Title

Private Health Insurance Sponsored Wellness Programs: Examining Participation in the Healthy Lifestyle Rewards Financial Incentives Program on Health Care Costs, Utilization, and Risk Behaviors

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Publication Date

2010

Peer reviewed|Thesis/dissertation

Private Health Insurance Sponsored Wellness Programs: Examining Participation in the Healthy Lifestyle Rewards Financial Incentives Program on Health Care Costs, Utilization, and Risk Behaviors

By

Zoë Kimberly Harris

A dissertation submitted in satisfaction of the requirements for the degree of

Doctor of Philosophy

in

Health Services & Policy Analysis

in the

Graduate Division

of the

University of California, Berkeley

Committee:

Professor Helen A. Halpin, Chair
Professor Thomas Rundall
Professor Sophia Rabe-Hesketh

Spring 2010

Abstract

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In theory, workplace wellness programs offer an important public health and policy opportunity to improve the health of the working population, encourage prevention, and lower the cost of healthcare. However, the success of these programs is highly dependent on the level of participation, the effect on health claims costs, on medical utilization, and the resulting decrease in health risk behaviors as a result of participation in the program.

This three-paper dissertation evaluates a workplace wellness program in California that uses a financial incentive to recruit people to participate. The study is a two-year observational cohort study utilizing data provided by Blue Shield of California Health Insurance Plan from their Healthy Lifestyle Rewards (HLR) program. Demographic, claims, and medical utilization data from a subset of 8,003 participants in 2006 and 2007 are compared with a control group of non-participants. Program exposure and Wellness Assessment survey data is available for a subset of the participating population.

Paper 1 evaluates the determinants of employee participation and retention in the program from 2006 to 2007. The analysis finds that lower-income and high-risk employees have greater odds of participating in HLR as compared to high-income employees. Participation in HLR is significantly related to medication usage for two chronic conditions: high cholesterol, and depression.

Paper 2 evaluates the effect of participating in HLR on health care utilization and medical claims. The results find that participation in HLR in 2006 was associated with significant declines in all measures of outpatient utilization (including non-institutional physician and non-physician claims, and physician visits) in the following year. There were no significant effects on claims spending for cholesterol and depression medications, or in utilization in the categories of emergency department visits, and inpatient admissions.

HLR may serve as a substitute for some forms of outpatient physician and non-physician care, most likely acting as an informational resource.

Paper 3 evaluates the impact of participating in HLR on modifiable health risks. The results find that the use of specific HLR help modules is associated with a significant improvement in many biometric and health risk factors. Participants in HLR exercised more frequently, consistently ate more fruits and vegetables, and reported lower stress levels.

Overall, it is found that HLR reduces health care expenditures and decreases medical utilization without a detectable effect of negative health behaviors or increased health risks. These findings suggest that promoting workplace wellness programs may be a promising component of comprehensive health care reform.

Table of Contents

Acknowledgements

This dissertation would not have materialized without the early support of Chuck Larsen at Blue Shield of California. In addition, Vicki Harrison and her HLR project team aided me in countless ways through answering questions and assisting with data collection.

I thank Dion Shimatsu-Ong for her unwavering commitment to the success of doctoral students in the HSPA program, and Todd LaPorte, for his exemplary teaching on matters related to public organizations and Paris.

I gratefully acknowledge Professor Helen Halpin for her advice, supervision and support on not only this dissertation, but throughout my entire career at Berkeley. I am fortunate to have an outstanding committee of Professors whose comments and suggestions have greatly enhanced this dissertation. For their contributions, I thank Professors Joan Bloom, Sophia Rabe-Hesketh, and Thomas Rundall.

Paper 1

Determinants of Employee Participation and Retention in the Healthy Lifestyle Rewards (HLR) Worksite Wellness Program

Abstract

Objectives: This paper describes an online workplace wellness program that uses a financial incentive to recruit people to participate in the program. Little is formally known about the characteristics of individuals who participate in online wellness programs, and maintain participation for a sustained period of time.

Population: A cohort of 1,547,447 individuals who had an opportunity to participate in Healthy Lifestyle Rewards (HLR) in 2006 and 2007, as offered by Blue Shield of California (BSC,) is analyzed to determine the characteristics associated with participation. A subset of 8,889 participating individuals in 2006 who were eligible to participate again in 2007 is included in the analysis to analyze retention.

Study: This is a two-year (2006 and 2007) observational cohort study, with two distinct analytical models. The unconditional participation predicts the odds of joining HLR in 2007, regardless of any prior participation. The conditional model analyzes individuals who were participants in 2006, and observes factors associated with subsequent year (2007) participation / retention. The principal endpoints include participation (registration), and participation for more than 12 weeks.

Methods: Logistic regression was used for both the unconditional and conditional models. An exact matching technique was used for the unconditional model. Adjusted odds ratios and 95% confidence intervals were estimated to assess statistically significant differences.

Results: This paper found two distinct empirical patterns concluding that participation is significantly associated with certain characteristics. In the unconditional participation model, factors associated include having a low income, and positive spending for cholesterol and depression medications. Additional models assessing intense participation for 12 weeks or more confirmed the prior results, with participation associated with higher odds of ER admissions, and positive spending on depression medication and behavioral visits. In the conditional participation model, factors significantly associated with retention in HLR include female gender, age categories 40-49 and 50-59, participants who had a greater number of physician visits, total expenditures in 2006, and those in the CalPERS employer group. With respect to program utilization, participants who had a greater level of exposure to the HLR program in 2006 (measured by number of times they logged into the online website), and who used the weight loss management tools in the HLR program had the highest odds of remaining in the program after one year.

Conclusions: The results of this analysis find that in both the conditional and unconditional participation models, low-income and higher-risk employees have greater odds of participating in HLR as compared to high-income employees. The rationale may be that low-income individuals have less access to wellness programs outside of work, and are therefore more likely to participate. In addition, the economic incentive for participating may also be more meaningful to low income populations. If program designers can anticipate the characteristics of participating populations, and distinguish which populations are more likely to join and sustain participation, programs and incentives can be better tailored to meet participant needs.

Introduction

This paper describes an online workplace wellness program, Healthy Lifestyle Rewards (HLR), which uses a financial incentive to recruit eligible individuals to participate. Little is formally known about who is likely to participate in a worksite wellness program, or about the type of individuals that sustain their participation. However, a key policy challenge facing voluntary workplace wellness programs is recruiting individuals to participate for a sufficient amount of time so that program exposure is sufficient to result in behavioral change. Participation has consequences for both program justification and for the longer-term impact of the wellness intervention. Even if a wellness program is effective, a low participation rate will result in a minimal overall effect. Therefore, one of the key elements to the success of any wellness program is to determine what type of individual is likely to participate and remain in the program.

The goal of this research is to examine factors that affect 2006 and 2007 participation in Blue Shield of California's (BSC) Healthy Lifestyle Rewards (HLR) Web-Based Wellness Program, and to explore the characteristics of individuals, and the CalPERS employer plan, that tend to voluntarily participate in such a program for more than one year.

This study address two research questions regarding participation using distinct analytical models:

> *Research Question 1: What individual-level factors (demographic and medical claims, health risks) are associated with the decision of an individual to voluntarily participate in the HLR program that offers a financial incentive in 2007 regardless of prior participation?*
>
> *Research Question 2: What individual-level factors (demographic and medical claims, health risks, biometric measures, program exposure) are associated with the decision of an individual to maintain participation in the HLR program in 2007, conditional on their participation in the previous year, 2006?*

As the Healthy Lifestyle Rewards Program is a web-based program, the previous literature has not yet been fully developed with regards to addressing the factors that influence participation, which could ultimately lead to the success of workplace wellness programs.

Wellness Program Participation: Current Evidence

Low participation rates in wellness programs are not a new problem. A vast body of literature has commented on many aspects of participation including recruitment, program adherence, and drop out rates (Anderson 2007; Chapman 2005; Fielding 1990;

Fielding 1984; Goetzel 2008; Goetzel 2002; Harris 2009; Lovato 1990; Linnan et al. 2004; Lynch 1999; Mossberger 2007; Klesges 1988; Thompson 1995). While participation in workplace wellness programs has historically been low, the literature as a whole has yielded inconsistent conclusions with significant differences between participants and non-participants. Participation rates in workplace programs vary from 20-40% for on-site programs, and 10-25% for programs offered outside the workplace (Fielding 1984). Although commentary exists, inconclusive evidence-based data on participation in a *web-based* program is not fully explored, making this study novel in its approach to measuring factors that are predictive of web-based participation.

Consistent with the existing literature on participation rates for workplace wellness programs, in an independent assessment, the Blue Shield Analytics team reported variable enrollment rates for all eligible Healthy Lifestyle Reward program participants, ranging from 2-50%, with 20-40% of these participants earning monetary rewards for their participation (indicating they participated for more than 12 weeks) (BSC 2008 referencing the Analytics Report New Product Development; Miavita 4Q2004 Activity Report 2005). Briefly, each HLR participant receives $50 for registering for the program and completing an on-line Wellness Assessment, and an additional $50 for every 12 weeks of program involvement (defined as logging into the HLR website at least one time per week and completing an interactive prevention activity or information session), for a maximum of $200 per year (BSC 2008).

In general, studies have identified several categories of correlates that tend to predict participation and maintenance (retention) in wellness programs. These variables include demographic and socioeconomic characteristics (e.g., age, gender, income, education), theoretically based self-motivational characteristics, health status measures, and rewards and penalties (social or monetary) associated with participation. With respect to differences in participation by age and gender, numerous studies in the literature have found that females, and younger individuals (18-45 years) are significantly more likely to participate in a wellness program than their equivalent male counterparts (Linnan et al. 2004; Lynch 1999; Klesges 1988; Thompson 1995). A significant body of evidence exists that suggests that younger individuals are more likely (almost doubly as likely than their older counterparts) to use the Internet at least once a day (Mossberger 2007).

The use of incentives, both financial and non-financial, has been found to be positively associated with voluntary wellness program participation (Anderson 2007; Baiker 2010; Fielding 1990; Haynes et al. 1999; Klesges et al. 1988). In many programs, monetary incentives have been offered for participation, compliance with behavior change recommendations, or achievement of specific health goals (Goetzel 2008; Harris 2009; Fielding 1990; Goetzel 2002), and building incentives into wellness programs is suggested to raise participation among employees (Baiker 2010; Serxner 2004).

The literature has also demonstrated conflicting information about the characteristics and health status of individuals that influence their participation in health promotion activities. Some studies (Fielding 1984; Goetzel et al. 2008) have suggested that participants are healthier (lower-risk) than non-participants, while others reported that

voluntary wellness programs face a serious problem of adverse selection due to the fact that unhealthy individuals self-select into wellness programs incurring higher medical claims costs (Haynes et al 1999).

The purpose of the present analysis is to complement the existing literature on participation in workplace wellness programs by providing a quantitative analysis of the Blue Shield of California (BSC) Healthy Lifestyle Rewards (HLR) online wellness program. The goals of this analysis are to determine factors that are associated with unconditional participation in 2007, and to describe factors that are associated with retention in the program from 2006 to 2007. These results may guide workplace policy regarding design and recruitment for interventions that will increase employee participation and retain participants.

Methods

Setting: HLR Program

This analysis evaluates the Healthy Lifestyle Rewards (HLR) program; a web-based wellness program that incorporates the use of monetary rewards for completion of modules related to behavioral change. Piloted in 2004, BSC partnered with external vendor *WebMD* to create an online personalized program designed to help members reach wellness goals through education, tools, trackers, and monetary incentives (Blue Shield of California HLR Report, 2008).

Between 2004-2008, the HLR program was only offered to select employer groups that were insured through Blue Shield of California. The largest of these groups includes CalPERS (California Public Employee Retirement System), followed by Blue Shield of California employees. It has been hypothesized that participants in the CalPERS employer group differ from other participants with regards to sociodemographic and health characteristics, several analytic models aim to use statistical techniques to address these differences and the effect they may have on participation.

Participation in the HLR program is defined as the following: 1) Online Registration at the HLR/WebMD Website; 2) Completion of a Self-Reported Online Wellness Assessment Questionnaire; 3) Weekly logins to the HLR Website to complete any of the modules related to diet, exercise, nutrition, stress, or smoking; 4) On-site (workplace) biometric health screenings (uploaded into the Wellness Assessment) at the beginning of program enrollment. Note that Step 4 is not necessarily completed by every HLR participant, and some participants may have low weekly log-ins to the HLR website (Step 3). This analysis distinguishes between low participation (weekly logins less than 12) and high, or intense, participation. A participant in HLR is referring to an individual who logged into the website and registered online for the program with basic demographic information.

The online nature of the HLR program focuses on modification of individual behavior and reduction of risk factors through prevention and education, rather than a focus on

disease management and treatment. After an individual registers for the HLR program, he or she is encouraged to complete an online health risk assessment, referred to as the *Wellness Assessment*. This assessment focuses on behavior-related risk factors that individuals can change to improve their health, such as diet/nutrition, exercise, stress reduction, tobacco cessation, alcohol moderation, preventive screenings, and more. Biometric health screenings facilitated at the workplace (Step 4) compliment the Wellness Assessment by collecting biometric data including height, weight, blood pressure (diastolic and systolic), and cholesterol levels (LDL and HDL).

Whereas the Wellness Assessment and biometric screening are one-time events, weekly participation in the program is measured as an individuals' level of exposure to the on-line program focused on behavioral change in diet/nutrition, weight management, stress management, and tobacco cessation. The Wellness Assessment customizes the HLR program for each participant by providing the individual with a detailed report of their health risks and provides an action plan and recommendation.

Activity level on the online HLR/WebMD site (Step 3) is quantified as the number of times the participant logs in to the site. It is possible that a participant will complete the Wellness Assessment but not login to the interactive web-based component, therefore we see varying levels of participation in the program. For the web-based component, individuals are encouraged to engage in healthy activities with interactive tools such as Diet Manager (where individuals create a food log), Fitness Planner, Walking Tracker, Meal Planner, and health and weight related calculators. Additional online components provide participants with articles and information to educate them on behavioral changes including Recipe Finders, Quick and Easy Dinners, Fact Sheets, and health quizzes.

Data & Study Sample

This study uses data provided by the Blue Shield of California (BSC) Health Plan. Blue Shield of California is a not-for-profit health plan provider licensed by the Department of Managed Health Care (DMHC) and insures 3.2 million individuals in the state of California (BSC 2008). All data, including the participation and claims amounts for this analysis have been collected by the data informatics team at Blue Shield of California, located at 50 Beale Street in San Francisco, California. Confidential data were provided from Blue Shield of California through a formal Data Agreement in accordance with the guidelines of the Human Subjects Approval through the Institutional Review Board at UC Berkeley, and the Legal and Product Departments at Blue Shield of California.

Dependent Variable

The dependent variable in this sample for both research questions is participation in the HLR program on two levels: registration to the online program, and intense participation of greater than 12-weeks of web-logins. For research question 1, the dependent variable is unconditional participation in 2007; for research question 2, the dependent variable is participation in 2007 conditional on participation in HLR in 2006.

Independent Variables

Monetary health claims and health care utilization data are provided by Blue Shield of California for all insured lives, including individuals who were eligible to participate in the Healthy Lifestyle Rewards Program in the years 2006 and 2007. The self-reported and biometric data from the 2006 and 2007 Wellness Assessments have been collected by *WebMD* (and subsequently transferred to Blue Shield), a web-based information source providing reference material about a variety of health subjects and responsible for creating and administering the Wellness Assessment health survey.

Demographic variables included in this analysis are age, gender, and several zip-code level explanatory variables. The zip code of each member was matched to the Average Gross Income (AGI) 2006 data provided by the IRS Statistical Information Services Office for the State of California (Data were obtained and purchased through the IRS site and merged with the HLR data) (http://www.irs.gov/taxstats/indtaxstats/article/0,,id=96947,00.html). Zip code was used as a proxy variable for Average Gross Income for 2006, dependent on the average income in the given zip code for each member (with units in $10,000). In addition, zip code data were used to compute participation rates in each plan by zip code, and used as independent predictor variables in this analysis. The number of CalPERS participants in each zip code is calculated as the *rate of participation in the area* to assess the odds of participation for a member dependent on the participation rate of others in each zip code (for both CalPERS members and non-CalPERS members).

The data include individual level medical claim amounts, allowable amounts, and medical utilization data for Blue Shield of California insured members for 2006 and 2007 (N=2,077,989). Medical claims data include yearly total amounts for institutional utilization (inpatient admissions, outpatient visits, and emergency department visits), non-institutional visits (physician and non physician), and pharmaceutical claims (in the areas of cholesterol drugs, depression medications, and an "other" category). Utilization data include the yearly sum of the number of visits (count data) on inpatient admissions, outpatient visits, emergency department visits, and physician visits, and behavioral health visits. Non claims-related information includes employer group to which the individual belonged, and type of health plan (HMO or PPO). The two groups with the largest number of participants included CalPERS and Blue Shield of California employees. A complete table of participating groups is included in the Appendix to this paper. All medical claims data contain information on all members who had BSC health insurance for 2006 and 2007 and include members who had "zero claims" in either year.

Data on individuals who participated in HLR in 2006 and 2007 includes indicators of different levels of participation in the HLR program, and can be used to assess the level of exposure. The dependent variable of participation is quantified as whether the individual registered for the HLR program (binary) (Step 1) and the number of logins (continuous) to the HLR website. Independent participation variables include the number of times an individual utilized one of the online components of the program in the areas of diet/nutrition, weight management, exercise, stress, and smoking.

Sample for Research Question #1
The analysis to determine characteristics associated with the unconditional decision to participate in the HLR program in 2007 begins with a list of all of BSC's insured members in either 2006 and 2007 (N = 2,077,989). Seven individuals were dropped from the sample who could not be matched by any unique ID number, and 530,505 individuals who were not insured by Blue Shield of California for both years are also excluded. Variables that included values outside of the normal range, non CA-residents, dependents (spouses and children over 18 who were not the primary insured life for BSC), in the sample were re-coded to missing. The final sample for this analysis includes 1,547,447 individuals insured by BSC in both 2006 and 2007. Of the full set of individuals who had claims data for 2006 and 2007, 32,608 of these members participated in HLR in 2007 and could be matched by unique ID number, age, and gender to their corresponding information in the claims dataset.

Sample for Research Question #2
The sample to assess retention - whether an individual participated in 2007 given that he/she participated in 2006 – includes 10,368 unique individuals who participated in HLR in 2006. Of the 10,368 individuals who participated in 2006, 1,479 were dropped from the analysis because they had a member ID number that could not be located or matched to a member on the BSC claims dataset, or they were duplicate entries. The remaining sample of 8,889 individuals participated in 2006 in HLR and were eligible to participate in 2007; "eligibility" defined as being insured by Blue Shield of California in 2007, and belonging to an employer plan that offers the HLR program to its employees. (Note that 92% of the original 2006 sample is eligible to participate in 2007). The final sample used for the analysis of Research Question 2 contains 8,889 unique participants who participated in HLR in 2006 and were eligible to participate again in 2007.

Statistical / Analytic Approach

Research Question 1
The first analysis predicts the association between the dependent variable of participation in HLR in 2007 and independent variables of demographic characteristics and utilization data in 2006 for all insured individuals eligible to participate. While the conditional analysis (Research Question 2) confines analysis to those who participated in HLR in 2006, the unconditional analysis predicts participation regardless of whether an individual participated in the previous year, 2006. Independent variables in this analysis include: gender, age category, network (HMO or PPO), average gross income for 2006, a fixed effect for each employer plan the individual belonged to with a minimum number of members of 150, and various utilization variables derived from the 2006/2007 claims data including positive values for depression, cholesterol, and behavioral health claims. The dependent variable is a binary variable indicating whether an individual voluntarily participated in 2007. Due to the fact that over half the participants were CalPERS (and t-tests found significant differences between characteristics of the CalPERS sample versus the rest of the population), a logistic regression restricted to the CalPERS participants was compared to a similar logistic regression for the remainder of the sample, as well as

to a logistic regression with interaction variables with CalPERS (included in the Appendix).

To further test the hypothesis that CalPERS participants differ significantly in terms of characteristics that predict their participation in HLR, a statistical test matching the CalPERS sample to non-CalPERS members was performed. An exact matching model was used to predict participation in 2007, where the sample of CalPERS participants was matched exactly to a sample of the same number of non-CalPERS participants on age and gender, using a weighting technique (King and Zeng 2000). In this model, the CalPERS sample is matched to other participants on age and gender to determine whether the characteristic of belonging to the CalPERS employer plan has an impact on participation in HLR. Odds ratios were computed to determine the difference between CalPERS and non-CalPERS members using matching with a fixed effect for each pair[1].

The empirical model is as follows:

$$\textit{Logit}\ (\Pr\ (Y_{it} = 1/x)\ ) = b_0 + b_1\ \mathrm{AGE}_i + b_2\ \mathrm{SEX}_i + b_3\ \mathrm{INCOME} + b_4\ \mathrm{NETWORK}_{it} + b_5\ \mathrm{FIRM} + b_6\ \$\_\mathrm{CLAIMS\_2006} + b_7\ \#\_\mathrm{UTILIZATION\_2006}$$

Y_{it} = Participation in 2007 if participant was insured by BSC in 2006
AGE_i = Based on date of birth of individual at the baseline (to avoid multi co-linearity); broken down into age groups: 18/29, 30/39, 40/49, 50/59. 60/69, 70+
SEX_i = Indicates female gender
INCOME = Indicates Average Gross Income (AGI) of zip code of participant in 2006, in $10,000
$\mathrm{NETWORK}_{it}$ = Insurance product of subscriber (HMO, PPO)
FIRM_{it} = Indicates the employer group that the subscriber belongs to with participating members > 150. Indicator variables for CalPERS and BSC are included as fixed effects variables in the analysis
$ CLAIMS 2006 = Includes variables for positive medical claims in the areas of: Depression Medication, Cholesterol Drugs, and Behavioral Health Visits. A variable for "zero expenditures" and positive expenditures is used in several models.
# UTILIZATION 2006 = Includes variables for visits in the areas of emergency department visits, inpatient admissions, and physician visits.

Research Question 2:
Stage two of this analysis uses a conditional model to predict participation, defined as registration in the online HLR program, in 2007 *given* that the individual participated (registered for the online HLR program) in 2006 and was eligible to participate again and insured by BSC in 2006 and 2007. This analysis predicts factors associated with the odds of retention in the program from 2006 to 2007.

[1] A logistic model using the dependent variable of non-trivial or intense participation was computed to assess the determinants of participating in HLR in 2007 for over 12 weeks (for the total sample, CalPERS only sample, and non-CalPERS sample), and tables are shown in the Appendix of this Paper.

Utilization and Wellness Assessment data from 2006 participants are used to generate conclusions as to the differences among those who elected to participate in HLR in 2007 versus non-continuers. Independent predictor variables in this analysis include: gender, age category, zip code used as a proxy for income, network (HMO or PPO), a fixed effect for each employer plan the individual belonged to with a minimum number of members of 150, and total expenditure data (including zero expenditures) derived from the 2006/2007 claims data. Additional independent variables in this model are utilization measures of the HLR program in 2006 including diet/nutrition, exercise/fitness, smoking prevention/cessation, stress reduction, and uptake of recommended preventive services. Biometric measures including body mass index, and cholesterol level are included in the analysis.

Out of the 8,889 individuals who participated in 2006 and were eligible in 2007, 37.8% of them (N = 3,360) voluntarily participated in HLR in 2007. T-tests are calculated to assess whether there are significant differences between continuers and non-continuers in 2007 given participation in 2006.

Logistic models are used to estimate adjusted odds ratios to determine what factors significantly predicted participation in 2007 given that an individual participated in 2006. A logistic regression includes all of the participants in 2006 that Blue Shield recorded as logging into the HLR Website at least once (N = 8,889) using demographic, utilization and claims variables to predict participation[2]. All analyses in this paper are conducted using Stata statistical software.

The empirical model for Research Question 2 is as follows:

$$Logit\ (PART_i = 1 \mid \text{PART in 2006} = 1) = b_0 + b_1\,AGE_i + b_2\,GENDER_i + b_3\,INCOME + b_4\,NETWORK_i + b_5\,FIRM + b_6\,UTILIZATION\_2006\ b_7\,LOGINS + b_8\,DIET\_HLP + b_9\,MEAL\_HLP + b_{10}\,SMOKE\_HLP + b_{11}\,WEIGHTLS\_HLP + b_{12}\,STRESS\_HLP + b_{13}\,DEPR + b_{14}\,BEHAV + b_{15}\,CHOL + b_{16}\,TL\_EXPEND + b_{17}\,ZERO\_EXPEND$$

$PART_i$ = Participation in HLR in 2007 given that the individual participated in 2006 and was eligible to participate in 2007.
AGE_i = Based on date of birth of individual; with categories 18/29, 30/39, 40/49, 50/59, 60/69, 70+
$GENDER_i$ = Female Gender
$INCOME_i$ = Indicates Average Gross Income (AGI) of zip code of participant in 2006, in $10,000
$NETWORK_i$ = Insurance network/product of subscriber (HMO, PPO)
$FIRM_i$ = Fixed effect of the employer group that the subscriber belongs to, greater than 150 participating members: CalPERS, Blue Shield of California, High Desert Trust, City and County of San Francisco, County of Santa Barbara, County of Riverside, and Individual and Family Plans.
LOGINS = Number of unique weeks participant logged into the HLR web site in 2006
DIET_HLP = Number of times participant utilized diet help tool in 2006

[2] A final logistic model is calculated using self-reported data from a smaller subset of individuals (N = 1,168) who logged into the HLR website and completed the HLR Wellness Assessment (presented in the Appendix of this paper).

MEAL_HLP = Number of times participant utilized the Meal Planning / shopping list tool in 2006
SMOKE_HLP = Number of times participant utilized the Smoking Cessation tool in 2006
WEIGHTLS_HLP = Number of times participant utilized the Weight Loss help tool in 2006
STRESS_HLP = Number of times participant utilized the Stress Management tool in 2006
DEPR = Binary indicator of whether person had a non-zero value for spending on depression medications in 2006
BEHAV = Binary indicator of whether person had a non-zero value for mental health / behavioral visits in 2006
CHOL = Binary indicator of whether person had a non-zero value for cholesterol medication spending in 2006
TTL_EXPEND = Total sum of expenditures for individual in 2006
ZERO_EXPEND in 2006 = Binary indicator of whether person had zero expenditures (no medical claims) in 2006.

Results

Research Question 1

The characteristics of the full sample for the unconditional model are presented in Table 1. Approximately 49% of the sample was female, with an average age of 44 years, and an average gross income in 2006 of $74,902. 54% of the sample belonged to an HMO plan. 11.3% of the sample was composed of the employee group, CalPERS, and in the CalPERS group, 10.69% of the eligible individuals participated.

Table 2 presents the results of the logistic model predicting participation in 2007, restricted to the CalPERS sample only. The same logistic model predicts participation in the non-CalPERS population, and results are presented in Table 2 of the Appendix. CalPERS is an important sub-group of insured members to test due to the fact that not only does it have the largest number of HLR participants, but Blue Shield of California Health Plan uses CalPERS as a model to test many of its insurance products and programs. During the years 2006 and 2007, CalPERS and Blue Shield promoted the HLR program through emails and pamphlets to the CalPERS population (Source: Vicki Harrison Interview), and comparison models of CalPERS versus non-CalPERS populations suggest significant differences in the characteristics of the CalPERS participants. CalPERS members who participated in HLR had an average higher income than non-CalPERS participants, and had significantly lower spending for cholesterol medication, inpatient admissions, and emergency room visits in 2006 than non-CalPERS members. The participation rate of CalPERS sample in any given zip code had a strong effect on the participation rate of other CalPERS members, but a weaker effect on the non-CalPERS population. This result suggests that CalPERS members may influence other CalPERS members to participate in HLR, but not members in other plans. In the non-CalPERS population model in the Appendix, where participation rates are low, risk factors such as depression and cholesterol use are high, and low-income are factors significantly predictive of participation[3].

[3] To further test the hypothesis of whether the CalPERS participants had significantly different characteristics than the non-CalPERS participants, five interaction variables were added to an independent regression model. The five variables were interactions between CalPERS and: age *(CalPERS*age)*, gender *(CalPERS*gender)*, behavioral health *(CalPERS*behavioral health visits in 2006)*, depression *(CalPERS*depression medication use in 2006)* and income *(CalPERS*AGI by Zip Code)*. The interaction

Therefore, at low participation levels, HLR attracts high-risk populations; individuals that spend higher amounts on cholesterol and depression medication, have greater numbers of inpatient admissions and ER visits, and are lower-income.

The magnitude of the differences can be interpreted as the population of participants in CalPERS have lower odds of being female, and have lower odds of spending on depression medication, and fewer behavioral health visits. In addition, the CalPERS sample as compared to the other population is higher income, and slightly older.

The exact matching model presented in Table 3 is an additional statistical justification to determine whether there are any errors generated through using a logistic model to predict participation in HLR. Due to the fact that the predicted probabilities of participating in HLR in 2007 are small, this revised matching model creates a balanced sample of participants and matches, so that the predicted probability of participation in HLR is 50%. This model balances the sample to assess whether the logistic model resulted in gross errors. The results indicate similar results to the logistic models. Unconditional participation in HLR in 2007 was significantly associated with all independent variables in the model. Specifically, in the CalPERS sample, the odds of participation were greater if the individual was female, in age groups 30-39, 40-49, 50-59 (as compared with group 18-29), and in an HMO network (as compared to a PPO network). In addition, the CalPERS sample, those who had depression medication use in 2006, and ER visits had lower odds of participating in 2007. These results are consistent with the previous models that indicate that in the CalPERS population, participants tend to higher income on average, and have fewer ER admissions and lower depression medication usage.

One final test (Appendix Table 5) of intense participation uses a logistic regression model to replaces the dependent variable of "participation" as "participating for 12 weeks or more" in the online component of the HLR program. Participants who remain in the program for 12 weeks are eligible for an additional $50 reward, and are described as "intense" participants. These individuals had significantly lower rates of income, emergency room visits, and inpatient admissions in 2006. In addition, belonging to a PPO network (as compared to an HMO) significantly decreases the odds that an individual will participate. The Appendix of this paper includes three tables replacing the

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variables were included as additional independent variables in a model with a sample of 1,532,642 insured members eligible for participation in HLR in 2007. Results from this regression, presented in the Appendix of this paper, allow the researcher to take advantage of more information in the larger sample size and continue to observe the behavior of CalPERS members. The results indicate that the odds of participating in HLR in 2007 if an individual belongs to CalPERS, regardless of prior participation in 2006, are 12.36 times the odds of a non-CalPERS member, and interaction variables with age, gender, behavioral health, depression and, income are all highly significant indicating that the relationship between income and participation in HLR (as well as gender, age, behavioral health visits, and spending on depression medication) is significantly different for those in CalPERS as compared to the rest of the non-CalPERS sample.

independent variable of 12+ weeks of participation including distinct analysis for the unique CalPERS sample compared to non-CalPERS participants.

Research Question 2

The characteristics of individuals who participated in HLR in 2006 and were eligible to participate in 2007 are presented in Table 4. Of the 8,889 individuals who participated in HLR in 2006, 5,529 (62.20%) opted not to participate a second year in 2007. Just over a third of the 2006 HLR participants 3,360 (37%) continued to participate in 2007. Out of the 8,889 individuals that participated in HLR in 2006 the average age in 2006 for participants is 42 years (range 18-29), and 72% of the participants are female.

Table 5 compares the mean values for the 8,889 individuals described in Table 4 who were non-continuers (Y=0), and continuers (Y=1) in 2007, all of whom participated in HLR in 2006. Table 5 shows the calculation of a t-statistic to evaluate the equality of means for each independent variable and finds that continuers are more likely to be of female gender, to be between in the age category groups of 40/49 and 50/59, and to belong to CalPERS, Blue Shield of California, or High Desert Trust employer groups. Continuers had higher utilization of voluntary physician visits, and greater program exposure including higher number of logins, and greater use of all components of the online program including diet, weight loss, and stress. 2006 participants were less likely to continue if they belonged to a PPO plan (as compared to an HMO), had lower total expenditures in 2006, and lower inpatient admissions and ER visits.

The results of a logistic regression predicting conditional participation in 2007 are presented in Table 6. Independent predictor variables for this analysis included gender, age category (reference group 18/29), PPO plan (reference HMO), and a fixed effect for each plan with > 150 participating members (CalPERS, the largest plan, is the reference group). Claims in 2006 as well as exposure to the HLR program are included in this table (the Appendix includes the results of an additional analysis without the utilization of the measures for diet/nutrition, exercise/fitness, stress, and smoking cessation for comparison). The odds of continuing in HLR are significantly higher for females, those aged 40/49, and 50/59. Other significant predictors of 2007 continuation in HLR included a higher number of physician visits in 2006, and higher usage of the weight tracker, diet manager, and stress module. A significant finding is that individuals with positive spending for depression medications in 2006 had significantly lower odds of following up in the next year.

A logistic regression utilizing a smaller sample of participants with available data on biometric variables from the 2006 Wellness Assessment is shown in Appendix Table 9 of this analysis. This sub-sample includes 1,126 individuals that participated in both 2006 and were eligible to participate from 2007 who completed a Wellness Assessment. This final considered factors such as whether the individual was a smoker, was overweight or obese, physically active, had a high self-health rating, were depressed, takes medications, and had a high blood pressure to predict continuation. The only biomarker that was significant of continuation in 2007 included high blood pressure, as well as high utilization of the program in the previous year, 2006, and an HMO plan type.

Strengths

This study has several strengths addressed briefly here. Although there is an extensive literature on the effectiveness of workplace wellness programs, there are few current studies on how web-based wellness programs work. The HLR web-based wellness plan is more representative of the types of on-line wellness programs that will be used moving forward, creating a second generation type of wellness plans relying heavily on the use of the Internet, and financial incentives for joining. In addition, because data from 2006 is used to predict participation (both unconditional and conditional) in 2007, the temporal sequence addresses and eliminates the issue of reverse causation.

Limitations

This study utilizes the variables available in the Blue Shield informatics database, including limited demographic and aggregate claim amounts. Additional information on race/ethnicity, job type (and industry), office location, marital status, education, and a host of other factors would provide for a more comprehensive analysis of participation. The methods used, specifically the fixed effects regression models, and the use of IRS zip code income data attempt to overcome this limitation by allowing the researcher to take into consideration that there are unmeasured variables that remain stable over the time period of the two year analysis for this study. The external generalizabiliy of this study may be limited by the analytical focus on the CalPERS sample population, as CalPERS employees are concentrated in the state of California. However, the characteristics of the sample population, specifically with regard to their income and risk factors, can be applied to other non-CA populations. The analysis of one's likelihood of participation based on the rate of participation of other employees in their same zip code can be generalized to the peer-effect influence of participating in wellness programs. Finally, the marketing tactics used to influence participation in the CalPERS sample can be transferred to other populations with similar characteristics.

With regards to the conditional participation model based on utilization in previous years, a limitation stems from the fact that the utilization variables of the HLR program in 2006 are general. It is unclear whether a person that logged into the Diet Module, for example, actually read all the material and made any corresponding changes. However, a researcher can interpret this information in a general sense of observing which HLR modules attract participation and frequent use of the program. A program focused exclusively on diet modification, for example, may apply the findings of this study to suggest that these individuals may need additional incentives to retain participation from year to year.

A final limitation with regards to understanding why participation rates in the CalPERS sample were so intense, is that this study does not have data to measure the level or organizational commitment of each employer group with respect to marketing or promoting the HLR program, and therefore cannot measure common shock effects to the entire group population. While research has shown that intensity of promotion and type of recruitment into the program can significantly effect participation rates (Fielding 1984), little is known at this time regarding the exact methods of recruitment for

CalPERS members into HLR. Additional interviews with marketing executives and participants from each firm could shed further insight on efforts each group is making to promote participation in HLR. Qualitative data including interviews with participants may greatly enhance this analysis.

Discussion

The predictors of participation in the CalPERS group were distinctly different from the remaining groups, including plans such as Blue Shield of California Employees, which had a relatively high rate of participation. In addition, CalPERS participants displayed different determinants of participation. In the CalPERS sample, there was a positive relationship between the income of one's zip code and participation in HLR. There was also, apparently, a peer effect of participation, tested through the fact that if a greater number of CalPERS members participated in the zip code in which the member resided, the higher the odds that the member would join HLR. Overall, the individuals that joined HLR in the CalPERS group tended to be low-risk. That is, there tended to be a negative relationship between the risk factors of emergency room visits and inpatient admissions with participation in HLR.

In other plans, (and the non-CalPERS sample) participants tended to be higher risk. There was a strong relationship between participation and low-income, in addition, risk factors of depression medication spending and emergency room admissions were associated with a higher adjusted odds of participating. Low-income is often a proxy for being high-risk for adverse medical conditions, and lower-income individuals could have higher rats of depression and use the emergency room more frequently as compared to higher-income individuals. In addition, numerous studies have found that individuals who have low income are more likely to be overweight or obese, and to be depressed (Anderson 2005; Gibson 2003).

The findings suggest that joining an online wellness program depends heavily on the message that is sent to the potential participants. It appears that in the case of CalPERS, the message was essentially to heavily recruit all people in the CalPERS plan through marketing emails, brochures, and pamphlets (Harrison Interview 2009). The results of the analysis, supported with interviews with program managers indicate that promotional and marketing materials may be reaching the CalPERS population but not other populations. This strong marketing effort aimed at CalPERS may be an unobserved variable common to all individuals belonging to the CalPERS group.

In non-CalPERS plans, where the marketing efforts were less, high-risk individuals were attracted to participation in HLR. One explanation for this finding may be that low-income individuals have less access to wellness programs and services outside of work, and are therefore more likely to take advantage of the program. In addition, the economic incentive for participating, up to $200 a year, may also be more meaningful to low income populations. These results indicate providing financial incentives may be

essential for employers to increase participation and ultimately behavior change among there employees.

Results from this study are consistent with previous literature that repeatedly shows voluntary participation in workplace wellness programs has been low (Baiker 2010; Serxner 2004). As noted earlier, there exists conflicting information about the characteristics of individuals that influence participation in health promotion activities, and some studies have suggested that participants are healthier than non-participants. The findings of this study are similar to other studies that found that in some cases (as in the non-CalPERS population) participation in wellness programs may face an adverse selection problem because high-risk individuals self-select into wellness programs (Haynes et al. 1999). However, results from the lower-risk sample (CalPERS population) are consistent with recent literature which suggest that healthier individuals (non-smokers, frequent exercisers) are much more likely to participate than their un-healthy counterparts (Goetzel 2008; Fielding 1984).

The rationale gained from this study is that wellness programs should be targeted towards the population at hand to yield the greatest level of participation and retention (Goetzel and Ozminkowski 2008; Young 2006). Awareness of the risk level of the potential pool of participants is critical to engage both high-and low-risk populations alike, so that the program will result in higher rates of utilization and greater cost savings (Rose 1994).

Implications for future research are that program planners must research factors that determine why the low risk CalPERS individuals joined. One hypothesis is that promotion to get everyone to participate in HLR may not be the most effective for attracting high-risk people. Future wellness programs that incentivize individuals to participate should focus on recruiting individuals that are high-risk. In addition, a further explanation for the findings in the CalPERS sample could be that the decision to participate in HLR by an individual is not based solely on one's individual characteristics, but on the context that they make the decision to participate. A potential participant could be exposed to significant promotional efforts, or belong to a company with a culture geared towards wellness. Peer effects refer to the idea that individuals in the same workplace influence each other and make the decision to participate in the HLR program jointly. Once enough people participate (a critical threshold), others imitate peer behavior and join HLR. While this data does not allow an exact test of peer effects because it is unclear whether each individual worked in the same physical office, data from zip codes indicates that in the CalPERS sample, a higher participation rate for others your zip code is positively correlated to participating in the HLR program.

Another important finding is that in evaluating wellness programs, it is important to distinguish between simply logging in and registering for the program, versus taking full advantage of intensely participating in the program, which was defined in this analysis as participating for 12 weeks or more, sufficient time to earn an additional $50 cash incentive. It is easier to recruit individuals simply to sign up for an online website versus actually getting them to participate more intensively. The fact that these risk factors (including a higher odds of participating if one was lower income, and had a greater

number of behavioral health visits, depression medication usage, and physician visits in the previous year.) Note that in the Appendix (Tables 5-7) the result of intense participation is validated in the CalPERS population as well. CalPERS participants who intensely participated were lower risk in the sense that they had fewer spending on cholesterol medications, fewer depression claims, and fewer ER visits and inpatient admissions.

These findings suggest that monetary incentives to continue to participate intensely in a wellness program may be even more important than the incentive just to sign up. Program planners and policy makers must reinforce continued participation by providing incentives to encourage greater levels of continued participation, and not simply to provide a one-time financial incentive upon joining.

The analysis also suggests that certain, but not all, indicators of high-risk factors were predictors of continuing to use the HLR program in 2007 (Table 5). It also appears that the HLR program was successful in some populations, and with certain risk factors, but not others. In particular, expenditures for cholesterol and depression medications were not significantly different between participants and non-participants. Its conceivable that for cholesterol control, the diet and meal planner modules in HLR were not entirely helpful to predict retention and lower cholesterol medication. Continuation in HLR from one year to the next is not automatic, and it appears that continued participation is highly dependent on whether the product was successful for the participant in addressing his or her particular problem or concern. Among the people eligible to continue, the rate of continuation was approximately one-third.

The findings with respect to continuation of participation suggest that many high-risk individuals continued, including those with the greater number of physician visits. However, utilization of medical care may indicate that the individual is at high risk. For example, if a person has an underlying medical condition, such as diabetes, the individual both goes to the doctor and enrolls in HLR. (Note that this is not contradictory to the conclusion in Chapter 2 that participation in HLR is associated with a reduction in physician visits.) Continuing the HLR program allowed these individuals to reduce their physician visits.

An attempt to zero in on a smaller sample (only those individuals who filled out wellness assessments) provided only minimal additional evidence that high-risk people tended to continue. A biometric measure of high blood pressure suggested much higher odds of continuing, as did those individuals with a greater number of physician visit claims in 2006.

Continuation in wellness programs is not automatic. Retention from 2006 to 2007 also remains a significant obstacle to the long-term success of these programs. This analysis finds that continuation is dependent on whether the program was successful in addressing a health concern with a specific module. In the case of systolic high blood pressure, the program had little effect on the treatment of high blood pressure. However, if a participant had high blood pressure or high cholesterol, they had no incentive to join

again. This explanation is consistent with the hypothesis that people join because they are focused on a specific problem they want to address (e.g., weight loss, diet improvement).

In conclusion, populations that participate in HLR are heterogeneous. In the design of wellness programs, planners must be highly sensitive to this, and not assume that sending out a promotional recruitment message will capture the same risk-level individuals. It is important to tailor economic incentives to high-risk participants, and to continue to motivate individuals to remain in the program through additional incentives beyond just simply joining the program. Continuation in the HLR program may also be contingent on the strength of the problem-specific modules in HLR and their effectiveness in resolving health-related problems for the participants, a question which is addressed in Paper #3.

Conclusions

If the goal of worksite wellness programs is to find high-risk individuals and reduce their health risks, it is essential that the wellness programs tailor the incentives for signing up, and retention in the program, towards the high-risk populations. Extensive marketing by a firm to its employees may result in large herd effects where lower risk individuals join HLR, as shown in this analysis, specifically in the CalPERS sample. It may be the case that the marketing and promotion of wellness programs are not targeting individuals that have high health risks and high medical spending. Further research to explore successful outreach and promotional efforts made by firms and how they subsequently affect participation rates and adherence is still needed.

The results from this study are a strong addition to the existing literature on participation in voluntary wellness programs. Results can inform how insurance companies view potential participants, market their wellness programs, and design an incentive system, which recruits high-risk members and encourages retention in the program.

Tables

Table 1: Descriptive Statistics of Insured Members Eligible for Unconditional Participation in HLR in 2007. N = 1,547,447 Potential Participants

Variable Name	Observations	Mean	Standard Deviation	Minimum	Maximum
Female Gender	758,340	0.490	0.500	0	1
Age, Continuous	154,7206	44.047	17.437	1	100
Age Group 18/29	234,218	25.34384	2.8623	18	29
Age Group 30/39	316,285	34.5755	2.8807	30	39
Age Group 40/49	331,496	44.544	2.844	40	49
Age Group 50/59	293,075	54.232	2.845	50	59
Age Group 60/69	161,843	63.718	2.789	60	69
Average Gross Income, 2006 (in $10,000)	1,547,447	74.902	61.068	3.6316	990.2154
Number of individuals who logged into HLR website and number of logins per year	16,727	11.581	22.180	0	726
% of Participants that Participated > 3 weeks (out of total 27,321 participants)	17,265	63.19%	48.2	0	100
% of Participants that Participated >=12 weeks (out of total 27,321 participants)	14,421	52.78%	49.9	0	100
Employer Group: CalPERS	174,123	11.25%	31.6	0	100
Percentage Participating from CalPERS Employers (out of 27,321 participants)	19,327	70.74%	5.478	0	100
Employer Group: BSC (out of all records)	5,114	0.33%	0.057	0	100
Percentage Participating from BSC Employers (out of 27,321 participants)	1,732	6.34%	0.244	0	100
HMO Network	807,750	52.20%	49.95	0	100
PPO Network	658,215	42.54%	5.27	0	100
Institutional Inpatient Admissions Claims 2006 ($)	1,547,447	$593.63	9797.49	0	1716143
Institutional Outpatient Visits Claims 2006 ($)	1,547,447	$411.38	3399.84	0	952172.5
Emergency Department Claims 2006 ($)	1,547,447	$121.89	800.47	0	193191.1
Non-Institutional, Outpatient Physician Visit Claims, 2006 ($)	1,547,447	$679.38	2562.55	0	642739
Number of Inpatient Admissions, 2006 (#)	1,547,447	0.047	0.264	0	15
Number of Outpatient Visits 2006 (#)	1,547,447	0.451	2.107	0	277
Number of Emergency Room Visits, 2006 (#)	1,547,447	0.089	0.405	0	113

($) Cholesterol Medication Claims in 2006 > 0 (Binary)	1,547,447	0.018	0.132	0	1
($) Depression Claims in 2006 > 0 (Binary)	1,547,447	0.082	0.274	0	1
Number of Behavioral Health Visits in 2006 > 0 (Binary)	1,547,447	0.060	0.237	0	1
Behavioral Health Visits > 0 & Depression Spending > 0	1,547,447	0.026	0.161	0	1
Total Dollar Expenditures	1,547,447	$2,456.03	12841.76	0	1,888,889

Table 2. Logistic Model Predicting Participation in HLR in 2007, restricted to CalPERS Sample Only; N = 174,119

Variable Determinant of Participation in HLR in 2007 IN CalPERS SAMPLE	Adjusted Odds Ratio	Std. Err.	z	p-value|	[95% Conf.	Interval]
Female Gender	1.577	0.025	28.42	<0.001*	1.529	1.628
Age Group 30/39**	1.155	0.040	4.16	<0.001*	1.079	1.236
Age Group 40/49	1.020	0.034	0.57	0.566	0.954	1.089
Age Group 50/59	0.953	0.032	-1.44	0.151	0.892	1.018
Age Group 60/69	0.738	0.028	-8.12	<0.001*	0.686	0.794
Average Gross Income, 2006	1.001	0.000	6.02	<0.001*	1.001	1.002
($) Cholesterol Medication Claims in 2006 > 0 (Binary)	0.996	0.043	-0.08	0.934	0.915	1.085
Number of Behavioral Health Visits in 2006 > 0 (Binary)	1.144	0.039	4.01	<0.001*	1.071	1.222
($) Depression Claims in 2006 > 0 (Binary)	0.983	0.027	-0.62	0.537	0.932	1.038
Positive for both Behavioral Health Visits and Depression Spending	0.986	0.050	-0.27	0.789	0.892	1.090
Number of Physician Visits in 2006	1.019	0.002	10.03	<0.001*	1.016	1.023
Number of ER Visits in 2006	0.910	0.016	-5.28	<0.001*	0.879	0.943
Number of Inpatient Admissions Visits in 2006	0.916	0.028	-2.9	0.004*	0.863	0.972
Number of Outpatient Visits 2006 (#)	1.017	0.004	4.86	<0.001*	1.010	1.024
Total Expenditures, 2006	1.000	0.000	-1.72	0.085	1.000	1.000
Zero Expenditures, 2006	0.707	0.021	-11.83	<0.001*	0.668	0.749
Participation Rate for all others besides yourself in CalPERS in your zip code if you are a participant	1.040	0.002	25.43	<0.001*	1.037	1.043

* Indicates Significance at the 0.05 level
** Reference Group Age 18-29
*** Plan Type omitted from regression due to co-linearity: 97% of sample in CalPERS is in an HMO plan

Table 3. Matching Model (King & Zeng 2000)
Model Predicting Participation in HLR in 2007, where the sample of HLR participants in CalPERS (N= 7,994) is equivalent to the number of non-participants, using weighting technique to find matches. (N = 15,988) ♣

Variable Determinant of Participation in HLR in 2007 Using King Matching Technique with CalPERS Participating sample	**Odds Ratio**	**Std. Err.**	**z**	**P-value**	**[95% Conf.**	**Interval]**
Female Gender	2.331	0.001	3021.94	<0.001*	2.330	2.333
Age Group 30/39**	1.230	0.000	529.35	<0.001*	1.230	1.231
Age Group 40/49	1.178	0.000	410.82	<0.001*	1.177	1.179
Age Group 50/59	1.229	0.001	502.79	<0.001*	1.228	1.230
Age Group 60/69	0.666	0.000	-706.41	<0.001*	0.666	0.667
Average Gross Income, 2006	0.999	0.000	-607.27	<0.001*	0.999	0.999
PPO Network***	0.525	0.000	-873.66	<0.001*	0.524	0.526
($) Cholesterol Medication Claims in 2006 > 0 (Binary)	1.085	0.001	81.55	<0.001*	1.083	1.087
Number of Behavioral Health Visits in 2006 > 0 (Binary)	1.056	0.001	89.20	<0.001*	1.054	1.057
($) Depression Claims in 2006 > 0 (Binary)	0.943	0.000	-113.32	<0.001*	0.942	0.944
Positive for both Behavioral Health Visits and Depression Spending	1.422	0.001	364.68	<0.001*	1.419	1.425
Number of Physician Visits in 2006	1.029	0.000	891.99	<0.001*	1.028	1.029
Number of ER Visits in 2006	0.861	0,000	-407.41	<0.001*	0.861	0.862
Number of Inpatient Admissions Visits in 2006	1.017	0.001	27.47	<0.001*	1.015	1.018
Number of Office Visits, 2006	0.977	0.000	-276.21	<0.001*	0.977	0.977
Total Expenditures, 2006	1.000	0.000	-95.26	<0.001*	1.000	1.000
Zero Expenditures, 2006	0.568	0.000	-1531.08	<0.001*	0.568	0.569

* Indicates Significance at the 0.05 level
** Reference Group Age 18-29
*** Reference Category HMO

♣ The number of participants in CalPERS is 7,994, and is equivalent to the number of control group matches. This creates a predicted probability of participation of 50%.

Table 4. Descriptive Statistics. The mean, standard deviation, and minimum and maximum values for characteristics of individuals insured by BSC that participated in HLR in 2006 and were eligible to participate again in 2007 (N = 8,889)

Independent Variable	Observations	Mean	Standard Deviation	Min	Max
Y Binary Indicator of whether individual continued HLR in 2007	8889	0.38	0.48	0	1
Age, Continuous	8889	42.00	11.70	18	89
Female Gender	8889	0.72	0.45	0	1
Average Gross Income, 2006	8462	$72.63	$54.09	21.49	990.22
Age 18/29 in 2006	8889	0.18	0.38	0	1
Age 30/39	8889	0.26	0.44	0	1
Age 40/49	8889	0.26	0.44	0	1
Age 50/59	8889	0.23	0.42	0	1
Age 60/69	8889	0.06	0.24	0	1
HMO Plan Type	8889	0.56	0.50	0	1
Plan Type: CALPERS	8889	0.15	0.36	0	1
Plan Type: Blue Shield of California	8889	0.16	0.37	0	1
Plan Type: High Desert Trust	8889	0.09	0.28	0	1
Plan Type: City and County of San Francisco	8889	0.04	0.19	0	1
Plan Type: County of Santa Barbara	8889	0.05	0.21	0	1
Plan Type: County of Riverside	8889	0.08	0.26	0	1
Plan Category: Individual & Family Plan	8889	0.20	0.40	0	1
Number of Emergency Department Visits 2006 (#)	8889	0.11	0.42	0	10
Number of Physician Visits 2006 (#)	8889	3.95	4.43	0	64
Number of Outpatient Visits (2006) #	8889	0.61	2.16	0	60
Depression: Binary Indicator for Positive Claim for use of Depression Medication (2006)	8889	0.15	0.36	0	1
Behavioral/ Mental Health: Indicator for positive use of behavioral health visits (2006)	8889	0.12	0.33	0	1
Cholesterol: Indicator of Positive Spending on Cholesterol Medication (2006)	8889	0.02	0.14	0	1
Total Expenditures (2006)	8889	3487.21	10542.76	0	402630.70
Zero Expenditures - Binary Variable (1 indicates person had zero expenditures in 2006)	8889	0.09	0.29	0	1
Logins: Number of times the participant logged in to the HLR Website in 2006	8889	15.64	28.24	0	971
Weeks Tracked: # Times Participant Logged Weeks Eligible to Earn Monetary Rewards (k_logged_weeks)	8873	9.48	13.32	1	45
Number of times participant utilized the Web-Based Weight Loss Help Module in 2006	8889	0.19	0.58	0	7

Table 5. Means, Standard Deviations, and T-Statistics for "HLR 2007 Continuers" Versus "Non-Continuers" (N = 8,889)

Variable Name	Y= 0 HLR Non-continuers in 2007 (N=5,529) Mean (SD)	Y = 1 HLR continuers in 2007 (N=3,360) Mean (SD)	T-test for equality of means between Y=0 and Y=1 t (p-value
Female Gender	0.68 (0.47)	0.78 (0.42)	10.07 (<0.001)*
Age, Continuous	41.34 (11.91)	43.09 (11.26)	6.85 (<0.001)*
Age 18/29	0.20 (0.40)	0.15 (0.35)	-6.63 (<0.001)*
Age 30/39	0.27 (0.45)	0.25 (0.43)	-2.90 (0.004)*
Age 40/49	0.24 (0.43)	0.28 (0.45)	3.89 (<0.001)*
Age 50/59	0.21 (0.41)	0.26 (0.44)	5.06 (<0.001)*
Age 60/69	0.06 (0.24)	0.07 (0.25)	0.58 (0.564)
Average Gross Income, 2006	74.36 (54.84)	69.96 (52.81)	-3.65 (<0.001)*
PPO Network	0.44 (0.50)	0.32 (0.47)	-11.30 (<0.001)*
CalPERS	0.13 (0.33)	0.19 (0.40)	8.64 (<0.001)*
BSC	0.09 (0.29)	0.29 (0.45)	24.86 (<0.001)*
High Desert Trust	0.07 (0.25)	0.12 (0.32)	7.92 (<0.001)*
City and County of San Francisco	0.04 (0.20)	0.03 (0.17)	-2.36 (0.018)*
County of Santa Barbara	0.04 (0.20)	0.06 (0.23)	3.63 (<0.001)*
County of Riverside	0.08 (0.27)	0.07 (0.25)	-1.99 (0.046)*
Individual and Family Plan	0.22 (0.42)	0.16 (0.37)	-7.22 (<0.001)*
2006 Cholesterol Medication Spending > 0	0.02 (0.14)	0.021 (0.14)	0.14 (0.887)
2006 Depression Claims > 0 (binary)	0.15 (0.36)	0.16 (0.36)	0.36 (0.722)
2006 Behavioral Visits > 0 (binary)	0.12 (0.33)	0.12 (0.32)	-1.07 (0.285)
2006 Total Expenditures	3551.09 (12031.97)	3382.08 (7472.51)	-0.73 (0.464)
Zero Expenditures in 2006	0.10 (0.30)	0.08 (0.28)	-2.44 (0.015)*
Number of Inpatient Admissions, 2006 (#)	0.06 (0.32)	0.06 (0.25)	-0.78 (0.436)
Number of Emergency Department Visits 2006 (#)	0.12 (0.43)	0.10 (0.39)	-1.94 (0.053)
Number of Physician Visits 2006 (#)	3.83 (4.43)	4.15 (4.411)	3.29 (0.001)*
Total # of weeks "tracked" for each participant in HLR program in 2006	3.39 (7.57)	17.62 (16.55)	55.17 (<0.001)*
Number of unique weeks participant logged into the HLR web tool in 2006 (logins)	4.08 (7.41)	18.37 (15.86)	57.42 (<0.001)*
# Times Participant used *Meal Planner* Module in 2006	0.31 (0.56)	0.44 (0.70)	9.32 (<0.001)*
# Times Participant used Diet Module in 2006 (called *Diet Manager*)	0.042 (0.24)	0.28 (0.61)	25.64 (<0.001)*
# Times Participant used Smoke Free Module in 2006	0.00 (0.07)	0.02 (0.150)	6.20 (<0.001)*
# Times Participant used Stress Relief Module in 2006	0.05 (0.25)	0.27 (0.56)	25.43 (<0.001)*
# Times Participant Used *Progress Weight Tracker* (Logged Weight) in HLR Program	0.08 (0.38)	0.38 (0.77)	24.62 (<0.001)*
"High Logins:" Whether Participant Logged in 12+ weeks in 2006	0.13 (0.34)	0.58 (0.49)	50.95 (<0.001)*

* Indicates significance at the p > 0.05 level

Table 6: Logistic Regression Predicting Conditional Participation in 2007 with 2006 Utilization Measures (N=8,462)

Independent Variable, Y Defined as = 1 if the 2006 participant continued in HLR in 2007	**Odds Ratio**	**Standard Error**	**z-statistic**	**P-value**	**[95% Conf.**	**Interval]**
Female Gender	1.181	0.075	2.61	0.009*	1.042	1.338
Age 30/39**	1.127	0.097	1.39	0.165	0.952	1.336
Age 40/49	1.269	0.111	2.73	0.006*	1.070	1.506
Age 50/59	1.291	0.117	2.83	0.005*	1.082	1.542
Age 60/69	1.144	0.147	1.05	0.292	0.890	1.471
Average Gross Income, 2006	1.001	0.001	1.40	0.163	1.000	1.002
PPO Network***	1.119	0.099	1.27	0.205	0.941	1.330
Depression (non-zero value for spending on depression medication in 2006)	0.823	0.070	-2.29	0.022*	0.697	0.972
Behavioral (non-zero value for spending on behavioral visits in 2006)	1.081	0.099	0.86	0.392	0.904	1.293
Cholesterol (non zero value for cholesterol medication in 2006)	1.013	0.189	0.07	0.944	0.702	1.462
Number of Physician Visits 2006	1.024	0.007	3.19	0.001*	1.009	1.038
Number of Number of Inpatient Hospital Admissions 2006	0.984	0.109	-0.14	0.885	0.791	1.224
Number of ER Visits 2006	0.931	0.064	-1.05	0.294	0.814	1.064
Total Expenditures	0.999	0.000	-2.51	0.012*	0.999	0.999
Zero Expend Binary Variable Indicating individual spent 0 in total claims in 2006	1.167	0.119	1.51	0.130	0.955	1.424
Total Utilization: Number of times participant logged into HLR website in 2006	0.960	0.086	-0.46	0.649	0.805	1.144
Plan: BSC***	0.263	0.072	-4.89	<0.001*	0.154	0.449
Plan: City of San Mateo	0.309	0.037	-9.89	<0.001*	0.245	0.390
Plan: High Desert Trust	0.413	0.057	-6.45	<0.001*	0.316	0.540
Plan: City & County of SF	0.646	0.078	-3.61	<0.001*	0.510	0.819
Plan: County of Santa Barbara	0.236	0.028	-12.35	<0.001*	0.188	0.297
Plan: County of Riverside	0.170	0.021	-14.23	<0.001*	0.133	0.217
Plan: Individual and Family Plan	1.049	0.002	21.76	<0.001*	1.044	1.053
# Times Participant Used Progress Weight Tracker (Logged Weight) in HLR Program	1.124	0.066	2.00	0.045*	1.003	1.261
# Times Participant used Meal Planner Module in 2006	0.966	0.044	-0.76	0.450	0.883	1.057
# Times Participant used Diet Module in 2006 (called Diet Manager	1.348	0.107	3.75	<0.001*	1.153	1.576
# Times Participant used Smoke Free Module in 2006	0.984	0.262	-0.06	0.952	0.585	1.657
# Times Participant used Stress Reduction / Management Module in	1.366	0.110	3.87	<0.001*	1.166	1.600

2006						

* $p < 0.05$
** Reference Age Group: 18-29
*** Reference Group Network: HMO
**** Reference Group Plan Type: CalPERS (largest)

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Appendix Tables

Appendix Table 1. Plan Type and Frequency of 2006 Participants Eligible to continue in 2007.

PLAN NAME	Number of Participants in HLR in 2007
CalPERS	1,356
Blue Shield of California	1,466
Delta Dental	291
Mendocino Schools	127
Stanford	131
High Desert Trust	778
City and County of San Francisco	332
County of Santa Barbara	425
County of Riverside	675
Individual and Family Plan (IFP)	1,771

Appendix Table 2. Logistic Model Predicting Participation in HLR in 2007, restricted to CalPERS Sample Only; N = 174,119

Variable Determinant of Participation in HLR in 2007 IN CalPERS SAMPLE	Adjusted Odds Ratio	Std. Err.	z	P-value	[95% Conf.	Interval]
Female Gender	1.577	0.025	28.42	<0.001*	1.529	1.628
Age Group 30/39**	1.155	0.040	4.16	<0.001*	1.079	1.236
Age Group 40/49	1.020	0.034	0.57	0.566	0.954	1.089
Age Group 50/59	0.953	0.032	-1.44	0.151	0.892	1.018
Age Group 60/69	0.738	0.028	-8.12	<0.001*	0.686	0.794
Average Gross Income, 2006	1.001	0.000	6.02	<0.001*	1.001	1.002
($) Cholesterol Medication Claims in 2006 > 0 (Binary)	0.996	0.043	-0.08	0.934	0.915	1.085
Number of Behavioral Health Visits in 2006 > 0 (Binary)	1.144	0.039	4.01	<0.001*	1.071	1.222
($) Depression Claims in 2006 > 0 (Binary)	0.983	0.027	-0.62	0.537	0.932	1.038
Positive for both Behavioral Health Visits and Depression Spending	0.986	0.050	-0.27	0.789	0.892	1.090
Number of Physician Visits in 2006	1.019	0.002	10.03	<0.001*	1.016	1.023
Number of ER Visits in 2006	0.910	0.016	-5.28	<0.001*	0.879	0.943
Number of Inpatient Admissions Visits in 2006	0.916	0.028	-2.9	0.004*	0.863	0.972
Number of Outpatient Visits 2006 (#)	1.017	0.004	4.86	<0.001*	1.010	1.024
Total Expenditures, 2006	1.000	0.000	-1.72	0.085	1.000	1.000
Zero Expenditures, 2006	0.707	0.021	-11.83	<0.001*	0.668	0.749
Participation Rate for all others besides yourself in CalPERS in your zip code if you are a participant	1.040	0.002	25.43	<0.001*	1.037	1.043

* Indicates Significance at the 0.05 level

** Reference Group Age 18-29

*** Plan Type omitted from regression due to co-linearity: 97% of sample in CalPERS is in an HMO plan

Appendix Table 3. Logistic Model Predicting Participation in HLR in 2007, non-CalPERS Sample, N = 1,373,087

Variable Determinant of Participation in HLR in 2007 CalPERS = 0	Odds Ratio	Std. Err.	z	P-value	[95% Conf.	Interval]
Female Gender	2.259	0.057	32.53	<0.001*	2.150	2.372
Age Group 30/39**	1.196	0.042	5.12	<0.001*	1.117	1.281
Age Group 40/49	1.115	0.040	3.06	0.002*	1.040	1.195
Age Group 50/59	1.141	0.042	3.61	<0.001*	1.062	1.225
Age Group 60/69	0.578	0.030	-10.67	<0.001*	0.523	0.639
Average Gross Income, 2006	0.025	0.004	-21.52	<0.001*	0.018	0.035
($) Cholesterol Medication Claims in 2006 > 0 (Binary)	0.998	0.000	-7.00	<0.001*	0.998	0.999
Number of Behavioral Health Visits in 2006 > 0 (Binary)	1.184	0.105	1.90	0.058	0.994	1.409
($) Depression Claims in 2006 > 0 (Binary)	1.187	0.065	3.15	0.002*	1.067	1.320
Positive for both Behavioral Health Visits and Depression Spending	1.014	0.047	0.31	0.758	0.927	1.110
Number of Physician Visits in 2006	1.177	0.101	1.89	0.059	0.994	1.393
Number of ER Visits in 2006	1.027	0.002	10.97	<0.001*	1.022	1.032
Number of Inpatient Admissions Visits in 2006	0.883	0.028	-3.9	<0.001*	0.830	0.940
Number of Non-Institutional (Outpatient or in Clinic) Physician Office Visits, 2006 (#)	0.916	0.047	-1.73	0.084	0.828	1.012
Total Expenditures, 2006	0.982	0.007	-2.66	0.008*	0.968	0.995
Zero Expenditures, 2006	1.000	0.000	-0.24	0.811	1.000	1.000

* Indicates Significance at the 0.05 level

** Reference Group Age 18-29

*** Plan Type omitted from regression due to co-linearity: 97% of sample in CalPERS is in an HMO plan

Appendix Table 4. Logistic Model Predicting Participation in HLR in 2007 with full sample (N = 1,532,642) of participants. Model includes interaction variables with CalPERS sample (N = 174,123) to assess differences in characteristics of CalPERS participants.

Variable Determinant of Participation in HLR in 2007	Odds Ratio	Std. Err.	z	P-value	[95% Conf.	Interval]
Female Gender	2.267	0.056	33.02	<0.001*	2.159	2.380
Age Group 30/39**	1.158	0.029	5.89	<0.001*	1.103	1.216
Age Group 40/49	1.005	0.026	0.20	0.838	0.956	1.057
Age Group 50/59	0.926	0.027	-2.62	0.009*	0.874	0.981
Age Group 60/69	0.625	0.023	-12.52	<0.001*	0.581	0.673
Average Gross Income, 2006	0.999	0.000	-6.68	<0.001*	0.998	0.999
Employer Group: CalPERS***	12.356	0.766	40.53	<0.001*	10.941	13.953
($) Cholesterol Medication Claims in 2006 > 0 (Binary)	1.040	0.042	0.96	0.338	0.960	1.126
Number of Behavioral Health Visits in 2006 > 0 (Binary)	1.277	0.058	5.40	<0.001*	1.169	1.395
($) Depression Claims in 2006 > 0 (Binary)	1.106	0.045	2.51	0.012*	1.022	1.197
Positive for both Behavioral Health Visits and Depression Spending	1.029	0.047	0.64	0.522	0.942	1.125
Number of Physician Visits in 2006	1.022	0.002	13.93	<0.001*	1.019	1.025
Number of ER Visits in 2006	0.907	0.014	-6.16	<0.001*	0.880	0.936
Number of Inpatient Admissions Visits in 2006	0.933	0.025	-2.62	0.009*	0.886	0.983
Number of Outpatient Visits, 2006 (#)	1.009	0.003	3.26	0.001*	1.004	1.015
Sum of Total Expenditures in 2006	1.000	0.000	-1.80	0.072	1.000	1.000
Zero Expenditures in 2006	0.656	0.015	-18.91	<0.001*	0.628	0.685
Interaction: Female Gender & CalPERS	0.704	0.021	-11.80	<0.001*	0.664	0.747
Interaction: Age (cont) * CalPERS	1.004	0.001	3.83	<0.001*	1.002	1.006
Interaction: Behavioral Health Visits * CalPERS	0.870	0.043	-2.83	0.005*	0.789	0.958
Interaction: Spending on Depression * CalPERS	0.885	0.040	-2.69	0.007*	0.810	0.967
Interaction: Income * CalPERS	1.008	0.001	15.67	<0.001*	1.007	1.009

* Indicates Significance at the 0.05 level

** Reference Group Age 18-29

*** Of this sample, 174,123 (11.25%) were in the CalPERS group

Note: Plan Type omitted from regression due to co-linearity: 97% of sample in CalPERS is in an HMO plan

Appendix Table 5. Non-Trivial / "Intense" Participation Model Predicting Participation in HLR in 2007, where the number of participants has logged in for 12 weeks or more, indicating they were eligible for the second $50 reward. N = 174,119

Variable Determinant of 12+ Weeks of HLR Participation in HLR in 2007	Odds Ratio	Std. Err.	z	P-value	[95% Conf.	Interval]
Female Gender	1.452	0.025	21.27	<0.001*	1.403	1.503
Age Group 30/39**	1.643	0.054	15.04	<0.001*	1.540	1.753
Age Group 40/49	1.873	0.060	19.52	<0.001*	1.759	1.995
Age Group 50/59	2.118	0.068	23.33	<0.001*	1.989	2.256
Age Group 60/69	1.477	0.056	10.34	<0.001*	1.372	1.590
Average Gross Income, 2006	0.997	0.000	-16.43	<0.001*	0.996	0.997
PPO Network***	0.192	0.016	-19.35	<0.001*	0.162	0.227
($) Cholesterol Medication Claims in 2006 > 0 (Binary)	1.146	0.061	2.56	0.011	1.032	1.273
Number of Behavioral Health Visits in 2006 > 0 (Binary)	1.320	0.050	7.40	<0.001*	1.227	1.421
($) Depression Claims in 2006 > 0 (Binary)	1.118	0.035	3.57	<0.001*	1.052	1.189
Positive for both Behavioral Health Visits and Depression Spending	0.998	0.059	-0.03	0.976	0.890	1.120
Number of Physician Visits in 2006	1.035	0.002	20.90	<0.001*	1.031	1.038
Number of ER Visits in 2006	0.954	0.019	-2.41	0.016*	0.918	0.991
Number of Inpatient Admissions Visits in 2006	0.924	0.030	-2.40	0.016*	0.866	0.986
Number of Office Visits, 2006	0.969	0.005	-6.14	<0.001*	0.959	0.979
Total Expenditures, 2006	1.000	0.000	1.91	0.057	1.000	1.000
Zero Expenditures, 2006	0.468	0.013	-26.87	<0.001*	0.442	0.494

* Indicates Significance at the 0.05 level
** Reference Group Age 18-29
*** Reference Category HMO

Appendix Table 6. Unconditional Participation Model.
Non-Trivial / Intense Participation Model of 12+ Weeks Participation, Restricted to CalPERS = 1 (N = 174,119)

Variable Determinant of 12+ Weeks of HLR Participation in HLR in 2007 with CalPERS Participating sample	Odds Ratio	Std. Err.	z	P-value	[95% Conf.	Interval]
Female Gender	1.341	0.029	13.69	<0.001*	1.286	1.399
Age Group 30/39**	1.171	0.056	3.31	0.001*	1.066	1.285
Age Group 40/49	1.067	0.049	1.40	0.161	0.975	1.168
Age Group 50/59	1.038	0.048	0.80	0.421	0.948	1.136
Age Group 60/69	0.801	0.041	-4.32	<0.001*	0.725	0.886
Average Gross Income, 2006	1.002	0.000	7.29	<0.001*	1.001	1.002
($) Cholesterol Medication Claims in 2006 > 0 (Binary)	0.876	0.053	-2.17	0.030*	0.778	0.987
Number of Behavioral Health Visits in 2006 > 0 (Binary)	1.192	0.053	3.95	<0.001*	1.092	1.300
($) Depression Claims in 2006 > 0 (Binary)	0.987	0.037	-0.34	0.731	0.918	1.062
Positive for both Behavioral Health Visits and Depression Spending	0.869	0.060	-2.03	0.043*	0.759	0.995
Number of Physician Visits in 2006	1.017	0.003	6.53	<0.001*	1.012	1.022
Number of ER Visits in 2006	0.909	0.022	-3.91	<0.001*	0.867	0.954
Number of Inpatient Admissions Visits in 2006	0.938	0.038	-1.60	0.110	0.867	1.015
Number of Office Visits, 2006	1.017	0.004	3.89	<0.001*	1.008	1.025
Total Expenditures, 2006	1.000	0.000	-0.95	0.340	1.000	1.000
Zero Expenditures, 2006	0.741	0.029	-7.67	<0.001*	0.686	0.800

* Indicates Significance at the 0.05 level
** Reference Group Age 18-29
*** Network types: HMO/PPO was dropped due to co-linearity.

Appendix Table 7. Non-Trivial / Intense Participation Model of 12+ Weeks Participation, Restricted to Non-CalPERS Sample (N =1,373,087)

Variable Determinant of 12+ Weeks of HLR Participation in HLR in 2007, With NON CalPERS Sample	**Odds Ratio**	**Std. Err.**	**z**	**P-value**	**[95% Conf.**	**Interval]**
Female Gender	2.133	0.070	23.06	<0.001*	2.000	2.275
Age Group 30/39**	1.229	0.059	4.29	<0.001*	1.119	1.351
Age Group 40/49	1.234	0.059	4.38	<0.001*	1.123	1.357
Age Group 50/59	1.332	0.065	5.87	<0.001*	1.211	1.466
Age Group 60/69	0.707	0.047	-5.20	<0.001*	0.621	0.806
Average Gross Income, 2006	0.999	0.000	-4.61	<0.001*	0.998	0.999
Network = PPO (Reference HMO)	0.507	0.044	-7.84	<0.001*	0.428	0.601
($) Cholesterol Medication Claims in 2006 > 0 (Binary)	1.126	0.132	1.01	0.310	0.895	1.418
Number of Behavioral Health Visits in 2006 > 0 (Binary)	1.052	0.079	0.67	0.502	0.907	1.219
($) Depression Claims in 2006 > 0 (Binary)	0.921	0.058	-1.32	0.187	0.814	1.041
Positive for both Behavioral Health Visits and Depression Spending	1.322	0.157	2.35	0.019*	1.048	1.668
Number of Physician Visits in 2006	1.029	0.003	9.60	<0.001*	1.023	1.035
Number of ER Visits in 2006	0.847	0.038	-3.72	<0.001*	0.775	0.924
Number of Inpatient Admissions Visits in 2006	0.873	0.060	-1.98	0.048*	0.763	0.999
Number of Office Visits, 2006	0.989	0.008	-1.39	0.164	0.973	1.005
Total Expenditures, 2006	1.000	0.000	0.21	0.835	1.000	1.000
Zero Expenditures, 2006	0.622	0.027	-10.97	<0.001*	0.571	0.677

* Indicates Significance at the 0.05 level
** Reference Group Age 18-29
*** Reference Group is HMO

Appendix Table 8: Conditional Logistic Regression: Including 2006 Claim Variables Only (without utilization) (N= 8,462)

Independent Variable, Y defined as = 1 if the 2006 participant continued in HLR in 2007	**Odds Ratio**	**Standard Error**	**z**	**P-value**	**[95% Conf.**	**Interval]**
Female Gender	1.174	0.074	2.53	0.012	1.037	1.329
Age 30/39**	1.111	0.095	1.23	0.218	0.939	1.315
Age 40/49	1.252	0.109	2.59	0.010*	1.056	1.484
Age 50/59	1.270	0.114	2.67	0.008*	1.065	1.514
Age 60/69	1.114	0.142	0.85	0.396	0.868	1.431
Average Gross Income, 2006	1.001	0.001	1.46	0.144	1.000	1.002
PPO Network***	1.119	0.099	1.28	0.201	0.942	1.330
Depression (non-zero value for spending on depression medication in 2006)	0.826	0.070	-2.27	0.023*	0.700	0.974
Behavioral (non-zero value for spending on behavioral visits in 2006)	1.099	0.100	1.04	0.299	0.920	1.312
Cholesterol (non zero value for cholesterol medication in 2006)	0.995	0.187	-0.03	0.979	0.689	1.437
Number of Physician Visits 2006	1.024	0.007	3.22	0.001*	1.009	1.038
Number of Number of Inpatient Hospital Admissions 2006	0.984	0.108	-0.15	0.883	0.793	1.221
Number of ER Visits 2006	0.933	0.064	-1.02	0.307	0.816	1.066
Total Expenditures	1.000	0.000	-2.48	0.013*	1.000	0.999
Zero Expend Binary Variable Indicating individual spent 0 in total claims in 2006	1.182	0.120	1.66	0.098	0.970	1.442
Total Utilization: Number of times participant logged into HLR website in 2006	1.057	0.002	32.87	<0.001*	1.053	1.060
Plan: BSC****	0.971	0.087	-0.33	0.743	0.815	1.157
Plan: City of San Mateo	0.262	0.071	-4.91	<0.001*	0.153	0.447
Plan: High Desert Trust	0.318	0.038	-9.71	<0.001*	0.253	0.401
Plan: City & County of SF	0.413	0.057	-6.46	<0.001*	0.316	0.540
Plan: County of Santa Barbara	0.643	0.077	-3.67	<0.001*	0.508	0.814
Plan: County of Riverside	0.236	0.027	-12.52	<0.001*	0.188	0.296
Plan: Individual and Family Plan	0.173	0.021	-14.15	<0.001*	0.135	0.220

* $p < 0.05$
** Reference Age Group: 18-29
*** Reference Group Network: HMO
**** Reference Group Plan Type: CalPERS (largest)

Appendix Table 9. Logistic regression predicting conditional participation in 2007 including the 2006 Wellness Assessment Data (N = 1,126)

Independent Variable, Y Defined as = 1 if the 2006 participant continued in HLR in 2007	**Odds Ratio**	**Standard Error**	**z**	**P-value**	**[95% Conf.**	**Interval]**
Female Gender	1.181	0.201	0.98	0.327	0.847	1.648
Age 30/39**	1.259	0.329	0.88	0.379	0.754	2.102
Age 40/49	1.450	0.367	1.47	0.142	0.882	2.383
Age 50/59	1.622	0.424	1.85	0.064	0.972	2.707
Age 60/69	1.005	0.342	0.01	0.989	0.516	1.957
Average Gross Income, 2006	1.001	0.001	1.03	0.304	0.999	1.004
PPO Plan Type***	0.513	0.080	-4.28	<0.001*	0.377	0.696
Depression (non-zero value for spending on depression medication in 2006)	1.065	0.231	0.29	0.770	0.697	1.629
Behavioral (non-zero value for spending on behavioral visits in 2006)	1.005	0.229	0.02	0.983	0.643	1.570
Cholesterol: Non Zero Spending on Cholesterol Medications in 2006	0.910	0.382	-0.22	0.823	0.400	2.070
($) Claims Amount Spent on Physician Visits 2006	1.039	0.017	2.37	0.018	1.007	1.073
($) Claims Amount Spent on Inpatient Admissions Visits 2006	0.960	0.280	-0.14	0.889	0.543	1.699
($) Claims Amount Spent on ER Visits 2006	0.893	0.175	-0.58	0.564	0.608	1.311
Total Expenditures 2006	1.000	0.000	-0.07	0.942	1.000	1.000
Zero Expenditures: Binary Variable Indicating individual spent 0 in total claims in 2006	1.512	0.448	1.40	0.163	0.846	2.703
# Logged Weeks in HLR in 2006 – Exposure Variable	1.038	0.003	11.38	<0.001*	1.032	1.045
Overweight, BMI 25-30	0.941	0.163	-0.35	0.726	0.671	1.321
Obese, BMI > 30	0.870	0.176	-0.69	0.491	0.586	1.293
Diastolic Blood Pressure	0.991	0.007	-1.35	0.178	0.977	1.004
Systolic Blood Pressure	0.980	0.006	-3.02	0.003*	0.968	0.993
High Blood Pressure	1.711	0.365	2.52	0.012*	1.126	2.600
Self Health Rating (2006)	0.865	0.080	-1.57	0.116	0.722	1.036
Smoker (1= smoker)	0.945	0.143	-0.38	0.708	0.703	1.271
Physically Active	1.083	0.071	1.21	0.227	0.952	1.231
Diagnosed with Depression - 2006 or prior	1.256	0.285	1.01	0.314	0.805	1.960
Takes Some form of Daily Rx Medications (excluding birth control)	0.973	0.151	-0.18	0.859	0.718	1.318

* $p < 0.05$

** Reference Age Group: 18-29

*** Reference Group Network: HMO

Paper 2

An Assessment of the Relationship Between Participation in the Healthy Lifestyle Rewards Financial Incentives Program and Health Care Utilization and Medical Claims

Abstract

Objectives: Little is known about the effect of participation in an Internet based workplace wellness program on medical care utilization and medical claims. This paper investigates the hypothesis that participation in an online wellness program will decrease medical claims and utilization.

Population: A cohort sample of 8,003 individuals who participated in the Blue Shield of California Healthy Lifestyle Rewards (HLR) program in 2006 and 2007 and have medical claims data is used for this analysis.

Study: The study design follows participants measuring multiple dimensions of utilization in dollar claims and numbers of visits as matched to a control group of non-participants on five dimensions: age, gender, plan type, network, and zip code as a proxy for income. This study is a difference-in-difference analysis in which the change in medical utilization between 2006 and 2007 is compared between the intervention group (HLR participants) and the matched control group.

Methods: Monte Carlo simulations are used to repeatedly draw random matches of non-participants against participants to take account the uncertainty in any given match. Dependent variables include binary values for positive utilization of medical care in linear probability models, and the logarithm of medical claims spending in log-linear models.

Results: Participation in HLR in 2006 was associated with significant declines in all measures of outpatient utilization (including non-institutional physician and non-physician claims, and physician visits) in the following year. There were no significant effects on claims spending for cholesterol and depression medications, or in utilization in the categories of emergency department visits, and inpatient admissions.

Conclusions: Among HLR participants in 2006 and 2007, participation in the HLR program in 2006 is associated with a significant decline in outpatient health care use of both physician and non-physician visits, and institutional and non-institutional expenditures. This relatively short-term effect is consistent with the hypothesis that Internet based wellness programs serve as a substitute for some forms of outpatient physician and non-physician care, most likely acting as an informational resource. The results dispel concerns that wellness programs lead to an increase in medical expenditures through encouraging the use of medical care.

Introduction

Numerous studies have postulated that Internet based workplace wellness programs have varying effects for those who participate. Research has demonstrated that wellness programs have significant potential to reduce medical claims costs and medical utilization through the mechanism of managing health risk factors, but the effects have varied across populations (Baiker and Cutler 2010; Goetzel and Ozminkowski 2008). One hypothesis is that these programs actually improve health by focusing on diet, exercise, weight loss, stress reduction and smoking, and participants lose weight, lower their cholesterol, and manage their depression (Chapman 2005; Harris 2009; Ozminkowski 2002). A second hypothesized effect of participation is that participants end up increasing medical utilization because these programs help participants identify conditions and encourage them to visit a physician. A third hypothesized effect is that these programs could lead to decreased medical utilization among participants due to the fact that these programs serve as an informational substitute for some types of medical care. In this third case, one might hypothesize that wellness programs will result in a decrease in certain types of medical care that have an informational type function that does not require medication.

This paper analyzes Blue Shield of California's (BSC) Internet based Healthy Lifestyle Rewards (HLR) financial incentive wellness program. This study follows a sample of 8,003 individuals who participated in HLR in 2006 and 2007 to assess the following research question: *What effect, if any, has participation in 2006 in Blue Shield of California's Healthy Lifestyle Rewards wellness program had on medical utilization and medical claims spending in 2007 as compared to non-participating controls?* This study specifically tests the hypothesis that these programs result in a decrease in utilization of medical care, and in associated claims costs.

Background

The literature as a whole has found that workplace wellness programs have tremendous potential to reduce medical care utilization and claims costs. The effectiveness of wellness programs focused on diet, exercise, weight loss, stress reduction, and smoking cessation have been demonstrated as effective in reducing medical claims in several populations (Chapman 2005; Goetzel and Ozminkowski 2008; Harris 2009).

With respect to reduction in medical claims dollar amounts, research has shown promise that these programs reduce expenditures as a whole (Baiker 2010; Goetzel and Ozminkowski 2008; Goetzel 1999; Harris 2009; Musich 2000; Musich et al. 2002; Keehan 2008). Studies have found a significant return on investment (on average, medical costs fall by about $3.27 for every dollar spent on programs) and a reduction in medical costs after sustained participation (Aldana 2001; Baiker 2010; Goetzel 2002; Musich 2000). Not surprisingly, the highest costs savings were among the highest risk individuals (Musich et al. 2002).

Research has tested whether wellness programs that aim to reduce health care risks result in a decrease in medical utilization, measurable as the number of physician and other visits (Ozminkowski et al. 2002; Yen et al. 2001). Results that stand out include a significant reduction in medical care usage from reduced inpatient admissions, fewer mental health visits, and fewer outpatient visits compared with the baseline period (Ozminkowski et al. 2002). These outcomes are testable in this paper. Studies regarding the use of emergency room care have been indecisive in directionality.

Study Setting

Healthy Lifestyle Rewards (as described in detail: Harris 2009, Dissertation. Participation Paper #1) is an online wellness program focusing on modifiable risk factors including physical activity, diet/nutrition, smoking prevention and cessation, and stress management (BSC 2008). Participation in the program is voluntary, and is defined as 1) registration on to the HLR website, and, 2) completing a health risk assessment (HRA) or Wellness Assessment questionnaire. Supplemental components of participation include 3) logging into the HLR website at least once weekly and completing a wellness activity, and, 4) an on-site biometric screening of height, weight, among other markers. Participants can earn up to $200 per year for participating. An individual earns $50 for completion of the Wellness Assessment (step 2), and an additional $50 for every 12 weeks he or she logs into the HLR website and completes a wellness-related activity (step 3). Note that the rewards are not dependent on any biometric marker of success, but simply active participation.

Study Variables

This study uses data provided by Blue Shield of California and WebMD for Healthy Lifestyle Reward participants and non-participating BSC insured members in 2006 and 2007. Medical claims data include medical insurance utilization and claims in thirteen distinct areas: total dollar expenditures; 1) institutional (hospital) expenditures for inpatient admissions, 2) outpatient visits, 3) emergency department visits; 4) non-institutional (indicating non-hospital) expenditures for physician and 5) non-physician visits; pharmaceutical claims for the categories 6) cholesterol medication, 6) depression medications, and 8) other medications. Utilization (in number of visits) is measured for 9) inpatient admissions, 10) outpatient visits, 11) emergency department visits, 12) physician visits, and 13) behavioral health visits.

Aggregate Utilization Variables

The individual categories of medical spending were aggregated to generate five aggregate utilization categories for each participant. These categories include total expenditures in dollars, total utilization in visits, total pharmaceutical claims (cholesterol, depression, and other medications), and total institutional and non-institutional claim amounts.

Demographic variables used for this analysis include age, gender, and several zip-code level explanatory variables. Income data for each participant is also used as a variable in this analysis. Data from the Internal Revenue Service (IRS) income website with average

gross income for each California zip code in 2006 was purchased and downloaded from the IRS SSI Website (IRS 2006). The IRS-provided income data was imported into Stata and merged with the HLR data by zip code to create a proxy income for each member of the study sample. The final analytic data file contains the mean average adjusted gross income (AGI) for each zip code of each Blue Shield of California insured member.

Other variables on which participants were matched include the subscribers network (either HMO or PPO), and the employer group through which the subscriber was associated. The employer groups eligible to participate in HLR with greater than 150 participants in any given year include: CalPERS, Blue Shield of California, High Desert Trust, City and County of San Francisco, County of Santa Barbara, County of Riverside, and Individual & Family Plans (IFP).

Study Sample / Population

Intervention Group
The initial population of members consisted of 10,368 participants in HLR in 2006 as indicated by BSC. Of the 10,368 participants, 824 had no member ID, and therefore could not be matched to any member in the claims data set. The remaining 9,544 participants were reduced to a sample of 8,889 due to the fact that 655 of these members were not covered by BSC health insurance in 2007. In the remaining sample, 46 of the members had more than one record that corresponded to their unique member ID, age, and gender, due to the fact they changed network (HMO to PPO) or employer plan during the year 2006 or 2007. A correction is made for 46 members to sum their claim amounts, utilization, and member months, so each record in the HLR database represents a unique insured member. The final sample for this analysis contains 8,843 unique members who were participants in HLR in 2006 and eligible to participate again in 2007. However, of these 8,843 members, only 8,003 could be matched to a control. The intervention group is the 8,003 individuals who could be matched on five dimensions to a control.

Control Group
The control group for this analysis consists of individuals who were insured by BSC health plan in both 2006 and 2007, had spending data for both years, but did not participate in HLR in either year. The control group population begins with 2,069,054 individuals who were non-dependents insured by BSC in 2006 and 2007. Individuals who did not have California zip codes were dropped from the control group, as were those who had multiple records associated with their unique ID number, or appeared to be erroneous entries (e.g. 174 people marked as insured more than 12 member months per year). An attempt was made to match the remaining 2,068,706 individuals in the sample to the HLR participants. After multiple attempts, 187,631 individuals remain in the control group sample because they could be matched to participants on five dimensions.

Research Design

The study design analyzes whether medical claims and utilization changed between 2006 and 2007 for HLR participants as compared to a matched control group of non-participants. The sample consists of HLR participants in the year 2006, and computes the difference in their medical claims between 2006 and 2007. This difference is compared to matched controls that did not participate in HLR in either year.

Due to the highly skewed nature of the medical claims expenditures and utilization data, a logarithmic transformation of medical expenses is performed to diminish the influence of extreme values and zeros. This approach minimizes the skewness of the residual, and a test of the transformation of the variables looks roughly normal. This approach to taking the logarithm of medical care expenditures has been applied widely and is accepted in the literature (Diehr, Yanez et al. 1999; Duan, Manning et al 1983; Manning, Newhouse et al. 1987).

Statistical Models

The basic difference-in-difference model is as follows:

$y_{itk} = \mu + \theta_{it} + \alpha_t + \lambda_k + \varepsilon_{itk}$, where

y_{itk} = The dependent variable represents the claims value for HLR participating individual i = 1, 2 (participants and their matched pairs) and time t = 0, 1 (2006 and 2007) within matched pair k = 1…. K. It represents the dependent variable: utilization, log of utilization, or a binary indicator (0, 1) indicating positive utilization of medical spending [4]

μ = constant

θ_{it} = The treatment effect (interaction between the treatment and the year), where the treatment is participation in HLR in 2007. Assume $\theta_{it} = 0$ (no HLR participation) unless i = 1, t = 1. The effect of HLR in 2007 is θ_{11}

α_t = For the entire sample, what the trend of expenditures was between 2006 and 2007.

λ_k = Fixed effect for both the year and the pair. For each matched pair, the model adds a fixed effect, which indicates that one person is specifically matched to another. The fixed effect incorporates the information from each pair, k, as a combination of the combined influence of age, sex, network, plan, and zip code.

[4] This paper uses two forms of this model. In one form, the dependent variable is an observed, continuous variable, such as the logarithm of medical expenditures. This model is used either in the one-equation form to model the logarithm of the utilization. It can also be used for the second part of the two-part model, where the sample is restricted to those people for whom y_{itk} is positive. In the first part of the utilization model, the probit model is y_{itk} * due to the existence of an unobserved latent variable. The first part of the two part model runs the probit model where is y_{itk} * is the latent variable and is y_{itk} is observed as either 0 or 1.

The model calculates the response variable, y_{itk}. The estimate of θ is the treatment effect, the mean of the difference-in-difference (DD):

$$\mathbf{DD}(y_{itk}) = (y_{21k} - y_{20k}) - (y_{11k} - y_{10k})$$

The difference-in-difference tests whether the sample mean of $\{ \mathbf{d_k} \}$ is statistically different from zero.

Exact Matching
An exact matching (and near exact matching) statistical procedure is used for a one-part difference-in-difference analysis. Participants in 2006 are matched to controls on age group (intervals of 5 years), gender, plan (HMO or PPO), employer group, and Aggregate Gross Income (AGI) based on the zip code of the participant. Stata Statistical Software is used to compute the matches.

Out of the 8,843 unique individuals that participated in HLR in 2006, 6,674 generate exact matches, and 2,169 remain that could be matched by gender, age, plan, and group, but *not* matched exactly by zip code. A secondary attempt at exact matching is made, where the remaining 2,169 individuals are matched to controls that have zip codes with a similar mean value of AGI (within a 20% absolute deviation of the participant zip code AGI), and within 30 kilometers (18.64 miles) of the participant. Of the 2,169 unmatched participants, near matches could be made on an additional 1,324 leaving a final analytic sample of participants numbering 8,003.

Note that when an exact match is conducted, without using the nearest zip code strategy, 6,674 individuals generate exact matches on all five dimensions. The approximate zip code for people who were in California using a radius of 30K and absolute value income of 20% AGI resulted in a significantly greater number of individuals being matched, therefore this technique was used to generate the final sample. However, the difference-in-difference results using the sample with only the exact matches were conducted in Stata to determine whether results changed significantly. The results were unchanged, and the table is presented in the Appendix of this paper.

Monte Carlo Simulation
For each HLR participant, there were a number of potential matches in the control group sample that sufficiently match on all the parameters of age, gender, plan, network, and zip code (with the variability of within 20% of the AGI, and a distance of 30 kilometers). Monte Carlo simulations so as to repeatedly draw random matches of non-participants against participants take into account not only the uncertainty in any given match but also as to the uncertainty across matches. The Monte Carlo simulation runs the given match program a specified number of iterations and randomly selects a match for each participant. The program saves all of the estimated coefficients and standard errors from the specified number of draws, and averages them to generate a coefficient for the beta value and standard error. The Monte Carlo simulation of how each estimator varies depending on the potential matches has been used in health economics and health

services research studies (Manning 1998; Manning 2001; Norton 2008; Veazie 2003). The Monte Carlo simulation is performed 100 times on each potential match. (A test of 50 simulations was also conducted; results are not presented in this paper). The Monte Carlo simulations used with the exact matching technique results in 8,003 participants and 8,003 matched pairs (averaged with 100 simulations run).

Logarithmic Transformations with a Global Zero

Since health expenditures are highly skewed and tend to have a right tail and many values of zero, the logarithm is taken to normalize the values for this analysis. However, because a value of "0" cannot be log transformed, a constant, termed a "global zero" was added to each of the depended variables to take into account this feature of logarithms. This statistical technique has been applied widely in the literature on logarithmic transformations, and used in the regression analysis in the RAND Health Insurance Experiment (Duan 1983; Duan 1987; Guevara 2003; Lawless 1989; Manning 1998; Motheral and Henderson 1999; Suka 2009; Vaezie 2003). The closer this constant is to *zero*, the more the outcome is similar to a binary variable. Statistical tests are performed on a basic logarithmic transformation model setting the constant equal to 0.1, 0.01, and 0.001. The models for this analysis are conducted using a constant of 0.01. Because the strategy employed for handling zero logarithmic values can influence the resulting statistics, the results for the other values (0.1 and 0.001) are presented in the Appendix of this paper.

CalPERS Interaction Model

To examine the hypothesis that the effect of the HLR program is different among CalPERS participants (see Harris, 2009; Participation Paper #1), a version of the log-linear difference-in-differences model (based on 100 repeated draws from a random set of matches) is conducted which estimates the interaction effect with CalPERS members. A dummy variable indicates whether a person is an HLR participant in 2007 and in CalPERS, and the model tests whether this interaction variable is significant for each individual and aggregate utilization category. Specifically, the model with the CalPERS interaction is:

$$y_{itk} = \mu + \theta_{it} + \mathbf{Bit^*\ CalPERS_k} + \lambda_k + \alpha_t + \varepsilon_{itk}$$

The difference in difference for each pair (CalPERS participant and his match) is:

$$\mathbf{d_k = \theta_{11} + B_{11}^*\ CalPERS_k} + \mu_k$$

B_{it} will only be non-zero for the participant in the second year with a CalPERS component. Therefore, the constant term shown in the model is equivalent to the effect of HLR among the non-CalPERS sample (CalPERS is equal to zero), and the beta coefficient is how the effect of participation in HLR changes in the CalPERS members as compared to the non-CalPERS members. The coefficient $\mathbf{B_{11}}$ determines whether CalPERS affects the result, where B is the additive effect of belonging to CalPERS.

Two-Part Conditional Model

In analyzing utilization data, the first approach in this paper employs a one-part linear model with a logarithmic transformation of the data. This one-part matching model

compares changes in the dependent variables from the pre-period to the post-period regardless of the initial amount of spending.

A second method used in the literature to analyze non-normal data and to address the high concentration of zero values in medical spending is a two-part model. A two-part model attempts to correct the problem of non-spenders (zero values for medical claims) by separating behavior into two stages (Diehr, Duan et al. 1987; Duan, Manning, et al. 1983; Guevara 2003; Norton 2008; Yanez et al. 1999). The first part is a logit model predicting the binary event that an individual has any non-zero medical utilization in 2006. A second equation is a log linear function predicting the level of use on a logarithmic scale for only those individuals who have positive spending in part one of the model. The results from the two-part model are then used to estimate the proportional change in all measures of utilization attributable to participation in HLR. The two-part model predicts the mean value of the logarithm of positive utilization, where the first part of the two part model (beta coefficient) is multiplied by the proportion of "zero" claims values, and then added on to the second part of the two-part model, which is equal to the logarithm of the mean value of positive utilization. The results of this model are used to estimate the effect of the intervention [X] with the probability equation: $d(\ln E[Y])/dX = b * (1 - p) + g$. Results are presented in Table 4. The expected level of use for an individual is therefore calculated by using the results of the two-part model to estimate the proportional change in medical utilization due to HLR (Duan, Manning, et al. 1983).

All statistical analyses were conducted with Stata Statistical Software (Stata Corporation, College Station, Texas).

Results

Table 1 presents descriptive statistics for each dependent variable for the 8,003 HLR participants, and the mean values for the pool of potential matches based on the five dimensions of age, gender, plan, network, and zip code.

Table 2 shows the results for the complete sample of participants (N = 8,003) matched to non-participants who were insured by BSC in 2006 and 2007. The model specifications include 100 Monte Carlo simulations, and a log of zero set to the constant 0.01. Separate models were conducted with individual expenditures and aggregate expenditures. Results are highly suggestive of an effect of HLR on medical spending and utilization in both individual and aggregate dimensions. Participants had significantly lower outpatient visit claims, non-institutional physician and non-physician visits, and lower number of outpatient visits than their matched pairs. Aggregate categories show that total expenditures, non-institutional spending, pharmaceutical spending, and utilization in visits were significantly reduced for participants in 2007 after participating in HLR in 2006. This is an important initial finding indicating a short-term effect of participating in HLR.

The results of an additional log linear difference in difference model to determine whether the effect of participating in HLR on medical utilization for those in the

CalPERS sample was different than the general population in both aggregate and individual spending categories are presented in Table 3. Out of the 8,003 participants in HLR, 1,361 belonged to the CalPERS employer group, and 6,642 belonged to another employer group. The constant coefficient in the model shows the effect of participation on medical claims in the non-CalPERS sample, and the beta coefficient indicates (the interaction term) indicates the additional affect of adding a CalPERS sample. If the coefficient of the utilization category is significantly different from zero, the results indicate that the effect of HLR membership on utilization is different in the CalPERS group. The results in Table 3 show that in the non-institutional visit category, number of physician visits, and aggregate categories of total expenditures, total visits, and total non-institutional claims, CalPERS participants have a very strong positive interaction effect. For example, in the physician visit category, the effect in the CalPERS population is +0.36, yet the effect of HLR in the general population is -0.31. The coefficient for the effect of HLR participation on emergency department admissions for the CalPERS sample is negative; indicating that participation in HLR for CalPERS members decreased emergency department admissions. These results indicate that in the CalPERS population, HLR is stimulating utilization in these areas; a significantly different result from the general population of all participants, CalPERS and non-CalPERS combined (results in Table 2).

Table 4 presents the results of the two-part model, analyzing the trend in spending between HLR and non-HLR participants across two years. The first part of the model is a logistic model reported as odds ratios, e^B, with 95% confidence intervals. This model tests whether the odds ratio is significantly different from 1 (the odds of the probability of a change in the expenditure level). Significant spending is found in total expenditures, non-institutional (physician and non-physician) medical spending, and in total number of visits, specifically with high physician visit utilization. This logistic model also takes into account the fixed effects of the matched individuals and uses specifications similar to the other models with 100 Monte Carlo simulations and a constant log zero of 0.01.

The second part of the two-part model calculates the difference in the logarithm of spending for only those individuals who had a positive spending in part one of the logistic model. The results of the coefficients can be interpreted as the absolute percentage change in the probability of use of medical care among those people who had positive expenditures in part one. Table 4 shows that the change in expenditures in the categories non-institutional physician and non-physician visits has significantly decreased from 2006 to 2007, with an estimated decrease of approximately 7.5% among those individuals who had any positive spending at all in 2006. Total utilization (all categories aggregated) and count utilization in physician visits was highly significant, with a decrease in expenditures of 6.4% in physician visits, and 10.8% decrease in overall expenditures (among only those people who had positive expenditures in 2006). The models consistently show that HLR participation in 2006 was associated with significant declines in areas of non-institutional claims, and physician visit utilization.

Table 4 also shows the estimation results for the effects of HLR on utilization variables. All categories, with the exception of spending on cholesterol medication, and number of

inpatient admissions resulted in a percentage decline in medical utilization attributable to participation in HLR. Consistent with the findings presented thus far in this paper, the largest declines were in areas of non-institutional claims, and physician visits. Results showed a 28.56% decline in non-institutional physician visits attributable to HLR, a 8.57% decline in non-institutional non-physician visits, and a 31.52% decline in physician visits. Aggregate categories of expenditures also demonstrated huge declines in the percentage of spending attributable to participation in HLR. Total expenditures decreased by 40.53%, non-institutional claims decreased by 36.27%, and total number of visits declined by 31.46% attributable to HLR.

Strengths

Briefly, the statistical techniques used in this study add to the strength of the analysis indicating a true casual affect of HLR. This study does not ignore the highly skewed nature of medical costs (Bly et al. 1986; Lynch et al. 1989), and uses a logarithmic transformation to correct for the non-normal distribution of medical claims data. The study design addresses issues of confounding by employing a matched design to analyze the change in spending between the base year, 2006, and the subsequent year, 2007. Finally, the Monte Carlo simulations give this study a strong methodical base. Simply picking one random match for each of the HLR participants and then conducting a difference-in-difference model understates the true uncertainty in the analysis due to the fact that there is uncertainty in which individual was matched (Manning 2001; Norton 2008). The Monte Carlo simulations calculate the different values of the estimated coefficients between the 100 unique draws, and find that the "percent variance due to different draws" (the percent indicating what proportion of the uncertainty or variability in the estimate is due to the fact that the program is making different matches in each of the 100 draws) are between 25% and 30%, a relative low variance for this type of simulation (Duan 1987).

Limitations

The limitations of this study include the fact that the time period of this analysis is two years, and it may be that a longer time is required for HLR to have a true affect on medical claims. In addition, the two-part model procedure looses a lot of information in the sense that a lot of data are dropped due to a large percentage of participants with zero expenditures. Finally, it could be also that the logarithmic transformation doesn't sufficiently transform the data in the first models.

The internal validity of this study may be threatened due to the fact that there may be a causal relationship between individuals' use of medical care and voluntary participation in the HLR program. This is addressed in participation models in Paper 1 to address the research question of whether populations that participate in HLR are significantly different than non-participants with respect to medical claims. The repeated Monte Carlo simulations used in the methods of this study add to the validity that the effect is not due to confounding or spurious relationships. Threats to external validity in this study include the fact that the study sample is concentrated in California, and the participants are voluntary. Volunteers may systematically differ from non-volunteers in the characteristics causing them to participate in the HLR program. In addition, all

participants were insured throughout the entire period of the study, yielding limited generalizabiliy regarding the effect of medical care use and claims for uninsured, or for those without access to the Internet.

Discussion

This analysis addresses the research question of what effect participation in the 2006 HLR program had on participants' change in claims expenditures from 2006 to 2007. The results of multiple analyses consistently demonstrate that participation in HLR in 2006 was associated with significant declines in measures of outpatient medical use in the following year. Specifically, among individuals who remained insured members, participation in the HLR program in 2006 is associated with a significant decline in outpatient health care use both physician and non-physician, institutional and non-institutional.

The difference in difference model for both individual and aggregate expenditures of medical care found that there was no significant effect on reduction in utilization of medical care, such as non-voluntary inpatient emergency room admissions and behavioral health visits. However, results from the model demonstrate that in the general category of outpatient visits, whether they were to a clinic, a physician's office, or a non-physician provider, there were significant declines attributable to HLR. Results also demonstrated some overall declines in pharmaceutical spending that could not be attributed to any one category, such as spending on cholesterol or depression medication.

While these declines in expenditures may represent some improvement in health or risk factors from 2006 to 2007, there were not corresponding changes in indicators of non-voluntary, urgent health care utilization, leading to the conclusion that the HLR program may have had an independent effect on use of medical services controlling for health improvements. One explanation for these findings is that the reduction in medical expenditures could be a result of a reduction of risk factors of participants. However, when the model analyzed specific types of health care that were reduced, depression and cholesterol spending were not significantly changed as a result of the program. Emergency room visits were not reduced either. Reductions in cholesterol and depression medication may be a proxy for improvement in health risk factors, while an increase in medication usage may indicate that the program helped to identify an individual that had an untreated medical problem.

An alternative explanation is that voluntary medical use declined, specifically in physician visits, due to the informational nature of the HLR program. Aside from physicians treating symptoms of patients, they also provide an informational function to help diagnose and discuss medical problems. The use of HLR and the WebMD services provided may serve as a substitute informational function for visiting the doctor, but not as a substitute for an emergency room visit. This result is consistent with the hypothesis that participants were using the informational function as a substitute for visiting a physician when they had a non-urgent medical question.

The results of this analysis only take into account the difference in claims over one year. It is more difficult to hypothesize that this short-term effect over one year is due solely to health improvements, but rather partly as a result of participating in the HLR program. In trying to interpret these results and their interpretations for policy overall, it is important to take into account that these results only represent changes over one year. A longer-term study is ideal to assess future impact of the program.

It is possible that a participant may have improvements in health and risk behaviors over the course of one year, but is more realistic to conclude in the short-term that individuals can reduce spending on voluntary medical care for non-serious and non-urgent conditions in which information is a substitute for medical care. This also has to be balanced between the fact that one of the informational purposes of the program is to identify people that had previously undiagnosed conditions, and this would actually increased spending (countervailing factor). Again, the most likely explanation is that the program is serving as a substitute for some voluntary physician visits. This is consistent with the hypothesis that Internet based wellness programs serve as a substitute for some forms of outpatient care, most likely because they serve an informational function to participants seeking medical advice. The Internet content of HLR is, in fact, designed to meet the demand for information related to wellness (BSC 2007). The WebMD content on the HLR Program includes information on exercise, smoking cessation, stress management, nutrition, and weight loss. In addition, participants are also able to access twelve "Information Centers" and thirty-two "Conditions Centers" which provide mini-assessments and links to in-depth information on several important health issues such as substance abuse, cancer prevention and anxiety control (BSC, City of San Jose Retirement Newsletter 2008).

An important policy implication gained from the results of the claims analysis is that designers of wellness programs should continue to strengthen the informational resources, diagnostic tools, and medical references available for participants in the program. Promotional materials for HLR that recruit individuals into the program should emphasize that the program provides medical information that is accurate and inexpensive, which could serve as physician advice. In the most recent version of the HLR program, the incorporation of a telephonic "health coach" is available to participants (Harrison Interview, 2009). The telephonic coach is a resource that may be a direct substitute for physician advice or non-urgent care.

This paper also tests the question of whether the effect of HLR is consistent across employer plans, as the previous analysis (Paper 1) has shown that different employer plans have members of varying risk levels. The inclusion of CalPERS interaction effects for the sample (Table 3) indicates that in the CalPERS population, HLR may be stimulating utilization. One explanation for this finding is that if CalPERS members are a higher-income, lower-risk sample than the rest of the HLR population (Harris 2009; Dissertation Paper 1), then HLR does not result in the same effect because these participants may already be using the Internet to address wellness and health related questions. The monetary incentive may not be as strong a motivation for participation

due to the fact that this sample is of higher income as compared to the non-CalPERS participants.

However, a larger concern is that wellness programs may actually stimulate greater levels of expenditures by advising or alerting individuals to visit the doctor to receive the most up to date preventive care, or that these programs would genuinely identifying undiagnosed chronic conditions that require additional medical treatment. However, this analysis finds no evidence that these programs significantly stimulate medical care in any category of expenditures. Although the data are still short-term, and there is not enough detail about the nature of the physician visits (what medication has been prescribed, what medical conditions have been diagnosed), these results still dispel concerns that these programs lead to higher medical costs.

On a policy level, the results from this analysis indicate to policy makers and program administrators that if we begin to institute these programs on a greater scale, the result that there will be a massive increase in health care spending is not grounded in empirical evidence. Policymakers, insurers, and employers should be concerned with the design of the programs, the delivery of medical information, and as analyzed in Paper 1, creating the correct incentives for high risk populations to join. With that said, this paper finds no evidence that instituting these programs will result in harm with respect to increased medical spending.

A final policy level concern is whether the programs, through reducing physician visits and reducing overall medical expenditure claims, have subsequently improved or worsened consumer health. One argument is that not only does the informational nature of the Internet serve as an adequate substitute for medical information, but that there is no negative consequences on consumer risk factors and health status as a result of the reduction in medical costs. Paper 3 tests this research question in further detail.

Conclusions

In designing wellness programs that aim to not only improve the health of participants, but also lead to a reduction in their use of medical services, this paper found that participation in HLR was associated with a statistically significant decrease in certain categories of non-urgent medical care. This is supported by the finding that the Internet-based informational component of the HLR program may have served as a substitute for non-urgent medical advice. Specifically, the informational nature of the Internet may be of value to a participant as it may help him or her identify a condition, or recommend a treatment that may reduce the necessity of visiting a physician. Logging on to WebMD through HLR to resolve a medical question may serve the same function as visiting an outpatient clinic, a dietitian, or a non-urgent medical physician. In addition, the biometric screening of participants at the start of the HLR program may erase the need for a physician check up during that time period.

In terms of policy making, the results from this paper should reassure policy makers that participants in wellness programs do not create additional medical expenditures. Future programs should be designed with the goals of incorporating informational features and tools that will be relevant to participants so that they may be used as a policy strategy to lower non-urgent and voluntary medical visits.

The results from this study provide support for 2010 recent health care reform, and for President Barack Obama's emphasis on prevention as a central component of congressional reform proposals. In light of the recent Health Care Reform Legislation enacted in March 2010, the results of this paper provide empirical support for bill language specifies that authorizes grants will be made for small business to provide comprehensive wellness programs to their employees (US Congress and House Committee: http://rules.house.gov/bills.aspx; http://www.opencongress.org/). These results also encourage federal subsidies such as tax credits, or an easing of regulatory barriers for program design (Mello 2008) that are hypothesized to lead to improved health care outcomes and a slowed growth of medical care expenditures. This study should reassure employers that provision of additional wellness programs will not stimulate medical utilization or increase medical costs in their currently insured populations. In addition, the legislation encourages employer-sponsored wellness programs under the Health Insurance Portability and Accountability Act (HIPAA) by increasing the premium discount that employers can use to reward employees for participating in wellness programs (Mello 2008).

With increased participation in wellness programs and the added incentive of employee premium reduction, the results of reduced medical claims may be even more pronounced. Designing a successful wellness program, backed by political support, is a promising path to improving health and slowing cost growth among employees.

Tables

Table 1. Descriptive Statistics for Unique HLR Participants and Potential Matches

Variable Name	**HLR = 1** **Mean (SD) of HLR Participants** **N = 8,003**	**HLR = 0** **Mean (SD) of Pool of Potential Matches to HLR Participants** **N = 187,631**
Female Gender	0.7239 (0.4471)	0.743443 (0.4367)
Age, Continuous	40.06 (11.83)	36.99 (12.41)
Institutional Inpatient Admissions Claims ($), 2006	687.56 (6971.26)	654.34 (9454.38)
Institutional Inpatient Admissions Claims ($), 2007	809.55 (7260.20)	621.08 (8937.70)
Institutional Office Visit Claims ($), 2006	621.16 (3231.64)	493.30 (4040.59)
Institutional Office Visit Claims ($), 2007	591.48 (3152.83)	457.92 (3614.33)
Institutional Emergency Department Claims ($), 2006	160.228 (984.54)	142.6835 (806.50)
Institutional Emergency Department Claims ($), 2007	162.81 (920.29)	125.98 (800.61)
Non-Institutional Physician Claims ($), 2006	964.80 (2341.54)	804.04 (2661.95)
Non-Institutional Physician Claims ($), 2007	840.72 (2157.12)	657.34 (2363.22)
Non-Institutional Non-Physician Claims ($), 2006	316.06 (1156.67)	197.69 (1189.54)
Non-Institutional Non-Physician Claims ($), 2007	278.08 (1041.06)	173.59 (1542.03)
Pharmaceutical Claims for Cholesterol Medications ($), 2006	12.29 (117.89)	6.53 (80.18)
Pharmaceutical Claims for Cholesterol Medications ($), 2007	13.36 (125.31)	8.08035 (93.75)
Pharmaceutical Claims for Depression Medications ($), 2006	80.44 (330.58)	56.53601 (255.94)
Pharmaceutical Claims for Depression Medications ($), 2007	69.42 (323.48)	48.57 (254.27)
Pharmaceutical Claims for All Other Medications ($), 2006	613.80 (1606.91)	462.95 (1578.06)
Pharmaceutical Claims for All Other Medications ($), 2007	616.13 (2596.82)	447.78 (1744.54)
Utilization - Inpatient Admissions (#), 2006	0.0587 (0.3013)	0.0525 (0.2785)
Utilization - Inpatient Admissions (#), 2007	0.0589 (0.2732)	0.0425 (0.2446)
Utilization – Outpatient Visits (#), 2006	0.6055 (2.1263)	0.5335 (2.2351)
Utilization – Outpatient Visits (#), 2007	0.5434 (2.1022)	0.4527 (1.9831)
Utilization – Emergency Department Visits (#), 2006	0.1078 (0.4212)	0.1136 (0.4637)
Utilization – Emergency Department Visits (#), 2007	0.0930 (0.3819)	0.0856 (0.3835)
Utilization – Physician Visits (#), 2006	3.9543 (4.4281)	2.9928 (4.1560)
Utilization - Physician Visits (#),	3.3211 (4.3498)	2.4765 (3.9211)

Utilization - Physician Visits (#), 2007	3.3211 (4.3498)	2.4765 (3.9211)
Utilization – Behavioral Health Visits (#), 2006	2.0732 (10.6587)	1.3227 (8.2874)
Utilization – Behavioral Health	1.7818 (10.2130)	1.0715 (7.1793)

Table 2. Difference-in-Difference Analysis for 8,003 Matched HLR Participants vs. Non-Participants who were insured by BSC in both 2006 and 2007

Utilization – Behavioral Health Visits (#), 2006	2.0732 (10.6587)	1.3227 (8.2874)
Utilization – Behavioral Health Visits (#), 2007	1.7818 (10.2130)	1.0715 (7.1793)

Table 2. Difference-in-Difference Analysis for 8,003 Matched HLR Participants vs. Non-Participants who were insured by BSC in both 2006 and 2007

Separate Models for Individual and Aggregate Categories of Expenditures & Medical Utilization ß (Standard Error)* N = 8,003 Matched Pairs		
Dependent Variable (Logged)	**Individual Effects** 100 Monte Carlo Simulations Log of zero = 0.01	**Aggregate Effect** 100 Monte Carlo Simulations Log of zero = 0.01
Total Expenditures		-0.2994 (0.0880)**
Institutional		-0.1743 (0.1221)
Inpatient Admissions	0.0141 (0.0640)	
Outpatient Visits	-0.1979 (0.0907)*	
Emergency Department Admissions	0.0210 (0.0667)	
Non-Institutional		-0.3838 (0.0944)**
Physician	-0.2826 (0.0831)**	
Non-Physician	-0.2376 (0.0814)**	
Pharmaceutical Spending		-0.1565 (0.0794)*
Cholesterol medications	-0.0085 (0.0175)	
Depression medications	-0.0363 (0.0397)	
Other medications	-0.0853 (0.0737)	
Utilization		-0.2500 (0.053)**
Inpatient Admissions	0.0023 (0.0224)	
Outpatient Visits	-0.0875 (0.0387)*	
Emergency Department Visits	0.0056 (0.0268)	
Physician Visits	-0.1859 (0.0443)**	
Behavioral Health Visits	-0.0380 (0.0305)	

* Indicates significance at the $p < 0.05$ level

** Indicates significance at the $p < 0.01$ level

Table 3: The CalPERS Effect: Linear difference in difference model (with matched pairs) to estimate whether the effect of participation in HLR on utilization was significantly different in the CalPERS population as compared to the non-CalPERS

	ß (Standard Error)* N = 8,003 Specifications: 100 Monte Carlo Simulations Log of zero = 0.01	
Dependent Variable (Logged)	Constant Value in Model: Effect of HLR on population with CalPERS = 0	Estimate for different effect of HLR participation on CalPERS as compared to non-CalPERS (interaction term with CalPERS)
Total Expenditures ♣	-0.4044 (0.0976)**	0.6218 (0.2308)**
Institutional	-0.2107 (0.1289)	0.2354 (0.3307)
Inpatient Admissions	0.0133 (0.0834)	0.582 (0.1996)
Outpatient Visits	-0.2723 (0.1074)*	0.2232 (0.2604)
Emergency Department Admissions	0.0328 (0.0815)	-0.0753 (0.2118)
Non-Institutional	-0.5026 (0.1000)**	0.7072 (0.2525)**
Physician	-0.5187 (0.1074)**	0.7459 (0.2661)**
Non-Physician	-0.3336 (0.1012)**	0.2116 (0.2545)
Pharmaceutical Spending	-0.1949 (0.0885)*	0.2142 (0.2123)
Cholesterol medication	-0.0132 (0.0218)	-0.0006 (0.0544)
Depression medication	-0.0502 (0.0481)	0.0355 (0.1272)
Other medication	-0.1727 (0.0904)	0.2307 (0.2153)
Utilization	-0.2980 (0.0580)**	0.3048 (0.1436)*
Inpatient Admissions	0.0023 (0.0269)	0.0265 (0.0698)
Outpatient Visits	-0.1143 (0.0475)*	0.0844 (0.1185)
Emergency Department Visits	0.0012 (0.0344)	-0.0232 (0.0850)
Physician Visits	-0.3103 (0.0553)**	0.3616 (0.1380)**
Behavioral Health Visits	-0.0397 (0.0405)	-0.0655 (0.0984)

* Indicates significance at the $p < 0.05$ level

** Indicates significance at the $p < 0.01$ level

♣ Significant results indicate that belonging to CalPERS resulted in HLR having a different effect on the utilization category.

Table 4. Conditional 2-Part Model; Logistic, Log-Linear & Combined Effect of HLR Participation

	Part 1: Logit with Fixed Effects, Reported as Odds Ratios (95% Confidence Intervals)* N = 8,003	**Part 2: Log Linear for those who had Positive spending in Part 1 ß (Standard Error)* N = 8,003**	**Combined Effect of Participation in HLR N = 8,003 (Percent Reduction Attributable to HLR)**
Dependent Variable	100 Monte Carlo Simulations Log of zero = 0.01	100 Monte Carlo Simulations Log of zero = 0.01	(% change attributable to combined effect of Part 1 & Part 2)
Total Expenditures	0.6884 (0.5929 0.7993)**	-0.1080 (0.0402)**	-40.53%
Institutional	0.9144 (0.8091 1.0333)	-0.0007 (0.0942)	-2.53%
Inpatient Admissions	1.0384 (0.8214 1.3127)	-0.0090 (0.2634)	-0.71%
Outpatient Visits	0.8741 (0.7613 1.0036)	-0.0269 (0.1045)	-5.55%
Emergency Department Admissions	1.0041 (0.8236 1.2242)	-0.0346 (0.1746)	-3.43%
Non-Institutional	0.6843 (0.5970 0.7845)**	-0.0753 (0.0330)*	-37.57%
Physician	0.7419 (0.6501 0.8466)**	-0.0779 (0.0354)*	-28.56%
Non-Physician	0.8544 (0.7570 0.9645)*	-0.0251 (0.0545)	-8.57%
Pharmaceutical Spending	0.9274 (0.8214 1.0470)	-0.1085 (0.0486)*	-15.95%
Cholesterol	0.8878 (0.5923 1.3307)	0.0372 (0.1590)	3.47%
Depression	0.9642 (0.8236 1.1287)	-0.0167 (0.0899)	-2.19%
Other	0.9440 (0.8358 1.0662)	-0.0999 (0.0477)*	-13.85%
Utilization	0.7108 (0.6228 0.8114)**	-0.0664 (0.0268)*	-31.46%
Inpatient Admissions	1.0339 (0.8087 1.3217)	0.0182 (0.0867)	1.99%
Outpatient Visits	0.8753 (0.7644 1.0022)	-0.0254 (0.0493)	-5.39%
Emergency Department Visits	0.9986 (0.8186 1.2182)	-0.0254 (0.0726)	-2.55%
Physician Visits	0.7050 (0.6190 0.8030)**	-0.0638 (0.0233)**	-31.52%
Behavioral Health Visits	0.9525 (0.7948 1.1413)	-0.0480 (0.0991)	-5.31%

* Indicates significance at the $p < 0.05$ level

** Indicates significance at the $p < 0.01$ level

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Appendix

Appendix Table 1: Exact Matches Results (Without Nearest Zip Code Strategy Match)

Exact Matches on Age Category, Gender, Plan, Network, 5-Digit Zip ß (Standard Error)* N = 6,674	
Dependent Variable (Logged)	Specifications: 100 Monte Carlo Simulations Log of zero = 0.01
Total Expenditures	-0.2443 (0.0985)*
Institutional	-0.1767 (0.1292)
Inpatient Admissions	0.0160 (0.0781)
Outpatient Visits	-0.2478 (0.1131)*
Emergency Department Admissions	0.0234 (0.0848)
Non-Institutional	-0.3173 (0.1007)**
Physician	-0.3445 (0.1049)**
Non-Physician	-0.2974 (0.0988)**
Pharmaceutical Spending	-0.1331 (0.0892)
Cholesterol	-0.0102 (0.0219)
Depression	-0.0428 (0.0512)
Other	-0.1035 (0.0881)
Utilization	-0.2226 (0.0556)**
Inpatient Admissions	0.0056 (0.0273)
Outpatient Visits	-0.1099 (0.0481)*
Emergency Department Visits	0.0070 (0.0364)
Physician Visits	-0.2308 (0.0566)**
Behavioral Health Visits	-0.0440 (0.0388)

* Indicates significance at the $p < 0.05$ level

** Indicates significance at the $p < 0.01$ level

Appendix Table 2: Further Modification of Global Zero from 0 = 0.1, 0.01, 0.001

	ß (Standard Error)* N = 8,003		
Dependent Variable (Logged)	Specifications: 100 Monte Carlo Simulations **Log of zero = 0.1**	Specifications: 100 Monte Carlo Simulations **Log of zero = 0.01 ♠**	Specifications: 100 Monte Carlo Simulations **Log of zero = 0.001**
Total Expenditures	-0.2525 (0.0753)	-0.2994 (0.0880)**	-0.3332 (0.1091)**
Institutional	-0.1375 (0.0987)	-0.1743 (0.1221)	-0.2137 (0.1398)
Inpatient Admissions	0.0244 (0.0591)	0.0272 (0.0709)	0.0292 (0.0856)
Outpatient Visits	-0.1786 (0.0805)*	-0.2173 (0.0998)*	-0.2710 (0.1229)*
Emergency Department Admissions	0.0097 (0.0638)	0.0201 (0.0766)	0.0191 (0.0914)
Non-Institutional	-0.3170 (0.0742)**	-0.3838 (0.0944)**	-0.4489 (0.1103)**
Physician	-0.3227 (0.0779)**	-0.4036 (0.0984)**	-0.4708 (0.1145)**
Non-Physician	-0.2239 (0.0737)**	-0.2902 (0.0916)**	-0.3656 (0.1136)**
Pharmaceutical Spending	-0.1384 (0.0639)*	-0.1565 (0.0794)*	-0.1729 (0.1055)
Cholesterol	-0.0103 (0.0150)	-0.0137 (0.0197)	-0.0170 (0.0244)
Depression	-0.0410 (0.0337)	-0.0510 (0.0449)	-0.0627 (0.0559)
Other	-0.1183 (0.0619)	-0.1271 (0.0791)	-0.1493 (0.1007)
Utilization	-0.1690 (0.0341)**	-0.2500 (0.053)**	-0.3230 (0.0723)**
Inpatient Admissions	0.0035 (0.0129)	0.0065 (0.0252)	0.0136 (0.0386)
Outpatient Visits	-0.0589 (0.0244)*	-0.1026 (0.0446)*	-0.1497 (0.0622)*
Emergency Department Visits	-0.0012 (0.0164)	-0.0032 (0.0304)	0.0039 (0.0471)
Physician Visits	-0.1664 (0.0311)**	-0.2501 (0.0520)**	-0.3410 (0.0699)**
Behavioral Health Visits	-0.0325 (0.0224)	-0.0479 (0.0363)	-0.0589 (0.0484)

♠ Global Zero 0.01 results also presented in main results of paper

* Indicates significance at the $p < 0.05$ level

** Indicates significance at the $p < 0.01$ level

Paper 3

The Impact of Participation in the Healthy Lifestyle Rewards Program on Modifiable Health Risks

Abstract

Objectives: This study evaluates a cohort of insured participants in Blue Shield of California's Healthy Lifestyle Rewards (HLR) program in 2006 and 2007 to assess the change in endpoints of self-reported health behavior and biometric measurements after one year of program participation. The paper addresses the question of whether increased program exposure (through utilization of specific health-related programs) has a significant change in heath behaviors.

Sample: A cohort of 8,003 individuals is followed who participated in HLR in 2006 and 2007 and completed an online Wellness Assessment questionnaire. In 2006 and 2007, a group of 761 unique individuals filled out 1,658 assessments in both years. Additional data are used from a larger sample of 4,782 Wellness Assessment records representing 3,583 individuals who filled out a Wellness Assessment in either year. The sample is 79% female, has a mean age of 41 years, and two-thirds are enrolled in an HMO plan type.

Methods: Linear fixed effects and random effects regression models were used to evaluate the change in health related endpoints from 2006 to 2007 for participants in HLR. Control variables included the number of times the participant logged in to the program, as well as measures of medical utilization in 2006. Independent variables of age, gender, plan, network, and income were manipulated in an additional model to simulate the effect of the HLR program on specific profiles of participants.

Results: A significant association was found between participation in HLR and health related endpoints. While endpoints related to weight loss yielded inconsistent directional results, participants in HLR exercised more frequently, consistently ate more fruits and vegetables, and reported lower stress levels. In addition, participation in HLR was associated with an increase in the self-reported diagnosis of diabetes, high cholesterol, and depression. For endpoints with a specific program feature (such as weight loss help, stress management, or fitness tracker), those who utilized the program more frequently had greater improvements in these risk factors.

Conclusions: The results of this study find that the use of specific HLR help modules is associated with a significant improvement in numerous biometric and health risk factors. This paper provides meaningful evidence that participation in workplace wellness programs is associated with a decline in many health risks; effects which vary by age, gender, plan type, network, and income. In addition, this paper provides insight into the best design of wellness programs with the use of targeted disease-specific intervention modules.

Introduction

An extensive scientific knowledge base supports the benefits of preventive medicine focused on areas of diet, exercise, smoking, stress reduction, and weight management (USPSTF 2010). Although the evaluation of many interventions have resulted in positive behavioral change, at least in the short run, little is known regarding the effects of Internet-based interventions to understand whether or not these wellness programs result in positive changes for health related endpoints.

The existing literature has provided evidence that workplace wellness programs have been effective in modifying risk factors and incentivizing participants to make short-term changes their health behaviors (Anderson 1999; Fielding 1990; Goetzel 2002; Glasgow 1995; Harris 2009). A great deal of research has focused on interventions aimed at obesity reduction manifesting in improved diet and increased exercise (Sorensen 1998; Hersey 2008). These programs found that interventions related to behavior modification in these areas were in fact effective, and in some cases, regular receipt of e-mail messages led to increased physical activity level and healthier food choices (Hersey 2008; Harris 2009; Sternfeld 2009). Anti-smoking programs have also shown promise in leading individuals to quit, although the most effective interventions have found a successful mix of counseling for behavior modification, medication, and social support (Pelletier 1999; Glasgow 1995). On the whole, there is widespread agreement that participants in wellness programs often have improved health outcomes as a result of a targeted intervention, either through the worksite, or the Internet.

This paper adds to the existing literature on wellness programs by analyzing participation in Blue Shield of California's (BSC) Healthy Lifestyle Rewards (HLR) workplace wellness program. This paper follows a cohort of 8,003 individuals who participated in HLR in 2006 and 2007 and completed an online Wellness Assessment questionnaire. This analysis examines the effect of participating in prevention related activities through the HLR website on dependent health related endpoints including diet, exercise, stress, smoking, disease diagnoses, and biometric markers. In addition to following the entire cohort from 2006 to 2007, this paper selects demographic profiles that are representative of types of individuals that participate in HLR to determine whether participation in HLR estimated a change in health risk behaviors. Previous analysis of the HLR program (Harris, Dissertation Paper 2, Claims) as well as other research on wellness programs found that participation was associated with reduction in some forms of medical expenditures, specifically expenditures related to outpatient medical care, including physician visits. The same cohort of individuals analyzed in Paper 2 is further assessed to see whether participation in HLR (which resulted in a decrease in medical care) was also associated with a decline in health status.

The purpose of this research is to address the following questions:

1) For the endpoints of diet/nutrition, exercise, stress reduction, smoking reduction, disease diagnoses, and biometric markers, controlling for other factors, did the cohort of HLR participants demonstrate an overall improvement in health risk factors after one year of program participation?

2) For the health related endpoints where there was a specific HLR-program related module, did greater program exposure and use of the help or disease management tool have a significant effect on changes in the health risk factor?

3) Controlling for other variables such as program exposure and medical utilization, was there an overall improvement in the health of the cohort for a sample of demographic profiles specified in this paper?

A major limitation of this study is that there is no control group of non-participants who completed a Wellness Assessment. As a result, the hypotheses are designed to take this limitation into account. This research hypothesizes that there was a significant improvement in the trend of specific health related endpoints during the time period 2006 and 2007 among HLR participants. In addition, this paper hypothesizes that there is a positive association between utilization of program-specific components and changes in targeted health endpoints, and that greater program utilization is associated with larger health benefits. Finally, it is hypothesized that the reduction in certain classes of health expenditures (specifically physician visits) are not associated with any observable declines in health in the short run among participants.

Background

The Healthy Lifestyle Rewards Internet-based wellness program has been offered by Blue Shield of California (BSC) Health Insurance Company to select employer groups since 2004. Based on the availability of data, this research is restricted to participants in 2006 and 2007 in the following employer groups: CalPERS, Blue Shield of California Employees, High Desert Trust, City and County of San Francisco, County of Santa Barbara, County of Riverside, and Individual & Family Plans (IFP)[5].

The HLR program consists of several components, including an online health risk assessment created by *WebMD*, the "Wellness Assessment." The Wellness Assessment is a self-response questionnaire containing over 400 questions on health history, health behaviors, lifestyle, medical diagnoses and symptoms, and readiness to implement change. The Wellness Assessment has numerous questions focused on four key areas: stress, tobacco use, diet/nutrition, and physical activity, as the main focus of the HLR program is on modifying risk behaviors in these areas. An on-site biometric screening at the workplace measures the weight, height, blood glucose levels, cholesterol, blood pressure, and hemoglobin A1c of each participant. This biometric data is subsequently uploaded to each individual Wellness Assessment.

After completion of the Wellness Assessment and biometric screening, the majority of the HLR program consists of weekly participation in an online interactive program accessible through a customized *WebMD* website. The online program focuses on behavior modification for weight management (in diet/nutrition, and physical activity),

[5] Additional groups had the option of participating in HLR, but did not have a significant number of participating employees (< 150) to include in a meaningful way in this analysis.

stress reduction, smoking cessation, and encourages individuals to get up-to-date on their preventive screening measures. The online program also has a significant informational function, where questions regarding health, wellness, disease symptoms, and remedies can be assessed (BSC 2009).

Once an individual "logs-in" to the HLR website (a measure which is tracked and used for this analysis), the participant is offered targeted health programs in the following areas: diet help, weight loss and management, physical activity and fitness, stress relief, and smoke free help. For each of the programs, the following features were available for participants in 2006 and 2007: intake assessments, brief action oriented articles, reminder emails, activity or diet trackers, post-program assessments and interactive questionnaires (HLR Program Description BSC 2007). Interactive tools support each program and include recipe finders, walking trackers, diet manager, calorie calculator, meal and fitness planners, stress journals, program trackers, and module specific quizzes.

Individuals are provided with a financial incentive to complete the program as participants can earn up to $200 per year for program involvement, at 12-week intervals. Individuals receive $50 for completion of an initial Wellness Assessment, and an additional $50 for 12-week increments of recorded activity on the HLR website. A completion of a program features described above constitutes a point-eligible activity, whereas simply logging on to the website's main page does not.

Methods

Research Design

This study employs a cohort design of individuals participating in HLR in 2006 and 2007 and who completed a Wellness Assessment. This analysis constructs two cohorts of HLR participants derived from a sample of 8,003 individuals who participated in HLR in 2006 and were eligible to participate again in 2007. The first sample is an unrestricted cohort consisting of individuals who participated in both years and filled out at least one Wellness Assessment in either year. The second sample is a restricted cohort of individuals who completed Wellness Assessments in both 2006 and 2007. Due to the fact that only individuals who participated in HLR completed a Wellness Assessment, no comparison group is available for statistical analysis.

Study Sample

The sample for this analysis consists of individuals insured by Blue Shield of California, who participated in HLR in 2006 and 2007 and filled out a Wellness Assessment. Participants complete a Wellness Assessment upon registering for the HLR program, and approximately a quarter of participants completed an additional Assessment after a minimum of twelve weeks of participation, or after gaining additional biometric data from an on-site screening. Of the data available for the 10,368 HLR participants in 2006, and 38,434 HLR participants in 2007, only a small subset of data on Wellness Assessments is available for this group. In 2006, data are available for 2,313 valid Wellness Assessments, and for 2007, 2,469 assessments, comprising a total of 4,782 Wellness Assessment records representing 3,583 unique individuals (as several

individuals completed more than one Wellness Assessment over the course of the year of HLR participation). This full sample of all available data for Wellness Assessments creates the unrestricted sample used for the random effects linear and probit models. In addition, a restricted sample of individuals who participated in HLR in both years and had at least one Wellness Assessment in both 2006 and 2007 consists of 1,658 Assessments in both years from 761 unique individuals. A group of participants completed more than one Wellness Assessment to incorporate additional biometric information, or after participating for a number of weeks, and this supplemental data are taken into account using statistical models that account for the additional Wellness Assessments using fixed effects. This restricted sample creates a final dataset for the fixed effects linear models to match individuals to each other for both years.

The raw data from the Wellness Assessment questionnaire required an extensive amount of data cleaning. The Wellness Assessments from 2006 and 2007 were not identical, and therefore the questions and responses had to be re-coded to allow for statistical comparison. After questions were coded, extreme values (that existed outside of humanly possible ranges) for biometric data were identified and recoded to missing. Approximately one hundred questions were comparable for both years, and the final dataset contained 40 independent health related variables. Not every individual answered every question, or completed the in-person biometric screening, therefore there were a limited number of complete (every single question answered) Assessments comparable for the same individual for both years. Therefore, data were combined for individuals with more than one Wellness Assessment per year using fixed and random effects regression techniques to utilize the full information available.

Study Variables

Dependent Variables & Endpoints

This analysis sought to determine whether participation in the HLR program is associated with a change between baseline (2006) and follow up (2007) in the following biometric health measures: height, weight, BMI, waist measurement, cholesterol levels (reduction in LDL levels), and hemoglobinA1c.

Changes from baseline to one year follow up for *self-reported* health behavior measures included: being a smoker, measures of diet intake including fruits, vegetables and whole grains daily, exercise level, and seatbelt use. Diagnoses and symptoms of diseases were measured by self-report including: diabetes, depression, high cholesterol, high blood pressure, and back pain. Self-assessments including stress level, and depression symptoms were included as dependent variables.

Independent Variables

Independent variables included in every regression model of this analysis include age, gender, average gross income level of participant zip code[6], employer plan, and network type (HMO or PPO).

[6] Refer to Dissertation Paper 2 (Harris 2010) for an explanation of how average gross income was computed for each participant related to zip code.

Exposure to the HLR program was measured by the level of use of each of the following interactive modules: diet help, meal planner, weight log tracker, weight loss help, fitness planner, walking notes, diabetes help, heart help, smoke free help, and stress relief help. As described previously, each of these modules included interactive tools such as recipe finders, calorie calculators, and stress journals. The level of utilization of each help module was recorded by *WebMD* and used as independent predictor variables in the regression modules associated with the dependent variable. For example, the association of utilization of the meal plan tool, diet help, weight loss tool, and weight log tracker are examined with relation to changes in weight. The fitness planner, and walking notes are included as independent variables to assess the association of HLR on change in the number of days participants exercise per week. In addition, the stress management online tool, and smoking cessation help programs are included in relevant regression models to assess the association of program exposure on change in health risk factors.

Logins

For many of the endpoint variables, such as asthma, there did not exist a trackable or specific help related module on the HLR website. The number of logins is included in all of the regression models as a measure of how many times an individual went to the HLR website and logged-in with his or her password. However, the use of a specific module is a much more accurate predictor of program exposure due to the fact that an individual could log into the HLR website more frequently if they had better Internet access, or if they had more free time. The number of logins could be randomly associated with other factors such as Internet access, income, or Internet-related use policies at work, and therefore, logins is used only as a control variable in this analysis. Use of a specific module is a more accurate measure of program exposure and utilization.

Medical Utilization

Medical utilization (visits to the doctor) and medical claims (dollar amounts) in 2006 are included to test the relationship between physician visits and participation in the HLR program (as shown in Paper 2, Harris 2010). In Paper 2, it was found that participation in HLR was associated with a reduction in the number of physician visits. Therefore, the physician visits for participants in the cohort in 2006 is included as an independent variable, associated with changes in health status and behaviors. In addition, to estimate the relationship between changes in cholesterol diagnoses, and depression and stress related variables, the claim spending amounts for cholesterol medications and depression medications in 2006 are included as independent variables in select regression models.

Time interaction

For each independent variable, an interaction with time was generated to assess the effect of the variable on the rate of change over time. Therefore, each interaction coefficient with time in the regression models can be interpreted as the effect of that variable *per year* of time, or per year of age.

All data are provided by Blue Shield of California Health Plan and *WebMD* through a formalized data agreement complying with Human Subjects Review Standards approved by the Institutional Review Board at Berkeley.

Statistical Model

To address the research question regarding the association of participation in HLR and health related endpoints, the change in numerous measures are included in the following fixed effects model as the independent variable:

$$y_{it}^* = \mu + \alpha_t + (x_i * t)\,\beta + \omega_{it}\,\gamma + \upsilon_i + \varepsilon_{it},$$ where

y_{it} = Outcome of person *i* in time *t* = 0,1. The value or trend of the dependent variable *in* 2006 or 2007 measured in the Wellness Assessment.

μ = Constant

α_t = Fixed effect of time in the year *t* (0, 1), or mean growth in the response variable when all other x parameters are equal to zero; $\alpha_0 = 0$

λ_i = Fixed effect for each person from 2006 to 2007, to measure the effect of the change for each measure of the variable in the restricted sample

$(x_i * t)$ = Represents the time interaction with specific independent individual characteristics in the sample. x_i represents independent HLR variables specific to the individual that do not vary with time (the effect of the x_i variable on the time trend).

ω_{it} = Vector of variables that vary in both years t = 0,1. They are time varying determinants, such as medical utilization that vary over time

υ_i = Fixed effect (where observation exist in both years) or random effect, dependent on the model; in random effects model, this term becomes part of the error term

y_{it}^* = The asterisk indicates the existence of a latent variable. The asterisk is present if the regression is a logit or probit model. The asterisk represents the underlying continuous variable, where y_{it}^* is unobserved. y_{it} exists in the models where the dependent variable is continuous (weight, number of fruits consumed) and y it * exists in the latent variables where the response is binary (obese: yes/no)

This model can be used to compute the first difference in relation to certain intervention variables related to exposure to the HLR plan. The difference, $y_{i1} - y_{i0}$, represents the trend in the dependent variable from 2006 to 2007. The study design employs linear random effects models to include data from individuals who do not have data for both 2006 and 2007. Probit models were also tested but the results are not presented in this paper[7].

[7] For binary dependent variables, probit regression models were constructed to estimate the effect of the change on the dependent variable using the same independent variables in the linear models. A probit random effects model with the restricted and unrestricted sample was tested, as well as a probit population averaged model for binary dependent variables. Results did not differ significantly from the linear regression models, but were used to gain further insight into the correct types of models used for such data.

Linear Fixed Effects

Regression analyses were used to estimate the impact of participation in HLR on health risk behaviors and biometric measures. A linear fixed effects model (Allison 1996; Kennedy 1985) is used for the regressions with a restricted sample of 761 individuals that filled out a total of 1,658 Wellness Assessments in both 2006 and 2007. The coefficients in both the fixed and random effects models represent differences in the means. With non-experimental data, fixed effects methods tend to reduce bias due to the fact that stable variables are controlled in the fixed effects regression, even if direct measurement of these variables is not available (Allison 1996). This technique is particularly useful because it allows the researcher to control for person-level characteristics that are fixed over time (Hausman 1984; Ozminkowski & Ling 2002). In this model, a fixed effect observes the same individual over time and accounts for unmeasured socio-demographic characteristics such as marital status, job type, and education level. Fixed effects have been applied widely in the literature to assess within-person variation in non-experimental data (Norvell 2002; Ozminkowski Ling 2002).

Linear Random Effects

Two linear random effects regression models are used to estimate the change in health risk behaviors in the cohort of participants in the HLR program. The random effects model utilizes data from the full sample of 4,782 Wellness Assessments completed by 3,583 individuals. The unrestricted sample includes all the individuals who completed at least one assessment in either year. The advantage of a random effects model with the unrestricted sample is it yields a greater sample size, and less bias due to the fact that individuals who had Wellness Assessment in both years could be a biased sample and unrepresentative of the larger population of HLR participants. A linear random effects model was tested using the restricted sample as well.

Average Values & Policy Relevant Cases

In the linear and probit fixed effects and random effects regression models, the models estimate the average change in the dependent variable in the average person. A limitation in the design of these models is that the "average person" may not be representative of the type of HLR profile participant relevant to make policy recommendations. To gain further insight into what effect HLR has on representative individuals, an additional linear model simulates the effect of the HLR program on six policy-relevant "cases" based on profiles of individuals prevalent in the sample with specific policy interest. The policy variables include: age, gender, HMO plan type (versus non-HMO), high versus low income, and belonging to the CalPERS employer group, a population which has demonstrated significantly policy relevant differences in Papers 1 and 2.

For each one of the profiles, the predicted value of the dependent health variable is computed after one year of HLR participation. This model simulates what would occur in these sample cases and allows the researcher to gain additional insight into what the average effect of the HLR program was in 2006 by varying only the five independent characteristics.

The profiles are as follows:

1. Case A. 40 year old female, CalPERS, HMO, low-income
2. Case B. 25 year old male, non CalPERS, HMO, low-income
3. Case C: 60 year old female, non-CalPERS, non-HMO, high-income
4. Case D: 45 year old female, non- CalPERS, HMO, low-income
5. Case E: 50 year old male, CalPERS, HMO, high-income
6. Case F: 35 year old female, Non-CalPERS(BSC), HMO, low-income

The linear value of associated changes in dependent variables are estimated using these sample profiles in the cohort. For each set of covariate values, the sample mean utilization levels were obtained from the sample of individuals having these covariate values in the data set. The five demographic variables are the only independent variables modified in each policy relevant analysis. These cases are selected due to the fact that they are representative cases, attempting to show the effect of HLR for a typical person that otherwise had the average number of physician visits, and other utilization values.

Results

Descriptive Statistics

Table 1 presents the descriptive statistics for the sample populations used for the fixed effects and random effects linear regression models. The "restricted sample" is limited to those individuals who participated in HLR in both years and had a corresponding Wellness Assessment in both 2006 and 2007. The unrestricted sample includes all the responses from the Wellness Assessments in either 2006 or 2007 years. In both samples, the number of Wellness Assessments exceeds the number of individuals in the sample. Several participants completed more than one Wellness Assessment. Data from both assessments is included in the regression models due to the fact that regression analysis takes the multiple observations into account with a fixed effect for each person.

Weight

Table 2 presents the results of both the linear fixed effects model and the linear random effects model for four distinct individual-level indicators of weight change between 2006 and 2007. The dependent weight variables include: a biometric measurement of weight in pounds, body mass index (BMI) calculated from a biometric measurement of height and weight, and two binary variables: the percentage of the sample with a BMI over 30 (categorized as "obese"), and the percentage of the sample with a waist greater than 40 inches.

For the restricted sample, the average weight increased 5.78 pounds from 2006 to 2007, but was not statistically significant. However, significant results for *age* indicated that the older the participant is, the more likely there will be a reduction in weight associated with participation in HLR. The beta coefficient in the regression models can be interpreted as: for every decade of age, the resulting associated change in weight is a 1.28-pound decline. For the unrestricted sample with random effects, age, female gender, number of 2006 physician visits, and utilization of the weight loss help module were significantly associated with changes in weight from 2006 to 2007. The average weight increased by 15.57 pounds, yet older participants gained less weight, by 0.97 pounds per

decade. Female participants tended to gain approximately six pounds less than their male counterparts. The coefficient of 0.44 for physician visits indicated the effect of each additional physician visit in 2006 was associated with a 0.44-pound weight gain. For example, a participating individual with ten physician visits would have a weight gain of 4.4 pounds between 2006 and 2007. A participant who utilized the "weight loss help module" was 1.7 pounds heavier than non-weight loss help users.

Changes in body mass index (BMI) from 2006 to 2007 for program participants indicated significant results associated with age, and physician visits (for the random effects model only). Older individuals experienced a significant decline in their BMI as compared to younger participants. BMI also was associated with a positive relationship to physician visits, in the sense that for every 10 physician visits a participant had, his or her BMI increased by 4.6%. Measures of obesity were significantly associated with use of the HLR program in the use of the weight loss help module. Results from the random effects model indicated that individuals who utilized the Weight Loss Help Module had a slight, but significant increase in obesity, as well as having a waist greater than 40 inches. In the random effects model, the percentage of obese participants with a waist size greater than 40 inches significantly decreased by 1.9 inches per decade of age.

Physical Activity

A main focus of the HLR program was motivating individuals to increase their physical activity levels. Table 3 presents the results of the fixed and random effects linear regression models predicting the associated change in exercise days per week and change to a "frequent exerciser" defined as engaging in physical activity more than three times per week. Results from the linear fixed effects model demonstrate that the older an individual is, the less of an improvement (-0.021) in exercise days per week will be associated with participation in HLR. Individuals in CalPERS had one fewer day of exercise per week improvement than non-CalPERS, whereas individuals in the HMO had an approximate one-day increase in exercise (1.131) associated with participating. In the case of gender, females had a significantly greater number of exercise days per week as compared to males. Individuals that logged in to access the weight loss help module also demonstrated an increase in exercise days per week in both the fixed and random effects models. The fixed effects model results in the outcome that individuals who had higher numbers of physician visits, the more they were likely to exercise days per week by ½ a day. Regression models evaluating the association of participation with the dependent variable of being a high exerciser also revealed significant results, specifically that significantly more individuals became "high exercisers" and use of the weight loss help module was positively and significantly related to exercising more frequently.

Smoking

In the overall cohort sample, with all other variables set to zero, the number of smokers declined. The random effects model results in younger individuals having higher quit rates than their older counterparts. Controlling for logins to the HLR website, individuals that smoked had a greater number of physician visits in 2006, potentially an artifact of the fact that individuals who remained smokers had higher medical utilization as a result of

medical problems related to smoking. In both models, use of the smoke free help module was significantly associated with declines in smoking rates.

Diet

Although many questions were asked regarding eating habits and dietary behavior, the Wellness Assessment question regarding fruit and vegetable consumption per day was comparable across the 2006 and 2007 sample and was a focus of the diet help module and meal planner tool, which encouraged individuals to eat more healthfully. In the cohort, the number of fruits and vegetables increased significantly in both the fixed and random effects model, with the positive and significant effect of higher income individuals reporting a greater increase in their fruit/vegetable consumption (in the random effects model). Utilization of the meal planner tool and the diet help module was not significantly associated with either an increase or a decline in fruit/vegetable consumption.

Diabetes

Results from the random effects model using the full sample demonstrated an overall increase in the number of individuals that reported having been diagnosed with diabetes (Type 1 or Type 2). Specifically, statistically significant results for individuals in an HMO and individuals who had more frequent physician visits resulted in increased diabetes diagnoses. In addition, in both the fixed and random effects models, participation in the diabetes help module was statistically significantly associated with a change in their diabetes diagnosis status. These results are meaningful in the sense that an increased number of diagnoses of diabetes is a beneficial artifact of the program because participants became more aware that they had diabetes and could seek proper treatment. This statement is complemented by the biometric measure of hemoglobin A1c*,* the most valid medical test to determine whether a diabetes patients' blood sugar level is under control. Individuals with diabetes are advised to lower their hemoglobin A1c number so it is close to 7%. Participation in the HLR program within the CalPERS employer group was statistically significantly associated with declines in their hemoglobin A1c levels, as did participation in the diabetes help module in both the fixed and random effects samples.

Cholesterol

Similar to the results of diabetes diagnoses, participation was associated with had a greater number of positive diagnoses for high cholesterol. Specifically, in the random effects sample, older individuals, as well as individuals that had a greater number of physician visits, had significantly more diagnoses of high cholesterol. This indicates an informational function of HLR where the program helps individuals to identify their high cholesterol levels so that they can receive treatment either through use of cholesterol medication, or modification of health behaviors, such as diet, related to cholesterol management. The use of positive cholesterol medication claims in 2006 had no association with the change in diagnosis of high cholesterol. LDL cholesterol level was used as an endpoint to assess the effect of the program on improvement in cholesterol levels. To measure improvement in cholesterol levels, physicians measure LDL cholesterol, termed "bad cholesterol," to assess whether the levels have been reduced

through medication or behavioral change. In this study, HLR participants significantly reduced their LDL cholesterol levels from 2006 to 2007. In the random effects model, individuals who had a greater number of physician visits significantly reduced their LDL cholesterol level, and in the fixed effects sample, individuals that participated in the diet help module reduced their LDL cholesterol levels by 20.48 points, indicating an association with exposure to the HLR program.

Depression & Stress

In addition to demographic variables, the use of the HLR stress relief help module, and depression spending in 2006 were used as independent variables used to examine the association between utilization of these help modules and associated changes in depression diagnoses, persistent feelings of depression including insomnia and lack of pleasure in daily activities, and persistent feelings of stress. In the full sample, diagnosis of depression significantly increased for females, which can be interpreted as a beneficial finding due to the fact that depression is very often under diagnosed (Sheehan 2004). Physicians often use indicators of depression symptoms as a proxy for depression due to the fact that they are a much more valid indicator of depression than an actual clinical diagnosis (Sheehan 2004). The use of the stress relief help was positively and significantly associated with a diagnosis of depression in the full sample, yet resulted in a significant decline in feelings of stress in the restricted sample predicting relief of stress related symptoms. The unrestricted random effects model was associated with a significant decline in stress relief symptoms for those who are older and belong to the CalPERS group, and a slight decline for those who had a higher income. Spending on depression medications in 2006 had no significant impact on the change in any of the dependent variables.

Policy Relevant Cases

As described in the methods section of this paper, six policy relevant variables were manipulated to simulate the effect of the HLR program on specific profiles of participants. The values for all other independent predictor variables, including exposure to the HLR program and utilization of medical care, were set to the sample means (calculated from the unrestricted, full sample) to predict only what would occur if the six policy-relevant variables (age, gender, CalPERS or non-CalPERS, HMO versus non-HMO, and low versus high-income) were adjusted.

Table 7 presents the results of six profiles of individuals. The coefficient for each independent variable is the estimated change in the sample for the specific characteristics of the profile (with all other utilization and program exposure variables set to the sample means). For the first case, a 40 year old female in a CalPERS HMO who falls into the low-income category, the HLR program estimates a significant reduction in her waist measurement being greater than 40 inches, an increase in the number of days she exercised per week, and an increase in the number of fruits and vegetables she ate per day. Participating in the HLR program would be associated with her having a higher likelihood of a diagnosis of depression and high cholesterol, but lower depression symptoms and lower hemoglobin A1c levels.

Overall, these results suggests a positive predicted effect of change in health behaviors through participating in HLR for these sample profiles. In almost every profile, the estimated change as a result of participation in the HLR program is that participants significantly increased their number of days of exercise per week and ate more fruits and vegetables. Diagnoses of manageable diseases were detected, and symptoms of stress and depression decreased. Participation in HLR for these profiles was not associated with a detectable average effect on a reduction in smoking, and weight loss results were inconclusive.

The overall estimated change in weight loss associated with participation in HLR is difficult to interpret as the results from the previous regressions resulted in a significant and positive gain in weight (in the restricted sample, without controlling for other factors, participants gained an average of 5.8 pounds, and in the unrestricted sample, an average of 15.7 pounds). However, the results from Table 2 (Weight) results are less meaningful if interpreted on their own, as the coefficient describes what occurred in the cohort as a general trend from 2006 to 2007, with all other characteristics set to zero. The results of the regressions in Table 7 (Policy Relevant Cases) are can be interpreted more easily to assess associated changes in weight for each profile.

Limitations

This paper addresses the research question of whether HLR participation has any relationship to health. Measurement of these effects is limited by three considerations. First, many of the health changes in health behavior could take place over the long run. In this current study, data is available for only 2006 and 2007 for those individuals who participated in HLR and completed Wellness Assessments, and it is demonstrated in the literature that changes in risk factors often occur over the long run (Goetzel 2004; Harris 2009). Second, there are data limitations. The two most critical limitations are first that data is only available on health indicators for those people who participated and completed the Wellness Assessment questionnaire, and is not available for a comparable control group of non-participants. In addition, many of the health indicators are self-reported through the online Wellness Assessment process. Although there are some objective biometric measures, including weight, HDL and LDL cholesterol, the sample sizes are limited. Third, this particular research design has certain limitations. Both the use of medical care, and the use of the program are endogenous within the group of program registrants. An individual who has high blood pressure may visit the doctor repeatedly, or may log in to the program for advice and help more often, giving the false impression that these inputs resulted in a higher level of blood pressure.

This analysis presents a number of descriptive statistics and highlights important and significant associations between participation in HLR and changes in health outcomes. However, the lack of a control group raises questions about external validity of analysis based on a broader population, specifically those who are uninsured. Since data did not allow for an analysis of the peer effects of participation, or losing weight as a team, this study does not draw any conclusions regarding the benefits of group participation, or diffusion of treatments.

Additional threats to internal validity may include selection bias, where participants systematically differ from non-participants in their willingness to change their health behaviors. Drop out, or non-retention, from 2006 to 2007 may effect results as a specific type of individual, for example, one who is depressed or overweight, may be more likely to drop out of the HLR program. This paper attempts to overcome these limitations using reliable and consistent measures (comparing on-site biometric measurements with self-report), and using multiple tests of significance and differing regression models.

Since this study is non-experimental, employs no control group, and follows participants over time to assess the associated change in endpoint variables, several of the results could be due to reverse causation. Threats to internal validity, such as interaction of treatment and selection in the program may be problematic for the study. For example, those individuals who were heavier may have visited the doctor more frequently and utilized the weight loss help module for weight management. All results must be interpreted with caution due to potential problems with endogeneity, where the explanatory variable (physician visits) is influenced by the same factors that influence the dependent variable (diabetes diagnosis).

Finally, it is important to note that this study only uses short-run outcomes and may miss long-term consequences of participating in wellness programs.

Discussion

This study represents the effect of the HLR program on a cohort of individuals followed over a two-year period to assess several dozen endpoints. Although the size of the observed effects is modest in some areas of health risks, the results may be paired with prior analysis suggesting that participation is associated with significant declines in medical utilization without a significant decline in health risk factors.

This paper focused primarily on endpoints for which HLR had specific program modules designed to target, such as weight loss, exercise, smoking, stress and several disease management tools, while controlling for other demographic and utilization variables in the cohort of participants. Due to the fact that there is no control group, this analysis does not predict the causal affects of HLR, but aims to detect changes in the overall population of participants in HLR in 2006 and 2007 associated with participation.

For particular endpoints with HLR help-modules, controlling for other factors, this study found an association of program exposure in the cohort on improvement of biometric and risk factors. When controlling for demographic variables, the regressions in Tables 2-6 provide a detailed description of how the participating cohort changed from 2006 to 2007. The profile cases presented in Table 7 help the researcher gain insight on the estimated effect of HLR on specific profiles of participating individuals.

Overall, holding constant utilization and demographic factors, this study does show that use of specific help modules is associated with significant change in endpoint variables between 2006 and 2007. For example, this paper suggests a statistically significant

association between participation in the HLR program and improvements in managing weight, specifically with use of the weight loss help module. Regression models for physical activity revealed that there were some improvements in exercise frequency in the cohort of participants in HLR. Controlling for other variables, utilization of weight loss help was associated with a significant effect on whether the person exercised. In addition, regression models predict higher diagnoses of manageable diagnoses such as high cholesterol, diabetes, and depression. Previous literature has demonstrated a concern for under diagnoses of treatable diseases (Holmer 1999; Sheehan 2004), and participation in HLR is associated with increased disease identification and management.

Since this study is non-experimental, employs no control group, and follows participants over time to assess the estimated change in endpoint variables, several of the results could be due to reverse causation. For example, those individuals who were heavier may have visited the doctor more frequently and utilized the weight loss help module for weight management. All results must be interpreted with caution due to potential problems with endogeneity, where the explanatory variable (physician visits) is influenced by the same factors that influence the dependent variable (diabetes diagnosis).

Overall, the key policy implications from the results of this analysis are related to the design of wellness programs. Specifically, exposure to disease or health-specific modules is associated with changes in health related endpoints. Therefore, if the goal of a wellness program is to increase physical activity, interventions must be targeted specifically for that purpose. As demonstrated in the sample cases in this paper, of the association between HLR participation and changes in health endpoints vary by age, gender, income, and plan type. Therefore, the demographic profile of the participants should be taken into consideration when designing a wellness intervention.

Conclusions

This analysis assessed the change in health risk factors in the cohort of individuals participating in HLR in 2006 and 2007. The principal conclusion is that that the use of specific help modules as part of the HLR program is associated with a significant improvement in many biometric and health risk factors. The improvements in only select areas of health risks indicate that programs targeted at changing specific health-related endpoints are more successful than overall wellness programs without targeted interventions. This finding is consistent with other literature that demonstrates targeted wellness programs result in similar reductions in health risk behaviors such as weight loss and diet modifications (Glasgow 1995; Hersey; Sorensen 1998; Sternfeld 2009).

While this analysis cannot be generalized to the entire population of individuals eligible for a wellness intervention, this paper does provide meaningful evidence that participation in workplace wellness programs is associated with a decline in many health risks. In addition, this paper provides insight into the best design of wellness programs with targeted disease specific intervention modules. Employers can use the results of this study to gain an awareness of the risk level of the potential pool of participants and subsequently modify the proposed intervention to address specific risk factors prevalent

in their population. The Wellness Assessment should be used as a starting point to design a program best matched to the needs of the participant pool, rather than imposing a generalized uniform program on all participants.

This study also has implications for the success of online wellness programs in managing health risks and the associated costs related to obesity, physical activity, and stress. Research has found that if employees can manage their health risks related to obesity, estimates predict significant decreases in health care costs (Chapman 2005; Fielding 1990; Goetzel 2002; Pelletier 1999). Therefore, employers should continue to invest in the health of their employees through providing them with targeted prevention interventions through the use of the Internet. The findings from this research suggest that not only will the health status of the participating populations improve, but also that participation in HLR will not be associated with significant increases in health care costs. If a wellness program can decrease health care claims expenditures while improving health risk factors, employers should continue to provide these services to their employees.

Finally, in light of the 2010 health care legislation and the provisions related to Prevention and Wellness, designers of workplace wellness programs should be reassured that providing behavioral change programs to employees is associated with improvement in their health risk factors, without increasing medical expenditures (Paper 2). Grants for small businesses to provide comprehensive wellness programs may not only reduce health risk behaviors, but also have the additive effect of reduced absenteeism, and potentially even a larger peer effect of group participation in programs. Therefore small business owners should readily utilize Federal grant money to provide comprehensive workplace wellness programs with their pool of participants in mind. In addition, the provision that directs the CDC to provide employers with tools to evaluate their own wellness programs and build evaluation capacity among their workplace staff is paramount to the continued success of these programs. As policy makers have suggested, the workplace is an ideal setting to implement prevention and wellness programs to improve risk factors across populations. Programs targeted towards disease-specific management should continue to be available to employees and evaluated using financial incentives and web-based technology across diverse populations.

Tables

Table 1: Descriptive Statistics for Restricted and Unrestricted Sample of Wellness Assessments

	Unrestricted Sample for Random Effects Model: All Wellness Assessments in 2006 and 2007		Restricted Sample for Fixed Effects Model: Same Individual had Wellness Assessments in both 2006 and 2007	
Variable Name & Unit of Measurement	**2006 Mean (SD) N = 2,313 Assessments**	**2007 Mean (SD) N = 2,469**	**2006 Mean (SD) N = 816**	**2007 Mean (SD) N = 842**
Gender (female)	0.785 (0.411)	0.783 (0.412)	0.831 (0.375)	0.825 (0.380)
Age (as of 2006)	41.667 (11.497)	42.225 (11.241)	41.826 (11.457)	41.700 (11.313)
HMO Plan Type (versus non-HMO)	0.617 (0.486)	0.721 (0.449)	0.694 (0.461)	0.701 (0.458)
CalPERS Employer Group (versus non-CalPERS)	0.177 (0.382)	0.242 (0.428)	0.224 (0.417)	0.234 (0.424)
Height (inches)	65.986 (3.576)	65.824 (4.029)	65.839 (3.464)	65.839 (3.530)
Weight (pounds)	172.595 (45.458)	171.090 (45.875)	172.007 (46.338)	172.295 (46.451)
BMI	27.818 (6.845)	27.950 (11.338)	27.843 (7.041)	27.892 (7.066)
Obese (BMI > 30) (Binary)	0.297 (0.457)	0.284 (0.451)	0.294 (0.456)	0.292 (0.455)
Waist Measurement (inches)	33.761 (5.712)	33.548 (5.605)	33.439 (5.546)	33.790 (5.460)
HDL Cholesterol Level (Biometric Marker)	61.292 (20.567)	57.892 (19.791)	61.716 (17.529)	60.777 (20.945)
LDL Cholesterol Level (Biometric Marker)	112.071 (36.824)	110.530 (41.745)	108.715 (32.947)	110.005 (33.955)
Diagnosis of High Cholesterol (Binary)	0.174 (0.379)	0.202 (0.402)	0.165 (0.372)	0.200 (0.400)
Blood Pressure - Systolic	119.178 (13.840)	118.670 (22.220)	118.362 (13.940)	117.276 (13.038)
Blood Pressure - Diastolic	76.001 (10.668)	76.366 (10.523)	75.468 (10.780)	75.879 (10.967)
Diagnosis of High Blood Pressure (Binary)	0.157 (0.363)	0.167 (0.373)	0.156 (0.363)	0.160 (0.367)
Diagnosis of Diabetes	0.038 (0.192)	0.042 (0.120)	0.038 (0.191)	0.051 (0.221)
Glucose (Biometric Marker)	102.343 (34.872)	95.295 (22.368)	101.470 (29.908)	94.678 (17.956)
Hemoglobin A1C (Biometric Marker)	11.571 (23.901)	6.483 (0.832)	6.700 (0.811)	6.364 (0.901)
Smoker (Binary)	0.301 (0.459)	0.225 (0.418)	0.286 (0.452)	0.226 (0.418)
Exercise Days a Week (0-7)	2.077 (1.956)	3.354 (1.954)	2.108 (1.929)	3.374 (1.945)
Frequent Exerciser (more than 3x / week) (Binary)	0.236 (0.425)	0.488 (0.500)	0.241 (0.428)	0.480 (0.500)
Diagnosis of Depression (Binary)	0.112 (0.315)	0.195 (0.396)	0.105 (0.307)	0.210 (0.407)
Persistent Feelings / Symptoms of Depression (Binary)	0.319 (0.466)	0.214 (0.411)	0.342 (0.475)	0.219 (0.414)
Feeling of Stress (1-5 scale)	3.017 (0.799)	2.596 (1.017)	3.011 (0.805)	2.609 (1.019)
Diet Servings of Fruits and Vegetables per day	2.775 (1.572)	6.107 (2.273)	2.763 (1.562)	6.099 (2.226)

* Additional results for health related endpoints in the Wellness Assessment but not included in the regression models for this analysis are presented in the Appendix of this paper.

Table 2. Linear Fixed and Random Effect Regression Models for Independent Weight Related Endpoints Associated with HLR Participation

LINEAR MODELS	Fixed Effects, Sample Restricted ♠	Random Effects, Sample Unrestricted	Fixed Effects	Random Effects	Fixed Effects	Random Effects	Fixed Effects	Random Effects
Independent Variable	**Change in Weight (lbs) B (SE)**	**Change in Weight (lbs) B (SE)**	**Change in BMI B (SE)**	**Change in BMI B (SE)**	**Percentage Obese B (SE)**	**Percentage Obese B (SE)**	**Waist Greater than 40 Inches B (SE)**	**Waist Greater than 40 Inches B (SE)**
Number of Wellness Assessment Observations	**1632 (750 people)**	**4656 (3580 people)**	**1630 (750 people)**	**4651 (3578 people)**	**1635 (750 people)**	**4663 (3583 people)**	**1635 (750 people)**	**4663 (3583 people)**
Year	5.782 (3.181)	15.569 (3.040)*	1.176 (0.570)*	1.316 (0.545)*	0.094 (0.063)	-0.003 (0.048)	0.069 (0.126)	-0.189 (0.062)**
Age ♣	-0.128 (0.043)**	-0.097 (0.041)*	-0.021 (0.008)**	-0.021** (0.007)	-0.001 (0.001)	0.000 (0.001)	0.000 (0.002)	-0.005 (0.001)**
Female Gender ♣	-0.339 (1.258)	-6.626 (1.189)**	-0.109 (0.225)	-0.156 (0.214)	-0.008 (0.025)	0.022 (0.018)	-0.157 (0.050)**	0.098 (0.023)**
Plan Type: HMO ♣	0.167 (1.136)	2.408 (1.095)*	-0.054 (0.204)	0.154 (0.196)	-0.041 (0.022)	0.029 (0.017)	-0.080 (0.045)	0.018 (0.023)
Employer Group: CalPERS ♣	-0.481 (1.349)	-0.804 (1.282)	-0.154 (0.242)	-0.195 (0.230)	0.013 (0.027)	-0.025 (0.020)	-0.038 (0.053)	-0.047 (0.026)
Average Gross Income of Participant (2006) ♣	0.014 (0.009)	-0.007 (0.009)	0.001 (0.002)	-0.001 (0.002)	0.000 (0.000)	0.000 (0.000)**	0.000 (0.000)	0.000 (0.000)
Utilization (Number) of Physician Visits in 2006	0.048 (0.111)	0.441 (0.098)**	0.000 (0.020)	0.046 (0.018)*	0.002 (0.002)	0.009 (0.001)**	-0.002 (0.004)	0.008 (0.002)**
Number of Logins to HLR Website	-0.016 (0.016)	-0.038 (0.016)*	-0.002 (0.003)	-0.004 (0.003)	0.000 (0.000)	-0.001 (0.000)**	0.000 (0.001)	0.000 (0.000)
Program Exposure: Weight Loss Help Module	0.390 (0.607)	1.700 (0.599)**	0.084 (0.109)	0.197 (0.106)	0.015 (0.012)	0.037 (0.010)**	-0.003 (0.024)	0.034 (0.014)*
Program Exposure: Use of Meal Planner Tool	-0.521 (0.631)	0.054 (0.619)	-0.221 (0.113)	-0.192 (0.110)	-0.023 (0.012)	-0.001 (0.010)	0.044 (0.025)	0.002 (0.014)
Program Exposure: Logged Weight	-0.031 (0.048)	-0.016 (0.045)	-0.006 (0.009)	-0.005 (0.008)	0.000 (0.001)	0.001 (0.000)	0.000 (0.002)	0.000 (0.001)
Program Exposure: Use of Diet Help Module	0.770 (0.686)	0.900 (0.686)	0.161 (0.123)	0.166 (0.121)	0.005 (0.014)	0.000 (0.012)	-0.058 (0.027)*	-0.012 (0.016)

* Indicates Significance at the 0.05 level

** Indicates Significance at the 0.01 level

♠ Sample is restricted to those individuals who have Wellness Assessment Data in both 2006 and 2007. The unrestricted sample includes the individuals in the restricted sample, plus those who had a Wellness Assessment in either 2006 or 2007, but not necessarily both years.

♣ Indicates that this variable is interacted with time, and the result represents the year-to-year change of the independent variable.

Table 3. Linear Fixed and Random Effects Models to Predict Changes in Physical Activity Levels Associated with HLR Participation

LINEAR MODELS	**Fixed Effects, Sample Restricted**	**Random Effects, Sample Unrestricted**	**Fixed Effects**	**Random Effects**
Independent Variable	**Change in Exercise Days Per Week attributable to HLR B (SE)**	**Change in Exercise Days Per Week**	**Change to a High Exerciser (more than 3 days a week)**	**Change to a High Exerciser (more than 3 days a week)**
Number of Wellness Assessment Observations	**1632 (750 people)**	**4654 (3577 people)**	**1635 (750 people)**	**4663 (3583 people)**
Year	1.127 (0.728)	1.715 (0.256)**	0.371 (0.171)*	0.342 (0.061)**
Age ♣	-0.021 (0.010)*	-0.022 (0.004)**	-0.004 (0.002)	-0.005 (0.001)**
Female Gender ♣	0.670 (0.290)*	0.378 (0.096)**	0.047 (0.068)	0.067 (0.023)**
Plan Type: HMO ♣	1.131 (0.258)**	0.425 (0.094)**	0.192 (0.061)**	0.109 (0.022)**
Employer Group: CalPERS ♣	-0.990 (0.307)**	-0.495 (0.104)**	-0.109 (0.072)	-0.123 (0.025)**
Average Gross Income of Participant (2006) ♣	-0.004 (0.002)	-0.003 (0.001)**	-0.001 (0.000)*	-0.001 (0.000)**
Utilization (Number) of Physician Visits in 2006	0.053 (0.026)*	0.003 (0.006)	0.008 (0.006)	0.002 (0.001)
Number of Logins to HLR Website	-0.016 (0.004)**	-0.003 (0.002)*	-0.002 (0.001)	-0.001 (0.000)
Program Exposure: Use of Walking Notes	-0.004 (0.003)	-0.005 (0.001)**	-0.001 (0.001)*	-0.002 (0.000)**
Program Exposure: Use of Fitness Planner	-0.112 (0.426)	0.011 (0.199)	-0.052 (0.100)	-0.025 (0.047)
Program Exposure: Weight Loss Help Module	0.399 (0.136)**	0.109 (0.055)*	0.086 (0.032)**	0.033 (0.013)*

* Indicates Significance at the 0.05 level

** Indicates Significance at the 0.01 level

♣ Indicates that this variable is interacted with time, and the result represents the year-to-year change of the independent variable.

Table 4: Linear Fixed and Random Effects Models Predicting Changes in Smoking & Diet Associated with HLR Participation

LINEAR MODELS	**Fixed Effects, Sample Restricted**	**Random Effects, Sample Unrestricted**	**Fixed Effects**	**Random Effects**
Independent Variable	**Change in smoking status attributable to HLR B (SE)**	**Change in smoking status**	**Fruit & Vegetable Servings Per Day**	**Fruit & Vegetable Servings Per Day**
Number of Wellness Assessment Observations	**1,631 (731 people)**	**4,648 (3573 people)**	**1,634 (730 people)**	**4,661 (3582 people)**
Year	-0.163 (0.086)	-0.209 (0.053)**	3.496 (0.437)**	2.143 (0.248)**
Age ♣	0.002 (0.001)	0.004 (0.001)**	-0.006 (0.006)	0.020 (0.003)**
Female Gender ♣	-0.014 (0.034)	-0.022 (0.020)	-0.208 (0.173)	0.038 (0.094)
Plan Type: HMO ♣	-0.024 (0.030)	0.014 (0.019)	0.050 (0.156)	-0.380 (0.092)**
Employer Group: CalPERS ♣	0.048 (0.036)	0.028 (0.022)	0.160 (0.185)	0.301 (0.102)**
Average Gross Income of Participant (2006) ♣	0.001 (0.000)*	0.000 (0.000)	0.001 (0.001)	0.003 (0.001)**
Utilization (Number) of Physician Visits in 2006	-0.003 (0.003)	0.003 (0.001)*	0.006 (0.015)	-0.002 (0.007)
Number of Logins to HLR Website	0.001 (0.000)*	0.000 (0.000)	0.006 (0.002)**	0.008 (0.001)**
Program Exposure: Smoke Free Help	-0.585 (0.078)**	-0.210 (0.049)**	-	-
Program Exposure: Meal Planner Tool	-	-	0.094 (0.084)	0.044 (0.053)
Program Exposure: Diet Help Interactive Module	-	-	0.183 (0.094)	-0.009 (0.064)

* Indicates Significance at the 0.05 level

** Indicates Significance at the 0.01 level

♣ Indicates that this variable is interacted with time, and the result represents the year-to-year change of the independent variable.

Table 5: Linear Fixed and Random Effect Regression Models for Diabetes / Cholesterol Diagnosis & Select Biometric Measures Associated with HLR Participation

LINEAR MODELS	**Fixed Effects, Sample Restricted**	**Random Effects, Sample Unrestricted**	**Fixed Effects**	**Random Effects**	**Fixed Effects**	**Random Effects**	**Fixed Effects**	**Random Effects**
Independent Variable	**Diagnosis High Cholesterol**	**Diagnosis High Cholesterol**	**LDL Cholesterol**	**LDL Cholesterol**	**Diagnosis Diabetes**	**Diagnosis of Diabetes**	**Hemoglobin A1c**	**Hemoglobin A1c**
Number of Wellness Assessment Observations	**1625 (750 people)**	**4637 (3571 people)**	**338 (238 people)**	**938 (808 people)**	**1632 (750 people)**	**4649 (3572 people)**	**47 (22 people)**	**96 (68 people)**
Year	0.058 (0.075)	-0.157 (0.046)**	-10.943 (30.972)	-37.871 (11.010)**	0.040 (0.032)	0.016 (0.021)	-1.916 (1.400)	-1.899 (1.398)
Age ♣	0.001 (0.001)	0.006 (0.001)**	-0.171 (0.410)	0.470 (0.157)**	0.000 (0.000)	0.000 (0.000)	-0.003 (0.017)	-0.002 (0.017)
Female Gender ♣	-0.045 (0.030)	-0.031 (0.018)	10.460 (8.951)	0.5273 (3.663)	-0.012 (0.013)	-0.017 (0.008)*	0.480 (0.463)	0.476 (0.462)
Plan Type: HMO ♣	0.015 (0.026)	0.019 (0.017)	1.020 (8.285)	5.412 (3.879)	0.026 (0.011)*	0.024 (0.008)**	0.505 (0.350)	0.487 (0.349)
Employer Group: CalPERS ♣	0.029 (0.032)	0.026 (0.019)	-4.014 (10.168)	2.573 (4.061)	-0.005 (0.013)	-0.006 (0.009)	-2.843 (0.505)**	-2.806 (0.504)**
Average Gross Income of Participant (2006) ♣	0.000 (0.000)	0.000 (0.000)*	0.050 (0.041)	-0.006 (0.025)	0.000 (0.000)	0.000 (0.000)	0.020 (0.008)*	0.019 (0.008)*
Utilization (Number) of Physician Visits in 2006	0.004 (0.003)	0.008 (0.001)**	-1.181 (0.893)	-0.754 (0.302)*	0.001 (0.001)	0.004 (0.001)**	-0.088 (0.049)	-0.082 (0.048)
Utilization of Cholesterol Medication, 2006	0.000 (0.000)	0.000 (0.000)**	0.021 (0.033)	0.005 (0.007)	-	-	-	-
Number of Logins to HLR Website	0.001 (0.000)	0.000 (0.000)	0.007 (0.078)	-0.012 (0.041)	0.000 (0.000)	0.000 (0.000)	0.031 (0.013)*	0.029 (0.013)*
Program Exposure: Diet Help Module	0.005 (0.016)	-0.012 (0.012)	-20.482 (7.768)**	-1.418 (3.067)	0.015 (0.007)*	0.009 (0.005)	-1.803 (0.640)*	-1.724 (0.635)**
Program Exposure: Diabetes Help Module	-	-	-	-	0.035 (0.013)**	0.048 (0.010)**	-1.552 (0.455)**	-1.502 (0.452)**
Program Exposure: Weight Loss Help	-	-	-	-	0.003 (0.006)	0.004 (0.004)	-0.269 (0.207)	-0.259 (0.207)

* Indicates Significance at the 0.05 level

** Indicates Significance at the 0.01 level

♣ Indicates that this variable is interacted with time, and the result represents the year-to-year change of the independent variable.

Table 6: Linear Fixed and Random Effect Regression Models for Mental Health and Stress Levels Associated with HLR Participation

LINEAR MODELS	Fixed Effects, Sample Restricted	Random Effects, Sample Unrestricted	Fixed Effects, Sample Restricted^	Random Effects, Sample Unrestricted	Fixed Effects	Random Effects
Independent Variable	**Diagnosis of Depression**	**Diagnosis of Depression**	**Depression Symptoms**	**Depression Symptoms**	**Persistent Feelings of High Stress**	**Persistent Feelings of High Stress**
Number of Wellness Assessment Observations	**1618 (750 people)**	**4603 (3543 people)**	**1461 (750 people)**	**4191 (3317 people)**	**1634 (750 people)**	**4661 (3582 people)**
Year	-0.199 (0.086)*	-0.015 (0.044)	-0.233 (0.118)*	-0.011 (0.062)	-0.219 (0.238)	-0.235 (0.118)
Age ♣	0.002 (0.001)	-0.001 (0.001)	0.000 (0.002)	-0.005 (0.001)**	-0.015 (0.003)**	-0.016 (0.002)**
Female Gender ♣	0.111 (0.034)**	0.070 (0.017)**	0.073 (0.046)	0.062 (0.023)**	0.182 (0.095)	0.276 (0.044)**
Plan Type: HMO ♣	0.025 (0.030)	0.035 (0.016)*	-0.003 (0.042)	0.037 (0.023)	0.161 (0.085)	0.167 (0.043)**
Employer Group: CalPERS ♣	-0.008 (0.036)	-0.011 (0.018)	0.028 (0.051)	-0.023 (0.026)	-0.054 (0.100)	-0.148 (0.048)**
Average Gross Income of Participant (2006) ♣	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	-0.001 (0.001)	-0.001 (0.000)**
Utilization (Number) of Physician Visits in 2006	0.000 (0.003)	0.006 (0.001)**	0.073 (0.046)	0.003 (0.002)*	0.005 (0.008)	0.012 (0.003)**
Depression Medication Claims Spending, 2006	0.000 (0.000)	0.000 (0.000)**	0.008 (0.004)	0.000 (0.000)**	0.000 (0.000)	0.000 (0.000)**
Number of Logins to HLR Website	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.002 (0.001)*	-0.001 (0.001)
Program Exposure: Use of Stress Relief Help	0.026 (0.021)	0.032 (0.012)**	0.001 (0.001)	0.001 (0.018)	-0.120 (0.059)*	0.092 (0.033)**

* Indicates Significance at the 0.05 level

** Indicates Significance at the 0.01 level

♣ Indicates that this variable is interacted with time, and the result represents the year-to-year change of the independent variable.

Table 7. Policy Relevant Sample Profiles: Estimated Change in Health Outcomes Using Sample Mean of Utilization & Program Exposure Variables

Policy Case (Dependent Variable)	Case A. 40 year old female, CalPERS, HMO, low-income B (SE)	Case B. 25 year old male, non CalPERS, HMO, low-income	Case C: 60 year old female, non-CalPERS, non-HMO, high-income	Case D: 45 year old female non-CalPERS non-HMO high-income	Case E: 50 year old male, CalPERS, HMO, high-income	Case F: 35 year old female, Non-CalPERS, HMO, low-income
Weight (lbs)	-0.5254 (1.2944)	8.3616 (1.5690)*	-4.3036 (1.4805)*	-2.8469 (1.2683)*	4.8970 (1.4906)*	0.7644 (1.1164)
BMI	0.0195 (0.2538)	0.6806 (0.2999)*	-0.3882 (0.2838)	-0.0779 (0.2492)	-0.0662 (0.2864)	0.3177 (0.2249)
Obese	0.0041 0.0180	0.0124 0.0226	-0.0211 0.0216	-0.0154 0.0178	-0.0352 0.0214	0.0306 (0.0149)*
Waist Greater than 40 Inches	-0.2265 (0.0225)*	-0.2069 (0.0283)*	-0.3012 (0.0277)*	-0.2305 (0.0224)*	-0.3814 (0.0269)*	-0.1561 (0.0182)*
Exercise days per week	1.2934 (0.0915)*	1.7472 (0.1146)*	0.8075 (0.1138)*	1.1447 (0.0921)*	0.5847 (0.1097)*	1.9006 (0.0724)*
High Exerciser	0.2401 (0.0218)*	0.3661 (0.0273)*	0.1438 (0.0271)*	0.2136 (0.0220)*	0.1087 (0.0262)*	0.3868 (0.0173)*
Smoker	-0.0561 0.0193	-0.1199 0.0242	-0.0192 0.0236	-0.0775 0.0192	0.0057 0.0231	-0.1033 0.0153
Fruits / Vegetables Per Day	3.2044 (0.0905)*	2.5684 (0.1136)*	3.7796 (0.1107)*	3.4825 (0.0898)*	3.4645 (0.1076)*	2.8042 (0.0732)*
Diagnosis of Depression	0.1047 (0.0160)*	0.0624 (0.0200)*	0.0556 (0.0197)*	0.0729 (0.0160)*	0.0212 (0.0190)	0.1213 (0.0126)*
Depression Symptoms	-0.0633 (0.0230)*	-0.0342 (0.0283)	-0.1730 (0.0280)*	-0.1043 (0.0226)*	-0.1748 (0.0268)*	-0.0179 (0.0179)
Stress Level	-0.3654 0.0427)*	-0.2463 0.0532)*	-0.7469 0.0527)*	-0.4998 0.0427)*	-0.8395 0.0510)*	-0.1347 (0.0335)*
Diabetes Diagnosis	0.0099 (0.0079)	0.0278 (0.0099)*	-0.0044 (0.0096)	-0.0092 (0.0078)	0.0270 (0.0095)*	0.0142 (0.0064)*
Hemoglobin A1c Level	-2.3986 (2.1838)	-0.0386 (2.2631)	0.4911 (2.2113)	0.5210 (2.2058)	-2.2851 (2.2075)	0.4178 (2.1980)
Cholesterol Diagnosis	0.0421 (0.0169)*	-0.0367 (0.0212)	0.0989 (0.0207)*	0.0149 (0.0168)	0.1188 (0.0203)*	-0.0119 (0.0134)
LDL level	-1.0486 (3.5249)	-15.9372 (5.0725)*	0.1676 (4.4341)	-6.8750 (3.7955)	-1.8156 (3.9804)	-5.9691 (3.5562)

* indicates statistically significant result (where 95% confidence interval does not include 1)

Note: All observations reported using the sample mean for all medical utilization and program exposure variables from the unrestricted (full) sample

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Appendix

Appendix Table 1. Descriptive Statistics on Additional Health Related Endpoints (Not Included in the Results of this Paper)

	Unrestricted Sample for Random Effects Model: All Wellness Assessments in 2006 and 2007		Restricted Sample for Fixed Effects Model: Same Individual had Wellness Assessments in both 2006 and 2007	
Variable Name & Unit of Measurement	**2006 Mean (SD) N = 2,313 Assessments**	**2007 Mean (SD) N = 2,469**	**2006 Mean (SD) N = 816**	**2007 Mean (SD) N = 842**
Overweight (24.9 < BMI < 30) (Binary)	0.296 (0.457)	0.302 (0.459)	0.297 (0.457)	0.304 (0.460)
Waist Greater than 40 inches (Binary)	0.511 (0.500)	0.289 (0.453)	0.565 (0.496)	0.293 (0.456)
High LDL Cholesterol Level (Binary)	0.276 (0.448)	0.235 (0.424)	0.244 (0.431)	0.242 (0.429)
Low HDL Cholesterol Level (Binary)	0.010 (0.097)	0.017 (0.131)	0.009 (0.092)	0.014 (0.119)
Biometric Marker Indicating High Blood Pressure	0.138 (0.345)	0.107 (0.309)	0.138 (0.346)	0.109 (0.312)
Secondhand Smoke Exposure (Binary)	0.082 (0.274)	0.114 (0.318)	0.090 (0.287)	0.115 (0.319)
Diagnosis of Asthma (Binary)	0.132 (0.338	0.122 (0.327)	0.134 (0.340)	0.153 (0.360)
Diet Servings of Whole Grains per day	2.032 (1.297)	3.355 (1.370)	1.990 (1.291)	3.355 (1.394)
Mammogram in Last 2 Years (Binary) Females	0.199 (0.400)	0.164 (0.371)	0.167 (0.374)	0.183 (0.387)
Self Health Rating (1-5) 1 = Excellent, 5 = Poor	2.719 (1.014)	2.562 (0.922)	2.719 (1.001)	2.607 (0.914)
Flu Shot This Year (Binary)	0.318 (0.466)	0.437 (0.496)	0.359 (0.480)	0.418 (0.494)
Pneumonia Vaccine This Year	0.114 (0.318)	0.072 (0.258)	0.119 (0.324)	0.070 (0.255)
Pap Smear in Last 2 Years (Binary) Females Only	0.315 (0.465)	0.306 (0.461)	0.318 (0.466)	0.326 (0.469)
Seatbelt Wear – Always	0.953 (0.213)	0.965 (0.184)	0.962 (0.192)	0.967 (0.180)
Symptoms of Persistent Back pain in past 3 months	0.153 (0.360)	0.115 (0.319)	0.186 (0.390)	0.105 (0.306)

Appendix Table 2: Linear Fixed and Random Effect Regression Models for Improvement in Prevention-Related Activities Associated with HLR Participation

LINEAR MODELS	Fixed Effects, Sample Restricted	Random Effects, Sample Unrestricted	Fixed Effects	Random Effects	Fixed Effects	Random Effects	Fixed Effects	Random Effects
Independent Variables	**Flu Shot B (SE)**	**Flu Shot**	**Pneumonia Vaccine**	**Pneumonia Vaccine**	**Females Only: Pap Smear in Last 2 Years**	**Pap Smear**	**Seat Belt, Always Wear**	**Seat Belt, Always Wear**
Number of Wellness Assessment Observations	**1627 (750 people)**	**4639 (3567 people)**	**952 (711 people)**	**2786 (2483 people)**	**1303 (750 people)**	**3499 (3567 people)**	**1627 (749 people)**	**4644 (3572 people)**
Year	0.145 (0.092)	-0.173 (0.056)**	0.080 (0.128)	-0.158 (0.066)*	0.000 (0.106)	-0.145 (0.051)**	0.010 (0.045)	-0.062 (0.025)*
Age ♣	-0.001 (0.001)	0.005 (0.001)**	-0.003 (0.002)	0.002 (0.001)*	0.000 (0.002)	0.004 (0.001)**	0.001 (0.001)*	0.002 (0.000)**
Female Gender ♣	-0.050 (0.037)	-0.030 (0.021)	0.065 (0.045)	0.017 (0.024)	-	-	-0.017 (0.018)	0.007 (0.010)
Plan Type: HMO ♣	0.075 (0.033)*	0.117 (0.021)**	-0.056 (0.055)	-0.008 (0.029)	0.039 (0.052)	0.023 (0.026)	-0.014 (0.016)	-0.003 (0.009)
Employer Group: CalPERS ♣	-0.001 (0.039)	-0.046 (0.023)*	-0.040 (0.050)	-0.017 (0.024)	-0.042 (0.063)	-0.052 (0.029)	0.023 (0.019)	0.005 (0.010)
Average Gross Income of Participant (2006) ♣	0.000 (0.000)	0.000 (0.000)	-0.001 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)
Utilization (Number) of Physician Visits in 2006	-0.001 (0.003)	0.012 (0.002)**	0.000 (0.005)	0.008 (0.001)***	-0.001 (0.001)	-0.001 (0.000)*	-0.001 (0.002)	0.000 (0.001)
Number of Logins to HLR Website	0.000 (0.000)	0.000 (0.000)	0.000 (0.001)	0.000 (0.000)	-0.010 (0.005)	-0.008 (0.002)**	0.000 (0.000)*	0.000 (0.000)

* Indicates Significance at the 0.05 level

** Indicates Significance at the 0.01 level

♣ Indicates that this variable is interacted with time, and the result represents the year-to-year change of the independent variable.