Financial Analysis

Modifiable Health Behaviors and Short-Term Medical Costs Among Health Plan Members

Patricia C. Bland, MA; Lawrence An, MD; Steven S. Foldes, PhD; Nancy Garrett, PhD; Nina L. Alesci, MPH

Abstract

Purpose. Describe the relationship among modifiable health behaviors and short-term medical costs.

Design. Prospective study linking cross-sectional survey data that assessed modifiable risk behaviors with insurance claims.

Setting. A large health plan in Minnesota.

Subjects. A stratified, random sample of 10,000 yielded an analytic data set for 7983 members.

Measures. The dependent variable was per-member-per-month insurance payment plus subscriber liability. Eighteen months of medical costs were analyzed. Control variables included subscriber age, sex, type of insurance plan, days of enrollment, chronic disease status, education, and marital status. Independent variables included self-reported health behaviors of smoking, heavy drinking, nutrition, and physical activity.

Analysis. Linear regression was performed on the natural log of the cost variable, followed by a retransformation to dollars.

Results. Physical inactivity and smoking were significant predictors of higher medical costs. Each day a member did not exercise there was a 2.9% difference in cost. Compared with never smokers, current smokers had 16% higher costs. Former smokers who had quit more than 1 year before taking the survey had 15% higher costs than never smokers. Recent former smokers cost 32% more than never smokers and more frequently experienced smoking-related medical conditions before they quit. Alcohol consumption was nonsignificant. Nutrition also was not significant but was narrowly measured by only fruit and vegetable consumption.

Conclusion. Physical inactivity and smoking were associated with higher short-term medical costs among health plan members. (*Am J Health Promot* 2009;23[4]:265–273.)

Key Words: Employer Health Care Costs, Prevention and Control, Smoking Cessation, Prevention Research. Manuscript format: research; Research purpose: modeling/relationship testing, descriptive; Study design: nonexperimental; Outcome measure: other financial/economic; Setting: state/national; Health focus: fitness/physical activity, nutrition, smoking control; Strategy: behavior change; Target population age: adults; Target population circumstances: education

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PURPOSE

To address growing concerns about rising health care costs, employers and health plans have begun implementing health improvement programs to reduce health risk behaviors such as tobacco and alcohol use, physical inactivity, and unhealthy eating. Several peer-reviewed studies have quantified the higher costs of these behaviors to health plans, employers, and individuals. Although estimated costs are measured and presented in various ways, the studies share a common finding: members who engage in these health risks consistently have greater average costs than those who do not. Some studies use self-reported data on health services use,[1–4] which may be subject to underreporting, recall, and several other forms of bias.[5] Other studies use utilization records, which also may be subject to error from incomplete coverage of all potential costs or inaccurate reporting of services by providers. More importantly, these utilization studies report allocated costs aggregated from the population rather than actual individual medical expenditures.[6–9] As a result, both study designs may calculate costs inaccurately.

Some studies use a stronger design linking self-reported participation in health risk behaviors to actual expenditures using that individual's health claims data.[10–16] Several of these designs rely on data from health risk assessment surveys voluntarily completed by employed populations, which tend to be healthier than other health plan populations.[10–13,15] In effect, these studies are neither representative of nor generalizable to health plans that cover both employed and unemployed members.

Only one study[14] attempted to randomly sample a health plan population. This sample, however, was limited to members older than 40 years.

The length of time commonly studied between a change in risk behavior and the potential subsequent reduction in health care costs may result in nongeneralizable findings. Many studies report average annual costs from claims that occur within 3 years of collecting the survey data.[11-13] For many employers, however, this is too long of a period to be helpful. Health plans or employers may believe that risky behaviors result in higher costs only in the long term and may make decisions about investing in prevention based on that belief. Isolating the short-term costs of these health risk behaviors may encourage more stakeholders to act upon findings from such economic studies. Analyses should also adjust short-term costs of risk behaviors for expenditures associated with chronic conditions such as diabetes, hypertension, and heart disease. Chronic conditions are influenced by health risk behaviors and contribute to higher costs; therefore, their presence makes it more difficult to ascertain whether costs resulted from chronic conditions or from risk behaviors. Only one study[13] controlled for chronic conditions to isolate short-term costs of these modifiable health risks.

Finally, many cost studies of smoking in particular have found that former smokers cost more than current smokers.[11,12,14,15] This finding seems counterintuitive in light of the known health benefits that result from quitting smoking.[17] A prospective study found that health plan members older than 40 years with higher medical costs were more likely to attempt to quit than those with lower costs, suggesting that a new smoking-related illness and the resulting encouragement to quit from a provider could lead to the quit attempt.[18] The current analysis builds on the strengths of previous studies to describe the short-term costs of self-reported health risk behaviors. It aims to answer the question: In a representative health plan population, are short-term total health care costs significantly lower for health plan members who abstain from the known health risk behaviors of tobacco use, physical inactivity, un-

healthy eating, and heavy alcohol consumption than for those who engage in such behaviors?

The current study offers several advantages over prior studies in answering this question. First, it links self-reported health risk to individual claims data. Second, the data represent a random sample of all health plan members and thus may better represent a health plan's population by including public program members in all adult age groups rather than only members insured through employers. The results are generalizable to health plans serving populations with similar demographics. Third, focusing on short-term costs fills a critical gap in the literature that key decision makers need to assess the potential value of health promotion programs. Finally, controlling for chronic conditions better tests for the hypothesized link between costs and health risk behaviors.

In light of the previous findings of greater costs among former smokers, a secondary research question is, do smokers who quit in the past year have a greater number of smoking-related diagnoses than the remaining group of former smokers, current smokers, and never smokers? The study hypothesizes that in the year prior to the survey, recent former smokers face a greater number of smoking-related diagnoses as defined by the Surgeon General and consequently experience higher costs than other former or current smokers. Such a finding would suggest that former smokers incur greater costs because a subgroup of this population quits smoking when they experience smoking-related disease symptoms.

METHODS

Design

This study used data from a 1999 telephone survey of Blue Cross and Blue Shield of Minnesota (Blue Cross) members. We surveyed members who were covered by commercial plans or subsidized government plans for low-income persons and publicly insured members, 30% of whom were unemployed. A random sample of adults 18 years and older was stratified by insurance product and drawn from the health plan's 1.9 million members who resided in Minnesota. The study linked

individual survey data to administrative and claims data generated within 18 months of survey administration.

Administrative data provided demographic characteristics. Claims data were analyzed for health care costs and selected chronic conditions. The presence of diseases identified by the Surgeon General as smoking related was also examined for 1 year preceding the month of the survey. For a detailed description of the sampling plan and survey, see Garrett et al.[19]

Sample

This study used a stratified random sample of adult members from Blue Cross commercial health plans and publicly subsidized programs. Public program members included those enrolled in MinnesotaCare and the Prepaid Medical Assistance Program (PMAP). MinnesotaCare is a unique, state-subsidized health insurance program for employed persons with low incomes. PMAP is Minnesota's Medicaid managed-care program for low-income persons, exclusive of persons with disabilities. We sampled PMAP members younger than 65 years. (PMAP members 65 and older were likely to live in institutionalized settings and were not included in this study.) The commercially insured population included members of fully and self-insured health plans. Total population counts were based on adult members of populations identified in Blue Cross membership files in February 1999. The response rate ranged from 75% to 90% depending upon the stratum. The total number of completed surveys was 9983. Matching the survey data with administrative and claims data resulted in 8664 members. Of those, 7983 members, representing 80% of the completed surveys that had nonmissing information on all variables, formed the final analytic group.

Measures

The survey instrument, called the Blue Cross and Blue Shield of Minnesota Adult Tobacco Prevalence Survey, assessed demographic characteristics, general and mental health status, tobacco use, alcohol use, physical inactivity, and fruit and vegetable consumption. The instrument was developed by a team of social scientists, physicians, epidemiologists, and public health pro-

fessionals from Blue Cross, Minnesota Department of Human Services, Minnesota Department of Health, University of Minnesota's Department of General Internal Medicine and Division of Epidemiology, and Minnesota Partnership for Action Against Tobacco (now ClearWay Minnesota). Clearwater Research administered the telephone survey with the use of computer-assisted telephone interview software. The survey was administered from April 1, 1999 through August 8, 1999.

Covariates from administrative membership files included age as of the survey date, sex, health plan in which the member was enrolled, and number of days enrolled during the study period. College education and marital status, both dichotomous variables, came from the survey. Persons with at least college degrees were compared with persons with less than 4-year college degrees. Married persons (including 183 members in unmarried couple relationships) were contrasted to never-married, divorced, and widowed persons. Covariates from the administrative claims included the presence of chronic conditions.

The independent variables were the presence of modifiable health behaviors and were determined from the survey items on alcohol consumption, fruit and vegetable consumption, physical activity, and smoking status. Alcohol consumption was measured as whether or not the respondent was a heavy drinker. Questions on alcohol consumption were taken directly from the Behavioral Risk Factor Surveillance System (BRFSS) survey of the Centers for Disease Control and Prevention (CDC).[20] The designation of heavy drinking was based on the five alcohol-related items in the BRFSS. An example question was, "During the past month, have you had at least one drink of any alcoholic beverage such as beer, wine, wine coolers, or liquor?" Heavy drinking was derived from the number of days in the past month the respondent consumed alcohol multiplied by the average number of drinks consumed per day. Men at risk for heavy drinking were defined as consuming the equivalent of at least 60 drinks per month. Women at risk for heavy drinking were defined as consuming at least 30 drinks per month.[21]

Two studies of reliability measures of alcohol consumption yielded Cohen's κ coefficients ranging from .73 to .93 and yielded .33 to .55 for chronic alcohol consumption (heavy drinking).[22] Cohen's κ is a common statistical test for measuring reliability (the reproducibility of results at different points in time) of survey questions. Values exceeding 0.75 suggest strong agreement above chance, values in the range of 0.40 to 0.75 indicate fair agreement, and values of 0.40 or lower indicate poor agreement above chance alone.[23] Using these criteria, heavy drinking in our study had poor to fair reliability. Validity is the degree to which a question measures what it was designed to measure. One measure of validity is a correlation coefficient between self-reported and observed data. A comparison using self-reported data on alcohol consumption and alcohol sales data yielded reliability estimates of $r = .81$ for per capita alcohol consumption and $r = .74$ for chronic (heavy) drinking, indicating moderate to strong validity.[22]

Healthy eating was measured by the survey question, "How many servings of fruits and vegetables do you usually eat each day?" We found only one study that examined a single-question assessment of fruit and vegetable consumption.[24] This study looked at change in fruit and vegetable consumption among participants enrolled in a health promotion intervention. The cross-sectional results suggested that one-question measures significantly underestimated fruit and vegetable consumption.

Physical activity was assessed with the following survey item, "Moderate exercise includes activities, for example: brisk walking, jogging, swimming, aerobic dancing, biking, or rowing. How many days per week on average do you do moderate exercise for a total of at least 30 minutes per day?" At the time the survey was written, the CDC's guidelines recommended that adults get 30 minutes of moderate exercise for at least 5 days per week.[25] Persons not engaging in regular physical activity were considered at risk for chronic disease and premature death.[25] To the best of our knowledge, no reliability or validity measures exist for a single-item physical activity measure.

Finally, for smoking status, respondents were first asked whether they had

smoked at least 100 cigarettes in their lifetimes. If they responded in the affirmative, they were asked if they currently smoke cigarettes every day, some days, or not at all. A "current smoker" was defined as a respondent who had smoked at least 100 cigarettes in his or her lifetime and reported smoking everyday or some days at the time of the survey. A "never smoker" had smoked fewer than 100 cigarettes in his or her lifetime. A "former smoker" had smoked at least 100 cigarettes in his or her lifetime but did not smoke at all at the time of the survey. These categories are consistent with the definitions established by the CDC.[26] We also asked former smokers how long it had been since their last cigarettes. Those former smokers who had quit smoking within 1 year of the survey were designated recent former smokers. The questions "Have you smoked at least 100 cigarettes in your entire life?" and "Do you now smoke cigarettes everyday, some days, or not at all?" are identical to those in the 1999 BRFSS. Reliability coefficients using Cohen's κ for ever smoking indicate substantial agreement to almost perfect. Current smoking was almost perfect. Former smokers spanned a larger range, from moderate agreement to almost perfect agreement.[22]

To capture the dependent variable of medical and pharmacy costs, survey data were merged with 18 months of administrative claims with dates on or after the members' interview dates. The total number of enrollment days was included in the model to adjust for members with less than full enrollment during the 18 months. To be included in the study, a member had to have a minimum of 90 days of enrollment. Indicator variables were used to represent the presence of commonly occurring chronic diseases, including diabetes, heart disease, hypertension, and dyslipidemia (Table 1). The presence of heart disease, hypertension, and dyslipidemia was established by at least one diagnosis of the condition in the administrative claims. The presence of diabetes was established in the claims data by at least one diagnosis of diabetes or by at least one prescription for a diabetes-specific medication.

In addition, we captured diagnoses for diseases or conditions related to

Table 1

Chronic Conditions

Condition	ICD-9-CM*
Diabetes mellitus†	250
	250.0, 250.1, 250.2,
	250.3, 250.4, 250.5,
	250.6, 250.7, 250.8,
	250.9
Heart disease	410
	410.0, 410.1, 410.2,
	410.3, 410.4, 410.5,
	410.6, 410.7, 410.8,
	410.9, 411.0, 411.1,
	411.8, 411.81, 411.89
	412
	413
	413.0, 413.1, 413.9
	414
	414.0, 414.00, 414.01,
	414.02, 414.03,
	414.04, 414.05, 414.1,
	414.10, 414.11,
	414.19, 414.8, 414.9
Hypertension	401
	401.0, 401.1, 401.9
Dyslipidemia	272.4

* International Classification of Diseases, Ninth Revision, Clinical Modification.

† Also at least one prescription of any diabetes-specific drug, such as insulin.

smoking as defined by the 2003 Surgeon General's report for 1 year prior to the survey. These diagnoses, represented by indicator variables, included neoplasms, cataracts, diseases of the circulatory system (e.g., chronic ischemic heart disease, cerebrovascular disease), respiratory diseases (e.g., chronic obstructive pulmonary disease, pneumonia), and reproductive disorders (e.g., low birth weight, stillbirth). We hypothesized that a higher proportion of these smoking-related diseases would be present in former smokers who quit in the year preceding the survey, who may have been prompted to quit by a health crisis.

Cost, the primary outcome measure, is in the form of per-member-per-month subscriber eligible amount in dollars. Subscriber eligible amount is the final insurance payment plus subscriber liabilities (e.g., deductibles, coinsurance) and is our best estimate of the final cost of health care to society. This amount includes medical, pharmacy, x-ray, and laboratory costs

and was summed for the 18-month period starting the month of the survey. To obtain per-member-per-month cost, the sum was divided by the total days of enrollment since the survey date over the average days in a month.

Per-member-per-month amount

= subscriber eligible amount

÷ (days enrolled/30.5)

In this article, the terms cost, subscriber eligible amount, and per-member-per-month subscriber eligible amount are used interchangeably.

Analysis

As is typical of medical expenditure data, in this study, per-member-per-month subscriber eligible amount was severely skewed. We transformed the dependent variable by taking its natural log. This produced a normally distributed logged cost variable with normally distributed residuals. We used ordinary least squares regression on the logged dependent variable.

The self-insured and fully insured commercial health plans did not differ significantly on demographic measures or cost; therefore, for ease of interpretation, we combined those two plans into a single category called commercial. Public programs varied. Indicator variables commercial, PMAP, and MinnesotaCare formed the health plan construct.

Smoking status was structured into four indicator variables for each of the following smoking status categories.

1. Never smokers as the omitted (reference) group.
2. Current smokers.
3. Former smokers whose last cigarettes were more than 1 year prior to the survey.
4. Recent former smokers whose last cigarettes were within 1 year of the survey.

The distributions of demographic characteristics are presented in Table 2. The multivariate analyses and accompanying tables of predicted means are unweighted.[27] There is a great deal of debate about the practice of not using survey weights when analyzing data.[28,29] The central concern for this analysis was to control for

Table 2

Characteristics of the Sample (N = 7983)*

Demographics	Raw N	Mean or Percentage
Age,* mean (SD)	7983	41.0 (12.8)
Gender*		
Male	3523	47.9
Female	4460	52.1
Married		
Yes	5704	74.2
No	2279	25.8
College graduate		
Yes	2050	34.0
No	5933	66.0
Plan type*		
Commercial	6416	95.5
PMAP <65	631	1.0
MinnesotaCare	936	3.5
Days enrolled, mean (SD)	7983	473 (134)
Modifiable health behaviors		
Heavy alcohol use		
Yes	244	3.2
No	7739	96.8
Servings of fruits/vegetables per day		
Mean (SD)		2.79 (1.49)
None	149	1.8
1 serving	1675	20.2
2 servings	2252	26.4
3 servings	1666	21.6
4 servings	1095	14.3
≥5 servings	1146	15.7
Physical activity (d/wk)		
Mean (SD)		3.37 (2.1)
0 days activity	993	12.4
1–4 days activity	4018	50.3
5–6 days activity	1662	20.8
Every-day activity	1310	16.4
Smoking status		
Never smoker	4412	55.3
Current smoker	1625	20.4
Former smoker; quit >1 year ago	1690	21.2
Former smoker; quit <1 year ago	256	3.2

PMAP indicates Prepaid Medical Assistance Program.

* Weighted percentages reflect the distribution within age, gender, and Blue Cross population of insurance product.

the fact that some Blue Cross members were selected from different strata with different probabilities of selection. To adjust for this differential probability of selection owing to the stratified random sampling design, we entered

the strata identifiers PMAP and Min-
nesotaCare into the model as indicator
variables, leaving commercial as the
comparison group.

Intercorrelations among the de-
pendent variable log(PMPM) and all
covariates produced no coefficients of
a magnitude greater than 0.25. We
also examined variance inflation fac-
tors to assess multicollinearity.[30] The
largest variance inflation factor was
1.4, indicating that multicollinearity
was not present among our covariates.
Seven observations for which the
absolute values of the standardized
residual of logged cost was three or
larger did not change the significance
of any of the covariates or the order-
ing in magnitude of the β coefficients.
Goodness of fit was measured using
the coefficient of determination (R^2).

In the case of the explanatory
variable smoking status, we ensured
the statistical significance of the overall
smoking construct by testing for a
significant difference between the R^2
for a model with all predictors except
the smoking status variables and the R^2
of a model that added current smok-
ers, former smokers who had quit
more than 1 year before, and recent
former smokers who had quit no more
than 1 year before (with never smokers
as the reference group).[31] The change
in R^2 between the first and second
models was statistically significant, and
the smoking status construct was in-
cluded in the final model.

In all multiple regressions, the con-
tribution of each covariate was assessed
using the unstandardized β coeffi-
cients. Covariates with coefficients with
$p \le .05$ were considered significant.

To enable us to discuss estimates of
dollars (instead of logged dollars), we
retransformed the predicted logged
subscriber eligible amount using
Duan's smearing method.[32] We exam-
ined the variances of the logged
dependent variable for heteroscedasti-
city using both the multivariate
Breusch-Pagan test[33] and the univariate
Levene test for homogeneity of vari-
ance.[34] The overall multivariate test
and Levene tests on smoking status
and physical activity were statistically
significant, ($p \le .0001$). We therefore
used subgroup-specific smearing fac-
tors to adjust for the unequal variances
in physical activity and smoking status
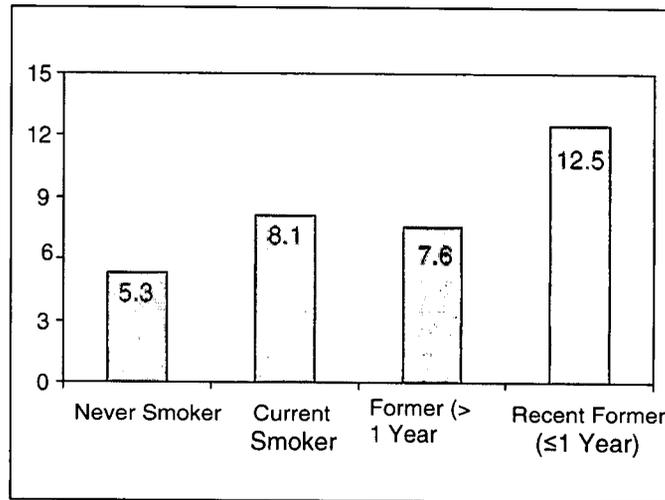
post hoc means tables.[35] The retrans-
formed, estimated means were annu-
alized and inflation-adjusted using the
Consumer Price Index.[36]

We included members with and
without utilization (i.e., subscriber eli-
gible amount of zero) in our analysis.
Thirteen percent of the respondents
had no utilization. We arrived at
positive predictions for everyone in our
sample.

RESULTS

Sample characteristics of the modi-
fiable health behaviors are shown in
Table 2. The average number of days
on which individuals participated in at
least 30 minutes of physical activity was
3.37 days. The proportion of analyzed
individuals reporting being current
smokers was 20.4%.

Diagnoses in the 414xx group of
chronic ischemic heart disease ICD-9
codes were common to both the
cardiovascular grouping of the smok-
ing-related diseases and to heart dis-
ease as a chronic condition. Although
chronic conditions and cost were
simultaneously summarized, thereby
including the cost of chronic condi-
tions in the overall cost, for the
smoking-related diseases, we were in-
terested specifically in the percentages
of never smokers, current smokers,
former smokers, and recent former
smokers who were diagnosed.[18]

To explore the smoking-related dis-
eases with respect to smoking status, we
looked at the presence of any of the
smoking-related diseases in the year
preceding the survey (Figure 1). Over-
all, 6.9% of the sample had one or
more of these antecedent smoking-
related disease diagnoses. Of those
members who had at least one diag-
nosis, recent former smokers had the
highest percentage of causal diagnoses
(12.5%). Of former smokers, 7.6% had
such diagnoses. Of never smokers and
current smokers, 5.3% and 8.1%,
respectively, had such diagnoses.

The multivariate model included
chronologic age; sex; education; mari-
tal status; insurance plan; days of
enrollment; the chronic conditions of
diabetes, heart disease, hypertension,
and dyslipidemia; and the modifiable
health behaviors smoking status, alco-
hol use (heavy drinker), servings of
fruit and vegetables per day, and
physical activity. Chronic conditions
have a demonstrated effect on health
care costs and were included to adjust
for costs that could arguably be attri-
buted to the chronic conditions them-
selves, independent of modifiable
health behaviors. Fifteen percent of
our sample had at least one chronic
condition. Among those members,
75% had one condition, 20% had two
conditions, and 5% had three or more
conditions. To investigate the potential
effect of members with more than one
condition, we removed the four indi-

Figure 1
Percentage of Members With Smoking-Related Disease

Table 3

Multivariate Results From Full Model Predicting Logged Cost

Dependent Variable: Natural Log of Per-Member-Per-Month Subscriber-Eligible Amount

	Coefficient (β)	SE (β)	p
Member age from administrative records*	0.011	0.002	0.0001
Member sex from administrative records	0.944	0.043	0.0001
College educated vs. less than college	0.180	0.046	0.0001
Married vs. divorced, widowed, never married	0.167	0.047	0.0004
Insurance plan (reference, commercial)			
PMAP <65	0.514	0.079	0.0001
MinnesotaCare	0.337	0.063	0.0001
Days enrollment from month of survey*	0.003	0.001	0.0001
Heavy drinking (reference, not a heavy drinker)	−0.078	0.115	0.5010
Servings of fruits/vegetables per day*	−0.001	0.014	0.9333
Days with no physical activity*	0.029	0.009	0.0012
Chronic disease status			
Diabetes	1.39	0.132	0.0001
Heart disease	1.50	0.154	0.0001
Hypertension	0.969	0.071	0.0001
Dyslipidemia	0.815	0.088	0.0001
Smoking status (reference, never smokers)			
Current smokers	0.160	0.054	0.0028
Former smoker; quit >1 year ago	0.148	0.052	0.0043
Recent former smoker; quit ≤1 year ago	0.297	0.113	0.0084

PMAP indicates Prepaid Medical Assistance Program.

* Continuous variable percentages were calculated by unstandardized β × 100. Discrete variable percentages were calculated by $e^{[\beta - 0.5(se\beta)^2]} - 1 \times 100$.

R^2: 22.7%

Contrasts among all other categories of smoking status were NS.

cator variables (one for each condition) and substituted a single variable representing a member's total number of conditions (from zero to four). The results of the regression did not materially change. The R^2 for the model was 22.7%. Table 3 presents the multivariate results for all covariates and independent variables.

Two modifiable health behaviors were statistically significant. For every day within the week a member did not

Figure 2

Per-Member-Per-Year Subscriber-Eligible Amount for Levels of Physical Activity

Subscriber-eligible amount is the final insurance payment plus subscriber liabilities (e.g., deductibles, coinsurance) including medical, pharmacy, x-ray, and laboratory costs.

engage in physical activity, there was a 2.9% difference in median per-member-per-month subscriber eligible amount. Cost also differed with respect to smoking status. Current smokers had 16% higher median costs than never smokers, former smokers had 15% higher median costs than never smokers, and recent former smokers had 32% higher median cost than never smokers.

The retransformed predicted per-member-per-year cost for the entire sample was $4270, with SD of $15,466. The median was $2200, and the interquartile range was $1122 to $3874.

The retransformed predicted per-member-per-year cost for days of physical activity is presented in Figure 2. (For ease of presentation, we categorized the 7-day measure used in the regression into groups of days reflecting the CDC's recommendations.) Those members who were sedentary had a mean per-member-per-year cost of $5684, compared with $4442 for persons who exercised 1 to 4 days and $3594 for those members who engaged in physical activity on 5 or 6 days. Every-day exercisers had an average per-member-per-year cost of $3453.

The retransformed predicted per-member-per-year cost for smoking status is given in Figure 3. Never smokers incurred the least cost in this analysis, $3550. Current smokers had a mean per-member-per-year subscriber eligible amount of $4803, and former smokers had a mean per-member-per-year subscriber eligible amount of $4848. Recent former smokers had the highest estimated per-member-per-year cost at $9467. This estimate of average cost was strongly influenced by one observation with a very large residual. The cost estimate from a regression excluding this outlier was $6990. Although the estimated cost was affected by this observation, removing this single observation did not affect the significance, absolute magnitude, or ordering of multivariate coefficients, and the observation was thus retained.

DISCUSSION

Key Findings

The key finding of this study was that among modifiable health risk behaviors, smoking and physical inactivity
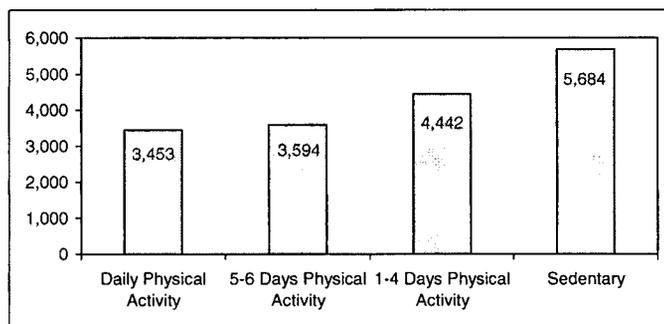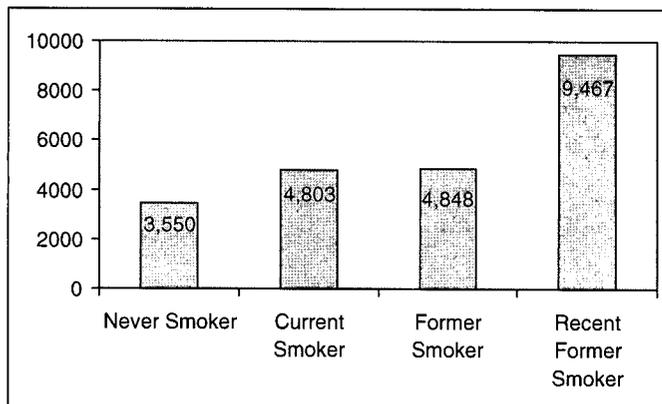
Figure 3

Per-Member-Per-Year Subscriber-Eligible Amount by Smoking Status

Subscriber-eligible amount is the final insurance payment plus subscriber liabilities (e.g., deductibles, coinsurance) including medical, pharmacy, x-ray, and laboratory costs.

were significantly related to short-term health care costs in a representative sample of a large adult population enrolled in a health plan. This finding remained significant even when controlling for major chronic diseases, including diabetes, heart disease, hypertension, and dyslipidemia, conditions to which smoking and physical inactivity are causally related.

Differences in short-term costs associated with different levels of physical inactivity and smoking were statistically significant. Health plan members who reported being sedentary had the highest health care cost compared with members who reported daily exercise within the week. Members with 1 to 4 days of exercise had the next highest health care cost compared with daily exercisers, followed by those with 5 to 6 days of exercise. Upon initial examination, these results may suggest a dose-response relationship between days of physical activity and lower health care costs. However, persons who exercised 5 to 6 days did not differ significantly from every-day exercisers, suggesting there may not be a beneficial effect beyond 5 or 6 days of exercise. Even persons who reported being physically active on 1 to 4 days, below the recommended level, ranked lower than sedentary persons in retransformed, predicted per-member-per-year average health care cost (Figure 2).

Current smokers and former smokers who quit more than 1 year prior to taking the survey incurred similar health care costs; both had higher costs than never smokers. The relationship between smoking and short-term health care costs is complicated by the presence of recent quitters. In this study, we attempted to identify the health care costs of recent former smokers who reported to have quit within the year prior to taking the survey. As measured by the retransformed per-member-per-year estimated cost, these persons had higher mean annual health care costs than did current smokers and former smokers who had quit more than a year before. Specifically, the recent former smoker retransformed, predicted average cost was nearly 2.7 times greater than that of never smokers and nearly two times greater than current smokers (Figure 3).

To investigate whether smoking-related health crises may have prompted recent former smokers to quit, we examined the proportion of the population whose medical claims indicated that they received treatment during the year before taking the survey for any of the conditions identified by the Surgeon General as being causally linked to smoking. Never smokers had the lowest proportion, followed by former smokers who reported quitting more than a year before, and then

current smokers. Recent former smokers had the highest percentage of members with these diseases or conditions, and in fact, had more than twice the percentage of never smokers (Figure 1). The relatively high level of such conditions among the recent former smokers supports the hypothesis that some of these smokers may have quit in response to an expensive health care crisis that was possibly caused by smoking.

Other Research

The findings from this study are consistent with evidence from other studies that link modifiable health risk behaviors with poorer health and higher treatment costs, but this study strengthens this conclusion by reporting results for a random sample of all adults in a health plan population. However, comparing the magnitude of the effects found in this study with those observed in other studies is fraught with many difficulties. As indicated previously, there are large differences in populations, data sources, measures, and methods, and few standard approaches exist for such investigations. Although some differences exist, the study that is perhaps most directly comparable to this one was conducted by Pronk et al.,[14] based on data collected in 1995 to 1996. The investigators found that median costs for participants with no days of physical activity were 4.7% higher than the costs for those who were active 1 day per week. In this study, the median costs for the sedentary were 2.9% higher for each day within the week they were inactive. Pronk et al.[14] found that current smokers incurred 18% more in median costs than never smokers. In this study, median costs for current smokers were 16% more than costs for never smokers. Pronk et al.[14] did not separate recent former smokers from all former smokers, and therefore there is no comparable measure between the two studies for this category.

In their investigation of quit attempts, Martinson et al.[18] looked at prior cost as a predictor of quit attempts. In their prospective study, they found that recent past health care charges were associated with an increased likelihood of making a smoking cessation attempt. These anteced-

ent charges could conceivably be a response to an adverse health event that prompted the quit attempt and tends to support our finding that costs associated with recent former smokers were a result of such an event.

Our results confirm those of many previous studies that found that heavy drinking was not associated with higher short-term health care costs. However, a few studies have found a positive relationship between excessive drinking and health care costs.[9,15] The mixed findings suggest that although excessive alcohol may have a moderate impact, the use of alcohol is not the first health risk behavior employers should target.

We also found that fruit and vegetable consumption was not associated with lower health care costs in our population. Only one study found that better nutrition was linked with lower health care costs,[12] but this study measured "poor nutritional habits," rather than fruit and vegetable consumption specifically. Goetzel et al.[15] found that poor nutritional habits were actually correlated with lower health care costs.

Limitations

Healthy eating was measured by a single question on fruit and vegetable consumption. Although food frequency questionnaires are common, nearly all such surveys use at least six questions on fruit and vegetable consumption, including questions on the consumption of these nutrients by other means such as vitamin and mineral supplements. In addition, Peterson et al.[24] found that a single-item assessment of fruit and vegetable consumption likely underestimates true consumption.

Like fruit and vegetable consumption, the measure of physical inactivity was limited to a single question and may also underestimate true activity levels. In addition, there was some slippage between the time at which the risk factor was measured and the claims experience; we could not ascertain whether a member just started exercising or stopped exercising before or after the survey.

Despite these limitations, our findings suggest that there may be a significant value in effective, popula-

tion-based prevention efforts in the short term.

Future Research

Few other studies have looked at the value of modifying unhealthy behaviors in the short term, and this research would benefit from replication. The rate of decline in health care costs over time since quitting smoking also deserves investigation to more fully describe the role of the health crisis in prompting smokers to quit.

Our work adds to the growing body of literature finding that health risk behaviors are costly to employers and society in the short term. The sum of this work provides information for employers making decisions on how to address rising health care costs and suggests that primary prevention has an important role to play in improving health and reducing costs.

SO WHAT? Implications for Health Promotion Practitioners and Researchers

This study seems to indicate that physical inactivity and smoking are significantly associated with higher short-term medical costs among a diverse sample of health plan members. It also seems to indicate that smokers who have recently quit are much more likely to have smoking-related medical conditions before they quit. Combined with other research, there seems to be preliminary support for the assertion that medical costs are related to lifestyle factors, even in the short term, and that higher prevalence of smoking-related medical conditions may explain why medical costs for recent quitters are higher than those for current smokers. If the assertions about short-term cost difference hold true, these findings strengthen the business case for health promotion programs. The implications for researchers about the higher prevalence of smoking-related medical conditions among recent quitters signals the need to conduct research on the relationship between smoking-related health conditions among recent vs. long-term former smokers, decisions to quit smoking, and related medical costs.

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