in YNHHS Medical Plan?	
Yes	17810 (86)
No	2820 (14)
Employment Location	
Bridgeport Hospital	2665 (12.9)
Greenwich Hospital	1803 (8.7)
Northeast Medical Group, Inc.	1611 (7.8)
Yale New Haven Health	2177 (10.6)
Yale New Haven Hospital	12374 (60)
Job Category	
Admin/Clerical	2877 (13.9)
Management	1114 (5.4)
Patient Care Support	1253 (6.1)
Professional*	9116 (44.2)
Service Support Trade	3775 (18.3)
Technical	2495 (12.1)

*Nurses and Professionals (clinical and non-clinical)

Table 2 Description of the Study Participants	N=8164 ŧ Mean (Range)
Age (years)	45 (23-89)
	No. (%)
Age Group	
20-30	1097 (13.0)
31-40	1685 (20.6)
41-50	1968 (24.1)
51-60	2356 (28.9)
61-70	1011 (12.4)
>70	48 (0.6)
Gender	
Female	6427 (78.7)
Male	1738 (21.3)
Race	
Asian	511 (6.3)
Black	1424 (17.5)
Caucasian	5421 (66.7)
Hispanic	659 (8.1)
Other	113 (1.4)
Marital Status	
Divorced/Separated	509 (6.2)
Married	3062 (37.5)
Missing	2693 (33.0)
Single	1838 (22.5)
Widowed	63 (0.8)
Have a Primary Care Provider?	
Yes	6549 (88.0)
No	892 (12.0)
Enrolled in YNHHS Medical Plan?	
Yes	7558 (97.2)
No	217 (2.8)
Employment Location	
Bridgeport Hospital	1122 (13.7)
Greenwich Hospital	753 (9.2)
Northeast Medical Group, Inc.	435 (5.3)
Yale New Haven Health	1381 (16.9)
Yale New Haven Hospital	4474 (54.8)
Job Category	
Admin/Clerical	1553 (19.0)
Management	685 (8.4)
Nursing*	2030 (24.9)

Patient Care Support	442 (5.4)
Professional-Clinical*	695 (8.5)
Professional-Non-Clinical*	710 (8.7)
Service Support Trade	783 (9.6)
Technical	1267 (15.5)
* Professionals	3435 (42.1)
ŧ Some items do not sum to 8164 because of missing data	

Table 3 provides a comparison of the descriptive statistics of the demographic categories between all YNHHS employees and the enrolled study participants. The mean ages between both groups demonstrated a difference that was statistically significant (p-value <0.001) based on t-test statistical analysis. Chi-square analysis of the demographic categories between both groups demonstrated statistically significant (p-value <0.0001) different distributions in all categories—age, gender, those already enrolled in the YNHHS medical plan, job location, and job categories. Noteworthy is the shift to higher participation into the wellness programs amongst older age categories between 51 and 70 years of age and comparatively less participation amongst the 20-30 year old age group. Compared to the baseline 86% of employees enrolled in the YNHHS health plan, 97% of the study participants were enrolled in the YNHHS medical plan. Wellness program participation was significantly more amongst the administrative/clerical, management, and technical trades compared to other job categories. The service support trade category demonstrated a lower percentage (9.6%) of participation compared to the total YNHHS employees within the same group (18.3%).

Table 3 Comparison between all YNHHS Employee Population and Study Participants	All YNHHS N=20630		Study Pop. N=8164ŧ				
	Mean	Range	Mean	Range	t-test	p-value	
Age (years)	43	18-91	45	23-89	-12.6	<0.0001	
	No.	%	No.	%	χ2	p-value	%*
Age Group					495.8	<0.0001	
20-30	4799	23.3	1097	13.0			23%
31-40	4768	23.1	1685	20.6			35%
41-50	4494	21.8	1968	24.1			44%
51-60	4471	21.7	2356	28.9			53%
61-70	1913	9.3	1011	12.4			53%
>70	185	0.9	48	0.6			26%
Gender					28.8	<0.0001	
Female	15626	75.7	6427	78.7			41%
Male	5004	24.3	1738	21.3			35%
Enrolled in YNHHS Medical Plan?					699.9	<0.0001	
Yes	17810	86	7558	97.2			42%
No	2820	14	217	2.8			8%
Employment Location					273.7	<0.0001	
Bridgeport Hospital	2665	12.9	1122	13.7			42%
Greenwich Hospital	1803	8.7	753	9.2			42%
Northeast Medical Group, Inc.	1611	7.8	435	5.3			27%
Yale New Haven Health	2177	10.6	1381	16.9			63%
Yale New Haven Hospital	12374	60.0	4474	54.8			36%
Job Category					524.7	<0.0001	
Admin/Clerical	2877	13.9	1553	19.0			54%
Management	1114	5.4	685	8.4			61%
Patient Care Support	1253	6.1	442	5.4			35%
Professional	9116	44.2	3435	42.1			38%
Service Support Trade	3775	18.3	783	9.6			21%
Technical	2495	12.1	1267	15.5			51%
ŧ Some items do not sum to 8164 because of missing data							
*Percentage of Study Population from All Baseline YNHHS Employees							

Table 4 displays the means of the biometric measurements taken in 2013 and 2014 of the participants. The distributions of the biometric measures were typically skewed due to extreme measurements: BMI of 75 kg/m^2, systolic blood pressure of 78-240 mm Hg, diastolic blood pressure of 33-120 mm Hg, fasting glucose level of 600 mg/dL, non-fasting glucose levels of 21-510 mg/dL, total cholesterol level of 400 mg/dL, HDL level of 3-173 mg/dL, LDL level of 7-256 mg/dL, and triglyceride level of 710 mg/dL. Information regarding clinical responses to some of the extreme blood test results was not available.

Table 4

Biometric Measures	Year			
N=8164	2013		2014	
Variable	Mean (SD)	Range	Mean (SD)	Range
Body Mass Index (kg/m2)	28 (6.5)	15-75	28 (6.4)	17-74
Systolic Blood Pressure (mm Hg)	121 (14.7)	78-240	119 (13.0)	80-220
Diastolic Blood Pressure (mm Hg)	77.9 (9.5)	33-120	75.7 (8.6)	35-120
Glucose				
Fasting Glucose (mg/dL)	90.6 (20)	53-341	92.4 (22.6)	53-600
Non-Fasting Glucose (mg/dL)	94 (27)	50-500	94.4 (25.1)	21-510
Total Cholesterol (mg/dL)	183 (35)	38-385	184 (39)	72-400
High-density Lipoprotein (mg/dL)	57 (17.5)	3-173	63.3 (19.3)	4-153
Low-density Lipoprotein (mg/dL)	103 (30)	7-256	98.5 (32.3)	14-256
Triglyceride (mg/dL)	121 (77)	23-710	119 (78.8)	20-222

Table 5 represents the calculated mean value changes for the biometric measurements with corresponding paired t-test statistics. Remarkably, the wellness intervention showed that the mean changes were all statistically significant (p-value less than alpha 0.05) except for the non-fasting glucose measure. Wellness participants after one year demonstrated a mean reduction in BMI by 0.12 kg/m^2 (SD=2.23), a mean reduction in systolic blood pressure by 2.37 mm Hg (SD=13.14), a mean reduction in diastolic blood pressure by 2.19 mm Hg (SD=9.48), a mean increase in HDL level by 5.99 mg/dL (SD=11.9), a mean reduction in LDL level by 5.8

mg/dL (SD=25.7), and a mean reduction in triglyceride level by 2.38 mg/dL (SD=72.3) (all of which are favorable improvements). However, they also demonstrated a mean increase in total cholesterol by 0.74 mg/dL (SD=30) and a mean increase in fasting glucose by 2.05 mg/dL (SD=19.5) after one year. The mean changes however do not specify movement between high risk to lower risk measures.

Table 5
Biometric Measure Change 2013-2014

Variable	Mean Change	SD	P-value
Body Mass Index (kg/m2)	-0.12	2.23	<0.0001
Systolic Blood Pressure (mm Hg)	-2.37	13.14	<0.0001
Diastolic Blood Pressure (mm Hg)	-2.19	9.48	<0.0001
Glucose			
Fasting Glucose (mg/dL)	2.05	19.5	<0.0001
Non Fasting Glucose (mg/dL)	0.58	25.6	0.193
Total Cholesterol (mg/dL)	0.74	30	0.0256
High-density Lipoprotein (mg/dL)	5.99	11.9	<0.0001
Low-density Lipoprotein (mg/dL)	-5.8	25.7	<0.0001
Triglyceride (mg/dL)	-2.38	72.3	0.0029

Table 6 represents biometric measurements of 2013 and 2014 into categories of significance. A third of the study participants in 2013 have a normal BMI, overweight BMI, and obese BMI with relatively similar distribution in the following year. Between 10-11% of the group had high measures of systolic and diastolic blood pressures in 2013, but notably had better controlled blood pressure the following year. Chi-square analysis was performed to determine if the categorical groups differed in their distribution between the years. Statistically significant (p-value less than alpha 0.05) shifts in category distribution occurred with the following biometric measures: systolic and diastolic blood pressures, total cholesterol, HDL, LDL, and triglycerides. Body mass index (normal, overweight, and obese) and blood glucose levels (normal, impaired, and high) did not reveal significant shifts in distribution. Based on Table 6, the significant shifts noted reveal a 40% reduction of high systolic blood pressure measurements from 2013 to 2014. There were also 50% reduction of high diastolic blood pressure measurements, 36% increase of high total cholesterol levels, 31% reduction of low HDL levels, 22% reduction in intermediate LDL levels.

Table 6
Biometric Categories

Variable	2013 No. (%)	2014 No. (%)	χ^2	p-value
Body Mass Index (kg/m2)			0.03	0.98
Optimal (<25)	2782 (34.5)	2784 (34.4)		
Overweight (25-29)	2603 (32.2)	2618 (32.4)		
Obese (≥30)	2689 (33.3)	2687 (33.2)		
Systolic Blood Pressure (mm Hg)			98.41	<0.0001
Normal (<120)	3609 (44.7)	3925 (48.1)		
Pre-Hypertensive (120-139)	3629 (45.0)	3737 (45.8)		
High (≥140)	835 (10.3)	500 (6.1)		
Diastolic Blood Pressure (mm Hg)			179.01	<0.0001
Normal (<80)	4397 (54.5)	4940 (60.5)		
Pre-Hypertensive (80-90)	2791 (34.6)	2780 (34.1)		
High (≥90)	885 (11.0)	442 (5.4)		
Glucose (mg/dL)*			3.33	0.19
Normal	7419 (90.9)	7371 (90.3)		
Impaired	561 (6.9)	620 (7.6)		
High	183 (2.2)	174 (2.1)		
Total Cholesterol (mg/dL)			29.65	<0.0001
Normal (<200)	5694 (69.7)	5518 (67.6)		
Borderline High (200-239)	1975 (24.2)	1976 (24.2)		
High (≥240)	494 (6.1)	671 (8.2)		
High-density Lipoprotein (mg/dL)			246	<0.0001
Normal (≥60)	3339 (41.0)	4316 (52.9)		
Intermediate (40-59)	3604 (44.2)	3023 (37.0)		
Low (<40)	1204 (14.8)	826 (10.1)		
Low-density Lipoprotein (mg/dL)			71.31	<0.0001
Normal (<100)	3557 (47.5)	3714 (54.3)		
Intermediate (100-159)	3635 (48.5)	2842 (41.6)		
High (≥160)	300 (4)	281 (4.1)		
Triglyceride (mg/dL)			7.41	0.02
Normal (<150)	6145 (75.3)	6203 (76.0)		
Intermediate (150-199)	1043 (12.8)	936 (11.5)		
High (≥200)	974 (11.9)	1026 (12.5)		

*Includes Fasting Glucose levels (normal<100, impaired 100-125, high ≥126)
*Includes Non-Fasting Glucose levels (normal<140, impaired 140-199, high ≥200)

Tables 7A through 7I represent parsimonious modeling to determine predictors of biometric measure changes amongst the study population. After backward deletion of non-significant independent variables, only significant variables were left and represented in the tables. The independent variables used include: age, gender, race, and marital status, having a PCP, and job classification/category.

In Table 7A, the statistically significant predictor of mean changes in BMI values was race (p = 0.0002). Of note, being African American predicted an increase of 0.3 kg/m^2 in BMI after 1 year in the wellness initiative compared to the Caucasian race (used as the reference group). Asian race predicted a decrease of .03 kg/m^2 in BMI; Hispanic race predicted an increase of 0.13 kg/m^2 in BMI; and other race predicted a decrease of 0.09 kg/m^2 in BMI.

In Table 7B, the statistically significant predictors of mean changes in systolic blood pressure values were age (p <0.0001), gender (p <0.0001), marital status (p <0.0001), race (p <0.0001), and job classification (p<0.0001). Each increase in age (years) predicted an increase of 0.1459 mm Hg in systolic blood pressure; female gender predicted a decrease of 3.6 mm Hg in systolic blood pressure compared to males (reference group); working in patient care support predicted a decrease of 1.2 mm Hg in systolic blood pressure compared to administration/clerical (reference group); working as a clinical professional predicted an increase of 1.4 mm Hg in systolic blood pressure.

Table 7A Parsimonious Model		**BMI**			
Parameter	Level	F Value	Pr > F	parameter estimate	Pr > |t|
Initial value	per unit	408.97	<.0001	-0.0801	<.0001
Age	per year				
Gender	Female				
Marital Status	Divorced/Separated				
	Married				
	Missing				
	Widowed				
	Single				
Primary Care Physician	No				
Race	Asian	5.49	0.0002	-0.0285	0.7820
	Black			0.3030	<0001
	Hispanic			0.1303	0.1542
	Other			-0.0922	0.6599
	Caucasian			0 (Ref)	-
Job Classification	Management				
	Nursing				
	Patient Care Support				
	Professional-Clinical				
	Professional-Nonclinical				
	Service Support Trade				
	Technical				
	Administration/Clerical				

In Table 7C, the statistically significant predictors of mean changes in diastolic blood pressure values were age (p <0.0001), gender (p <0.0001), marital status (p = 0.002), having a PCP (p = 0.0244), race (p <0.0001), and job classification (p = 0.042). Each increase in age (years) predicted an increase of 0.05 mm Hg in blood pressure; female gender predicted a decrease of 2.7 mm Hg in diastolic blood pressure; being of the black race predicted an increase of 1.9 mm Hg in diastolic blood pressure; working in management predicted an increase of 0.86 mm Hg in diastolic blood pressure.

Table 7B Parsimonious Model		**Systolic Blood Pressure**			
Parameter	Level	F Value	Pr > F	parameter estimate	Pr > |t|
Initial value	per unit	4069.01	<.0001	-0.5794	<.0001
Age	per year	157.31	<.0001	0.1459	<.0001
Gender	Female	120.76	<.0001	-3.5858	<.0001
Marital Status	Divorced/Separated	4.73	0.0008	0.0929	0.9495
	Married			-1.1098	0.4278
	Missing			0.0657	0.9627
	Widowed			-0.0847	0.9525
	Single			0 (Ref)	-
Primary Care Physician	No				
Race	Asian	14.39	<.0001	-1.3943	0.2133
	Black			1.9705	0.0609
	Hispanic			-0.5361	0.6002
	Other			0.1891	0.8627
	Caucasian			0 (Ref)	-
Job Classification	Management	5.52	<.0001	0.6975	0.0987
	Nursing			-0.2493	0.6368
	Patient Care Support			-1.2154	0.0028
	Professional-Clinical			1.3781	0.0273
	Professional-Nonclinical			-0.9798	0.0637
	Service Support Trade			-0.4854	0.3479
	Technical			0.5274	0.3044
	Administration/Clerical			0 (Ref)	-

In Table 7D, the statistically significant predictor of mean changes in fasting glucose values was age (p = 0.0009). Each increase in age (years) predicted an increase of 0.12 mg/dL in fasting glucose.

In Table 7E, the statistically significant predictors of mean changes in non-fasting glucose values were age (p <0.0001) and job classification (p = 0.0075). Each increase in age (years) predicted an increase of 0.16 mg/dL in non-fasting glucose. Working in the technical category predicted an increase of 3.58 mg/dL in non-fasting glucose.

Table 7C Parsimonious Model		**Diastolic Blood Pressure**			
Parameter	Level	F Value	Pr > F	parameter estimate	Pr > |t|
Initial value	per unit	4193.68	<.0001	-0.6265	<.0001
Age	per year	42.20	<.0001	0.0540	<.0001
Gender	Female	134.18	<.0001	-2.6805	<.0001
Marital Status	Divorced/Separated	4.23	0.0020	1.6282	0.1254
	Married			0.6724	0.5071
	Missing			1.4267	0.1612
	Widowed			0.8883	0.3881
	Single			0 (Ref)	-
Primary Care Physician	No	5.07	0.0244	-0.6346	0.0244
Race	Asian	15.34	<.0001	-0.1121	0.8902
	Black			1.8823	0.0134
	Hispanic			-0.0795	0.9145
	Other			0.6154	0.4374
	Caucasian			0 (Ref)	-
Job Classification	Management	2.96	0.0042	0.8605	0.0050
	Nursing			0.4693	0.2193
	Patient Care Support			-0.1882	0.5221
	Professional-Clinical			0.4784	0.2898
	Professional-Nonclinical			-0.3753	0.3269
	Service Support Trade			-0.0583	0.8762
	Technical			-0.0141	0.9697
	Administration/Clerical			0 (Ref)	-

In Table 7F, the statistically significant predictors of mean changes in total cholesterol values were age (p <0.0001), gender (p <0.0001), race (p = 0.0014), and job classification (p = 0.0496). Each increase in age (years) predicted an increase of 0.19 mg/dL in total cholesterol.

Female gender predicted an increase of 6.5 mg/dL in total cholesterol; working in nursing predicted an increase of 3.5 mg/dL in total cholesterol.

Table 7D Parsimonious Model		**Fasting Glucose**			
Parameter	Level	F Value	Pr > F	parameter estimate	Pr > |t|
Initial value	per unit	187.23	<>0001	-0.3104	<.0001
Age	per year	11.13	0.0009	0.1216	0.0009
Gender	Female				
Marital Status	Divorced/Separated				
	Married				
	Missing				
	Widowed				
	Single				
Primary Care Physician	No				
Race	Asian				
	Black				
	Hispanic				
	Other				
	Caucasian				
Job Classification	Management				
	Nursing				
	Patient Care Support				
	Professional-Clinical				
	Professional-Nonclinical				
	Service Support Trade				
	Technical				
	Administration/Clerical				

In Table 7G, the statistically significant predictor of mean changes in HDL values was gender (p <0.0001). Female gender predicted an increase of 4.3 mg/dL in HDL.

In Table 7H, the statistically significant predictor of mean changes in LDL values was age (p <0.0001). Each increase in age (years) predicted an increase of 0.15 mg/dL in LDL.

Table 7E Parsimonious Model		**Non-fasting Glucose**			
Parameter	Level	F Value	Pr > F	parameter estimate	Pr > |t|
Initial value	per unit	1327.05	<.0001	-0.5885	<.0001
Age	per year	20.78	<.0001	0.1593	<.0001
Gender	Female				
Marital Status	Divorced/Separated				
	Married				
	Missing				
	Widowed				
	Single				
Primary Care Physician	No				
Race	Asian				
	Black				
	Hispanic				
	Other				
	Caucasian				
Job Classification	Management	2.75	0.0075	-1.0043	0.5109
	Nursing			-2.7545	0.1453
	Patient Care Support			-2.2027	0.0854
	Professional-Clinical			1.2805	0.5334
	Professional-Nonclinical			-1.5751	0.3760
	Service Support Trade			-0.1164	0.9517
	Technical			3.5756	0.0293
	Administration/Clerical			0 (Ref)	-

In Table 7I, the statistically significant predictors of mean changes in Triglycerides values were age (p = 0.001), gender (p <0.0001), and race (p <0.0001). Each increase in age (years) predicted an increase of 0.2 mg/dL in triglycerides; female gender predicted a decrease of 12 mg/dL in triglycerides; being of the Asian race predicted an increase of 18.3 mg/dL in triglycerides; other race predicted an increase of 15.6 mg/dL in triglycerides.

Table 7F **Parsimonious Model**		**Total Cholesterol**			
Parameter	Level	F Value	Pr > F	parameter estimate	Pr > |t|
Initial value	per unit	785.37	<.0001	-0.2765	<.0001
Age	per year	43.64	<.0001	0.1943	<.0001
Gender	Female	58.08	<.0001	6.5403	<.0001
Marital Status	Divorced/Separated Married Missing Widowed Single				
Primary Care Physician	No				
Race	Asian	4.43	0.0014	-0.9944	0.7444
	Black			-4.4679	0.1191
	Hispanic			-0.6218	0.8236
	Other			-0.6869	0.8179
	Caucasian			0 (Ref)	-
Job Classification	Management	2.01	0.0496	0.7838	0.4951
	Nursing			3.5371	0.0135
	Patient Care Support			0.1837	0.8680
	Professional-Clinical			-1.1398	0.5029
	Professional-Nonclinical			1.8883	0.1894
	Service Support Trade			-1.5131	0.2821
	Technical			1.2820	0.3573
	Administration/Clerical			0 (Ref)	-

Table 7G Parsimonious Model		**HDL**			
Parameter	Level	F Value	Pr > F	parameter estimate	Pr > |t|
Initial value	per unit	286.38	<.0001	-0.1385	<.0001
Age	per year				
Gender	Female	160.63	<.0001	4.3364	<.0001
Marital Status	Divorced/Separated Married Missing Widowed Single				
Primary Care Physician	No				
Race	Asian Black Hispanic Other Caucasian				
Job Classification	Management Nursing Patient Care Support Professional-Clinical Professional-Nonclinical Service Support Trade Technical Administration/Clerical				

Table 7H Parsimonious Model		**LDL**			
Parameter	Level	F Value	Pr > F	parameter estimate	Pr > |t|
Initial value	per unit	846.42	<.0001	-0.3108	<.0001
Age	per year	31.90	<.0001	0.1539	<.0001
Gender	Female				
Marital Status	Divorced/Separated Married Missing Widowed Single				
Primary Care Physician	No				
Race	Asian Black Hispanic Other Caucasian				
Job Classification	Management Nursing Patient Care Support Professional-Clinical Professional-Nonclinical Service Support Trade Technical Administration/Clerical				

Table 7I Parsimonious Model		**Triglycerides**			
Parameter	Level	F Value	Pr > F	parameter estimate	Pr > |t|
Initial value	per unit	2256.89	<.0001	-0.4445	<.0001
Age	per year	10.93	0.0010	0.2001	0.0010
Gender	Female	46.58	<.0001	-11.9605	<.0001
Marital Status	Divorced/Separated Married Missing Widowed Single				
Primary Care Physician	No				
Race	Asian Black Hispanic Other Caucasian	5.99	<.0001	18.3216 5.5377 10.4132 15.6428 0 (Ref)	0.0051 0.3676 0.0821 0.0146 -
Job Classification	Management Nursing Patient Care Support Professional-Clinical Professional-Nonclinical Service Support Trade Technical Administration/Clerical				

Discussion

This study evaluated the effectiveness of the ongoing Yale New Haven Health System wellness initiative that started in 2013. The initiative aimed to promote various components of health for employees, measuring progress through recorded biometric markers. Individual participants enrolled in the program completed online health risk assessments and had objective biometric measurements taken. Health coaches met with the participants individually and provided recommendations regarding health-promoting strategies, goals, etc. after reviewing the screening data. Biometric measurements were repeated a year later.

Of the 20,630 YNHHS employees, 8,164 enrolled into the initiative during both years, marking a significant 39.6% participation rate. Compared to all employees, many of study participants (97.2%) were enrolled into the YNHHS medical plan prior to wellness enrollment, likely explained by being incentivized by the $500 credit off medical plan premiums. It is noted that the distribution of participants by age group compared to all of YNHHS employees shifts towards the older age groups. This may be attributable to older individuals having more diagnosed medical conditions, taking medications, and/or being more engaged with maintaining/improving their health compared to individuals in the 20-30 year age group. A large proportion of the health system's employees and study participants were female, comparable to other health systems.[15] Considering that Yale New Haven Hospital is the largest of the hospitals in the health system, it would be natural that a higher proportion of study participants are employed there. It is interesting to note that although there were good participation rates across most job categories, the service support trades (made up of food services, laundry, environmental services, maintenance, patient transporters, etc.) had lower participation for unknown reasons. Possibilities include lack of knowledge or awareness, disinterest, conflicts with shift work times, etc. However, this study was not designed to address reasons why individuals did not enroll into the program.

Biometric measures and their mean changes provided us insight into the descriptions of health of our study population and the overall effect of the wellness program. Biometric measures alone limited us from knowing baseline prevalence of health conditions across the group. HRA data was not available for our analysis to determine medication use, dietary patterns, exercise routines, smoking status, or other health behaviors. Despite this, we can still conclude that there were statistically significant generalized improvements in biometric measures after only one year of program enrollment and notable shifts of people from higher risk categories into intermediate/normal categories. It was successful in reducing rates of high blood pressures and high-risk cholesterol (HDL and LDL) levels. These improvements may be due to increased health awareness, increased participation in exercise activities, and/or better diet. Considering medical diagnoses were not evaluated at this time, it is possible that the recommendations from the health coaches enabled participants to cooperate with their primary care providers—improving their own medication adherence or increasing participation into primary preventive strategies. This may explain the reductions of high-risk groups from year one to year two. Also notable from the study is that job classification can be a significant predictor of biometric marker change, especially for blood pressure and total cholesterol. Other studies have noted that occupational class may be associated with various health conditions (i.e. obesity) but information is limited regarding associations between occupational category and improvements in other biometric markers.

Since prevalence rates were not examined in this study, it is worthwhile to compare the general health of the U.S. population with the YNHHS study participants based on review of the National Health and Nutrition Examination Survey (NHANES) data from 2009 to 2012. Approximately 65% of the study group is overweight or obese, similar to the 69% of US adults who are overweight or obese. 32.6% of US adults have diagnosed hypertension. With this in mind, it is likely that a third of the study group may have hypertension and that the wellness initiative consequently improved health behaviors like medication compliance as reflected by the reductions in mean blood pressures and high-BP categorical groups. As demonstrated in Table 6, 10-11% of the study participants had hypertensive range blood pressures in 2013, with reductions to 5-6% of individuals the following year. The NHANES study also noted that declines in cholesterol levels may "reflect greater uptake of cholesterol-lowering medications rather than changes in dietary patterns". This may explain the improvements seen in the wellness study group. Compared to the NHANES study, the study group had lower mean LDL cholesterol levels (103 mg/dL in 2013 and 98.5 mg/dL in 2014) than American adults (NHANES—115.8 mg/dL). The study group had better mean HDL cholesterol levels (57 mg/dL in 2013 and 63.3 mg/dL in 2014) than American adults (NHANES—52.9 mg/dL). The study group also had lower percentages of adults with high triglyceride levels (approximately 12%) than American adults (NHANES—25%).[16] This could be attributed to healthier individuals enrolling into a wellness program at baseline.

The literature was limited in evaluations of wellness programs across health systems, but the Berkshire Health System Evaluation Wellness Program was comparable to ours. The Berkshire Health System program also collected HRA data and cardiovascular biometrics and stratified participants into cardiovascular risk categories. Participants similarly met with health coaches (nurses) who reviewed the screening data and provided recommendations. Follow up of HRA and biometric measures occurred over an average of three years (2005-2007). They did not have a control group and did not analyze cost effectiveness but noted improvements in biometric measurements, specifically in prevalence of total cholesterol and non-HDL cholesterol between screenings. Their participation rate from their health system was 16% and included a study group size of 496 employees. Job categories were not evaluated. The YNHHS study group size was much larger and with higher rates of participation. However, in this study we did not access HRA data and could not risk stratify individuals into cardiovascular risk groups in a fashion similar to the Berkshire study. Both the Berkshire and the YNHHS studies reflect the beneficial effects and “impacts of an initial and follow up screening” with integrated health coaching.[15]

This study of the wellness initiative of YNHHS had several strengths. It had a significantly large study population and high participation rate to reflect the total health system’s employee population. Compared to other wellness programs, this study had access to health biometric measurements that were objectively collected rather than relying on self-reported measures (such as BMI).[2, 17] This was a longitudinal study that provided depth of analysis compared to only a cross-sectional study. It was also similar in study design (pre- and post-) in evaluating the effectiveness of wellness programs as described in the literature.[6] Further, the literature is relatively limited in evaluations of wellness programs in health care systems and so this study would add to this narrow workplace sub-group amongst the currently expanding wellness programs across all industries. This study further detailed and analyzed the data based upon job categories (specific classifications), which has been uncommon in the wellness literature.

This study did have limitations. It did not provide us with the data linked to the health risk assessments, preventing access to information like smoking status, medical condition prevalence (hypertension, diabetes mellitus, hyperlipidemia, metabolic syndrome, etc.), health behaviors, and those participants currently on medications. It did not track nutritional and activity levels, and medication compliance. Considering the large proportion of females in the study, pregnancy status was unavailable—since biometric measurements would be affected by such a state. The study time period was a short duration (1 year outcome), which may or may not predict longer lasting health improvements. [5] Consistent with other studies evaluating wellness initiatives, this study lacked a control group.[4, 8] With the added financial incentives and higher participation rate of medical plan enrollees into the wellness program, participation and selection bias (healthiest employees more likely to enroll in voluntary wellness programs suggesting that the programs are improving health more than they really are) is another limitation of this study.[5, 6] We lacked descriptions and reasons for the employees who did not enroll into the wellness program. We did not have access to information regarding what the health coaches specifically discussed with study participants, what options were available for health coaches to use with study participants, or background information on the number of health coaches available and their own specific qualifications. We did not have data on whether participants engaged the health coaches more than once in a given year. Aside from the health coaches, participation information and rates of engagement with other health promoting options (tobacco cessation, fitness programs, etc.) were unavailable. Further, we did not have information regarding how many participants engaged with their primary physicians regarding biometric data.

Further research of the YNHHS wellness initiative should incorporate the screening HRA data. This may in turn enable examination of cardiovascular risk groups (via Framingham or other American Heart Association Cardiovascular Health Metrics). Other study designs may also evaluate the flow of employees from risk stratification groups compared to natural flow models. Comparisons with control groups are also warranted since they would provide stronger evidence. In addition to the clinical outcomes, future cost-effectiveness analysis would be likely as seen in the literature.[8]

Conclusion

This study assessed the effectiveness of the Yale New Haven Health System wellness initiative at improving biometric measures. The program was designed to screen employees through HRA and biometric measurements and promote health through individualized interactions with health coaches. Biometric measurements as a function of demographic and job categories demonstrated significant overall improvement from initial screening to follow up screening a year later. Improving shifts from higher risk categories into intermediate/normal risk categories were also seen amongst the employees enrolled.

References

1. Ball, K. and D. Crawford, *Socioeconomic status and weight change in adults: a review.* Soc Sci Med, 2005. **60**(9): p. 1987-2010.
2. Bonauto, D.K., D. Lu, and Z.J. Fan, *Obesity prevalence by occupation in Washington State, Behavioral Risk Factor Surveillance System.* Prev Chronic Dis, 2014. **11**: p. 130219.
3. Goetzel, R.Z., et al., *Ten modifiable health risk factors are linked to more than one-fifth of employer-employee health care spending.* Health Aff (Millwood), 2012. **31**(11): p. 2474-84.
4. Short, M.E., et al., *Measuring changes in lipid and blood glucose values in the health and wellness program of Prudential Financial, Inc.* J Occup Environ Med, 2010. **52**(8): p. 797-806.
5. Loeppke, R., D.W. Edington, and S. Beg, *Impact of the prevention plan on employee health risk reduction.* Popul Health Manag, 2010. **13**(5): p. 275-84.
6. Baicker, K., D. Cutler, and Z. Song, *Workplace wellness programs can generate savings.* Health Aff (Millwood), 2010. **29**(2): p. 304-11.
7. Goetzel, R.Z., et al., *Do workplace health promotion (wellness) programs work?* J Occup Environ Med, 2014. **56**(9): p. 927-34.
8. Arena, R., et al., *The role of worksite health screening: a policy statement from the American Heart Association.* Circulation, 2014. **130**(8): p. 719-34.
9. Fonarow, G.C., et al., *Workplace wellness recognition for optimizing workplace health: a presidential advisory from the American Heart Association.* Circulation, 2015. **131**(20): p. e480-97.
10. Mattke, S., et al., *Workplace wellness programs study : final report*. 2013, Santa Monica, CA: Rand. xxviii, 137p.
11. *Biometric health screening for employers: consensus statement of the health enhancement research organization, American College of Occupational and Environmental Medicine, and care continuum alliance.* J Occup Environ Med, 2013. **55**(10): p. 1244-51.
12. Tryon, K., et al., *Making the workplace a more effective site for prevention of noncommunicable diseases in adults.* J Occup Environ Med, 2014. **56**(11): p. 1137-44.
13. Hochart, C. and M. Lang, *Impact of a comprehensive worksite wellness program on health risk, utilization, and health care costs.* Popul Health Manag, 2011. **14**(3): p. 111-6.
14. Sidhu, D. and C. Naugler, *Fasting time and lipid levels in a community-based population: a cross-sectional study.* Arch Intern Med, 2012. **172**(22): p. 1707-10.
15. Merrill, R.M., et al., *Efficacy of the Berkshire Health System Cardiovascular Health Risk Reduction Program.* J Occup Environ Med, 2009. **51**(9): p. 1024-31.
16. Mozaffarian, D., et al., *Heart disease and stroke statistics--2015 update: a report from the American Heart Association.* Circulation, 2015. **131**(4): p. e29-322.
17. Goetzel, R.Z., et al., *A multi-worksite analysis of the relationships among body mass index, medical utilization, and worker productivity.* J Occup Environ Med, 2010. **52 Suppl 1**: p. S52-8.