2004

Meeting Recommendations for Multiple Healthy Lifestyle Factors: Prevalence, Clustering, and Predictors Among Adolescent, Adult, and Senior Health Plan Members

Nicolaas P. Pronk

Louise H. Anderson

A. L. Crain

Brian C. Martinson

Patrick J. O'Connor

See next page for additional authors

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Prevalence, Clustering, and Predictors Among Adolescent, Adult, and Senior Health Plan Members

Nicolaas P. Pronk, PhD, Louise H. Anderson, MS, A. Lauren Crain, PhD, Brian C. Martinson, PhD, Patrick J. O'Connor, MD, MPH, Nancy E. Sherwood, PhD, Robin R. Whitebird, PhD

Background: Whereas much is known about single lifestyle-related health risk factor prevalence and covariates, more research is needed to elucidate the interactions among multiple healthy lifestyle factors and variables that may predict adherence to these factors. Such data may guide both clinical and health policy decision making and person-centered approaches to population health improvement.

Methods: We document the prevalence and cluster patterns of multiple healthy lifestyle factors among a random sample of adolescents (n =616), adults (n =585), and seniors (n =685) from a large Midwestern health plan. Modifiable, lifestyle-related health factors assessed included physical activity, nonsmoking, high-quality diet, and healthy weight for all subjects; adults and seniors were also asked about their alcohol consumption. Second, we sought to identify characteristics associated with the likelihood of meeting recommendations for healthy lifestyle factors. The healthy lifestyle factors sum score was categorized into three levels, that is, 0 to 2, 3, or 4 to 5 healthy lifestyle factors (4 for adolescents), and we used ordinal logistic regression to estimate the odds of meeting each of these criteria from several demographic characteristics and disease states.

Results: Overall, only 14.5% of adolescent, adult, and senior health plan members meet recommended guidelines for four common healthy lifestyle factors. Only 10.8% of adults and 12.8% of seniors met all five behavior-related factors. For adolescents, only being nondepressed was associated with an increased likelihood to be in adherence to multiple healthy lifestyle factors (odds ratio [OR]=2.15; $p<0.05$). For adults, being in the 50- to 64-year-old cohort (OR=1.46, $p<0.05$), having a college degree (OR=1.65; $p<0.05$), and having no chronic disease (OR=1.92; $p<0.05$) were all associated with an increased likelihood to be in adherence to multiple healthy lifestyle factors. For seniors, having a college degree (OR=1.61; $p<0.05$), was the only variable associated with an increased likelihood to be in adherence to multiple healthy lifestyle factors.

Conclusions: A small proportion of health plan members meet multiple recommended healthy lifestyle guidelines at once. This analysis identifies population subgroups of specific interest and importance based on adherence to multiple healthy lifestyle factors, and predictors for increased likelihood to be in adherence to multiple healthy lifestyle factors. It presents a potentially useful summary measure based on person-centered measures of healthy lifestyle factors. Clinicians may derive meaningful information from analyses that address adherence to multiple healthy lifestyle factors. Health systems administrators may use this information to influence health policy and resource allocation decisions. Further studies are needed to assess the usefulness of this comprehensive lifestyle-related health measure as a metric of progress toward public health goals, or as a clinical metric that conveys information on future health status and directs interventions at the individual level.

(Am J Prev Med 2004;27(2S):25–33)

From the Center for Health Promotion (Pronk, Sherwood), and HealthPartners Research Foundation (Pronk, Anderson, Crain, Martinson, O'Connor, Sherwood, Whitebird), HealthPartners, Minneapolis, Minnesota

Address correspondence and reprint requests to: Nicolaas P. Pronk, PhD, Vice President, Center for Health Promotion, HealthPartners, 8100 34th Avenue South, Minneapolis MN 55440-1309. E-mail: nico.p.pronk@healthpartners.com.

0749-3797/04/$–see front matter
doi:10.1016/j.amepre.2004.04.022

Introduction

General consensus exists among health researchers, health promotion and medical care practitioners, health systems administrators, and public health policy officials that chronic disease morbidity and mortality in the United States today is strongly associated with behaviors, or factors influenced by behavior, that may be characterized as modifiable, lifestyle-related health risk factors. Such individual-level health risk factors include the use of tobacco products, sedentary behavior and low levels of physical activity, less than optimal body weight for health, low multifactorial diet-quality practices (considering fat, fiber, fruits, and vegetables consumption), and excess consumption of alcohol.[1,2]

Meeting public health recommendations for controlling single health risk factors significantly reduces the likelihood of multiple chronic diseases. For example, not using tobacco products reduces the risk for cardiovascular disease,[3] but will also reduce the risk for cancer, chronic lung disease, and musculoskeletal diseases.[2,4] Similarly, the risk for chronic conditions is reduced when individuals meet public health recommendations for diet, physical activity, alcohol use, and obesity.[2] These modifiable lifestyle-related health risk factors also tend to cluster among themselves,[5–9] increasing the likelihood that individuals are dealing with multiple health risk factors at a given time.

Whereas much is known about the prevalence of single health risk factors and their associations with demographic characteristics including pairwise associations between behaviors and other lifestyle-related health factors, only a modest literature addresses the relationships among multiple lifestyle-related health factors or the clusters of such factors and their demographic correlates. It is important to explore such relationships for a variety of reasons. First, understanding the prevalence, distribution, and frequencies at which these behavioral clusters occur among various populations may inform health improvement planning efforts across multiple settings, such as primary care clinics, work sites, health systems, and public health agencies.[4,6,10–13] Second, there is a potential for synergistic effects of multiple healthy lifestyle factors on the risk of chronic conditions and health outcomes.[1,2,4,14,15] Therefore, an increased understanding of the prevalence and clustering patterns of multiple lifestyle-related health factors may support efforts to reduce incidence of disease, management of existing chronic disease, and improve overall health outcomes.

In addition, demographic characteristics, including age and disease status, are associated with lifestyle-related health behaviors.[16,17] Population-based analyses are needed to further enhance our understanding of the relationships between multiple health behaviors and health outcomes. Consequently, conducting analyses across various age groups and considering chronic conditions specifically, may provide additional insights into the challenges and opportunities that exist to improve upon the proportion of the population that meets not merely a single, but multiple health-related recommendations for healthy lifestyle factors.

Development of a meaningful summary score for lifestyle-related health factors could provide a useful clinical metric that quantifies the "state of health" of a defined population by enumerating the proportion that meets recommended guidelines for multiple behaviors or behavior-related factors. Such a summary measure may also prove to be a meaningful health policy metric, as it would represent in one comprehensive health measure several objectives typically stated in the context of multiple single behaviors, for example as in *Healthy People 2010*.[18] On the other hand, the inverse of such a comprehensive health measure would quantify risk, indicate the magnitude of potential benefits related to change, and draw clinician and patient attention to those who are most in need of change. Such a measure could be conceptualized as analogous to a cardiovascular risk index that scales in a single metric the risk associated with multiple components. Finally, since such a comprehensive lifestyle-related health measure would represent the number of individuals who meet all healthy lifestyle factors specified, it would also be an inherently person-centered metric. The overall objective would be to have all or most members of the population meet recommended guidelines for a specified list of healthy lifestyle factors. The comprehensive lifestyle-related health measure would describe the gap between current and optimal state.

It is the purpose of this study to document the prevalence of meeting recommended guidelines for healthy lifestyle factors, the clustering patterns among these healthy lifestyle factors, and the relative influence of demographic characteristics and chronic conditions on healthy lifestyle factors among adolescent, adult and senior health plan members. An additional objective of this paper is to provide support for the feasibility of a comprehensive lifestyle-related health measure that would be computed as the proportion of the population that meets multiple healthy lifestyle factors as quantified by the sum of the number of healthy lifestyle factors for which they meet recommended guidelines.

Methods

Sample and Procedures

The subject population for this study was derived from a stratified random sample of the HealthPartners membership, a large Midwestern health plan in the United States. Random samples of 1000 members were selected from among three subgroups of the entire health plan population: adolescents (aged 13 to 17), adults (aged 18 to 64), and seniors (aged ≥65). Subsequently, a survey, created specifically to monitor

the impact of a systemwide health improvement program, was mailed to the subjects. Following postcard reminders at day 7, a second mailing at day 21, and telephone follow-up to nonrespondents, survey responses were obtained from 65% of adolescents, 65% of adults, and 82% of seniors. Due to missing data related to several variables of interest, analyses were conducted on data obtained from 616 adolescents, 585 adults, and 685 seniors.

Demographics and Behavioral Measures

The survey instrument included items on demographics, modifiable lifestyle-related health factors, and self-reported diseases and conditions. More specifically, demographics included age, gender, race/ethnicity, education, height, and weight. The healthy lifestyle factors assessed for all subjects included physical activity, diet, and smoking status; adults and seniors were also asked about their alcohol use. Physical activity was measured using questions from the Behavioral Risk Factor Surveillance Survey conducted by the Centers for Disease Control and Prevention.[19] Study respondents were classified as having met recommended physical activity guidelines by either engaging in moderate physical activity for ≥30 minutes at least 5 days per week, or engaging in vigorous physical activity for ≥20 minutes at least 3 days per week.[20,21] Self-report of diagnosed disease included the following conditions: heart disease, diabetes, depression, stroke, arthritis, hypertension, and high cholesterol.

Recommendations for disease prevention and health promotion tend to emphasize simultaneous change of several dietary behaviors, such as increase the consumption of fruits and vegetables and decrease fat intake. Instead of considering the role of a single nutrient or food group in the context of healthy eating patterns, we were interested in assessing diet quality based on current food-based dietary guidelines. We used a previously developed measure of diet quality that includes complex mixtures of foods containing multiple nutrients (fruits, vegetables, whole grains, low-fat dairy, and lean meats and poultry); this diet quality scale has been associated with mortality and has been termed the Recommended Food Score (RFS).[22] The RFS is a sum of the foods recommended under current dietary guidelines that a person consumes in a typical week with a theoretical range from 0 to 23. The median response in this sample was 11, and respondents were classified as having a high-quality diet if they had a score of ≥11 out of a possible 23.

The survey included items that asked whether respondents had smoked ≥100 cigarettes in their lifetime and whether they were still smoking. We classified respondents as meeting recommended guidelines if they indicated that they had never smoked (<100 cigarettes) or were former smokers (≥100 cigarettes but not currently smoking). Smoking status was assigned to those who indicated they had smoked ≥100 cigarettes in their lifetime and were currently smoking.

Alcohol consumption was asked only of adults and seniors. Criteria for meeting recommended guidelines were set according to the number of drinks consumed per week or heavy episodic drinking. Drinks per week were computed as average number of days on alcohol was consumed multiplied by the number of drinks consumed per drink day. Heavy episodic drinking was defined as five or more drinks during a single drinking episode. Respondents were classified as meeting guideline recommendations if they reported no heavy episodic drinking and seven or fewer drinks per week for women or 14 or fewer drinks per week for men.[23]

Weight status, based on self-reported height and weight, was calculated for each respondent as body mass index (BMI) (kilograms/meters squared). For adolescents, a healthy BMI was operationalized as being at or below the 85th percentile for age and gender.[24] For adults and seniors, the criterion for meeting recommended guidelines was set at a BMI between 18.5 kg/m^2 and 25 kg/m^2.[25]

Finally, a composite measure of meeting multiple recommended healthy lifestyle factors was created by summing the number of dimensions on which respondents met recommendations. This variable, the comprehensive lifestyle-related health measure, has a theoretical range of 0 (met none of the recommendations) to 5 (high-quality diet consumption, nonsmoker or former smoker, no or moderate alcohol use, physically active, and healthy weight), and was used as the primary dependent variable in the analyses. Descriptive statistics on the study sample and each of these healthy lifestyle factors are displayed in Table 1.

Table 1. Demographic profile of study population

	Adolescents	Adults	Seniors
n	616	585	685
Age (years)	15.7 (1.5)	43.4 (11.8)	74.5 (6.7)
Gender (% female)	50	57	57
Race/ethnicity (% white)	90	91	95
Heart disease (%)	—	10	35
Diabetes (%)	—	6	14
Depression (%)	10	17	17
Stroke (%)	—	0.7	7
Arthritis (%)	—	15	52
Hypertension or high cholesterol (%)	—	40	73
Any chronic disease (%, listed above)		56	92
Education, college degree (% yes)	—	42	29
BMI (kg/m^2)	22.2 (4.2)	27.3 (5.7)	26.7 (4.9)
Physical activity (days/wk)[a]	5.6 (4.0)	3.8 (3.5)	4.0 (3.8)
High diet quality (score)[b]	11.6 (3.4)	11.4 (3.3)	13.1 (3.1)
Smoking status (%)[c]	91	85	93
Alcohol use[d]			
# drink days per week	—	1.4 (1.8)	1.4 (2.3)
# drinks per day	—	1.7 (2.1)	0.9 (1.1)
# drinks per week	—	3.3 (5.7)	2.6 (5.4)

Note: Data presented as means (standard deviation) or as otherwise noted.

[a]Physical activity is defined as the number of days per week during which ≥30 minutes of moderate physical activity was accumulated or during which the individual participated in ≥20 minutes of vigorous exercise.

[b]High diet quality is reflected using the Recommended Food Score.

[c]Smoking status reflects individuals who report being never or former smokers.

[d]Alcohol consumption is reported as the number of drinks per week and number of drinks per day when alcohol is consumed.

Analysis

The analysis had two objectives. First, we sought to describe the study population in terms of its healthy behaviors. Second, we sought to identify characteristics significantly associated with the odds of meeting more healthy behavior guidelines.

Our description of the population included three views: meeting guidelines for each healthy lifestyle factor independently, the number of healthy lifestyle factors for which guidelines were met, and the combination of healthy lifestyle factors being met. For each factor, we reported the percent of the study population meeting the guideline; this view reported prevalence of each healthy lifestyle factor singly. For each study subject, we summed the number of factors for which the subject met the guideline, and reported the percentage of the study population meeting guidelines for five, four, or more healthy lifestyle factors; this view reported the success of the study population in meeting multiple guidelines. For each possible cluster of healthy lifestyle factors, we reported the percentage of the study population within each cluster; this view indicated which clusters of healthy lifestyle factors were most prevalent. When subgroups were combined, observations for adolescents, adults, and seniors were weighted to reflect the entire health plan population.

For the second objective, we used the sum of healthy lifestyle factors as the ordinal dependent variable in a proportional odds model and estimated the effect of demographic characteristics on the proportional odds ratios. We collapsed the sum of healthy lifestyle factors into three levels: zero to two, three, or four to five healthy lifestyle factors (four for adolescents). We estimated separate models for each subgroup (adolescents, adults, and seniors). The proportional odds model estimates two logits (log odds), and the coefficient on each explanatory variable is constrained to be the same for each logit. The logits are cumulative over the levels of response. The two logits estimated for adults and seniors were:

$$(1)\ \log odds\left[\frac{4\text{–}5\ healthy\ behaviors}{0\text{–}3\ healthy\ behaviors}\right]=\alpha_1+x'\beta \text{ and}$$

$$(2)\ \log odds\left[\frac{3\text{–}5\ healthy\ behaviors}{0\text{–}2\ healthy\ behaviors}\right]=\alpha_2+x'\beta$$

Logits for adolescents had a maximum of four healthy behaviors.

The first of these logits estimated the log odds of meeting four to five healthy lifestyle factors relative to meeting zero to three healthy lifestyle factors; the second estimated the log odds of meeting three or four to five healthy lifestyle factors (cumulative) relative to zero to two factors. The model estimated separate intercepts for each logit (α_1 and α_2), but the proportional odds assumption constrains the relationship between each explanatory variable and the dependent variable to be constant, that is, is the same in each logit. In other words, the odds of four to five versus zero to three healthy lifestyle factors may be different from the odds of three to five versus zero to two healthy lifestyle factors (α_1 and α_2 may be different). However, the extent to which an explanatory variable (x) changes the odds (β) is constrained to be the same for both logits.

Table 2. Meeting individual healthy lifestyle factor recommendations across study populations

Healthy lifestyle factor recommended	Adolescents (%)	Adults (%)	Seniors (%)	All (%)
Healthy weight	78.9	39.3	38.8	43.9
No smoking	90.9	85.1	92.7	86.5
No or moderate alcohol use	—	89.4	94.0	—
Physical activity	59.1	38.8	40.7	41.3
High diet quality	64.0	63.8	80.3	65.3

Analyses were performed separately for each of the adolescent, adult, and senior subgroups. For adolescents, we tested gender and depression[26,27] as explanatory variables. We did not test for age because of lack of variation in the subgroup. For adults, we tested gender, age, chronic disease state, and education level as explanatory variables.[6,16] Age was coded as a binary variable segmenting the sample into younger adults (18 to 49) and older adults (50 to 64). We hypothesized that older adults might be more aware of the need to engage in healthy behaviors because of higher rates of diagnostic screening and chronic disease at ages ≥50. Chronic disease for adults was coded as a binary variable indicating none or any of the chronic diseases from Table 1. Education level was coded as a binary variable indicating college degree or no college degree. For seniors, we tested gender and education level as explanatory variables. Education level for this group as well was coded as a binary variable indicating college degree. Chronic disease was present in 92% of seniors and therefore was not tested as an explanatory variable. We did not test for age in the senior population because of less age variation and lack of rationale for its effect on healthy behaviors. We did not test for race because of lack of variation in the sample. The models were fit with maximum likelihood estimation using SAS version 8 (SAS Institute, Cary NC, 2000).

Results

Prevalence of Meeting Recommended Healthy Lifestyle Guidelines

Tables 2 and 3 show the prevalence of meeting healthy lifestyle guidelines. Table 2 shows the prevalence of meeting recommendations for each factor by subgroup. A large percentage of adolescents met recommendations for nonsmoking (90.9%) and healthy weight (78.9%). However, only 64.0% of adolescents met the recommendation for high-quality diet, and 59.1% met the physical activity recommendation. Most adults met recommendations for alcohol use (89.4%), nonsmoking (85.1%), and high-quality diet (63.8%). However, less than half of all adults met recommendations for physical activity (38.8%) and healthy weight (39.3%). Seniors were similar to adults on meeting recommendations for alcohol use (94.0%) and nonsmoking (92.7%). Seniors were more likely than adults to meet the high-quality diet recommendation

Table 3. Meeting recommended guidelines for multiple healthy lifestyle factors across study populations

Number of recommended healthy lifestyle factors	Adolescents % (cumulative)	Adults % (cumulative)	Seniors % (cumulative)	All % (cumulative)
5	—	10.8 (10.8)	12.8 (12.8)	—
4	31.2 (31.2)	26.7 (37.5)	36.2 (49.0)	14.5 (14.5)
3	38.6 (69.8)	36.6 (74.1)	37.4 (86.4)	29.8 (44.3)
2	22.6 (92.4)	20.7 (94.8)	11.8 (98.2)	35.9 (80.2)
1	7.1 (99.5)	4.8 (99.6)	1.8 (100)	17.7 (97.9)
0	0.5 (100)	0.5 (100)	0.0 (100)	2.0 (100)

(80.3%), but were similar to adults in terms of meeting recommendations for physical activity (40.7%) and healthy weight (38.8%). Across all three populations, more than half met recommendations for smoking (86.5%) and high diet quality (65.3%), whereas less than half met the recommendations for physical activity (41.3%) or healthy weight (43.9%).

Table 3 shows the percentage of health plan members who met recommendations for each possible number (zero to five) of healthy lifestyle factors. Among adolescents, only 31.2% are in adherence to recommendations for all adolescent-specific healthy lifestyle factor guidelines, yet over two thirds (69.8%) met recommendations for three or four factors. Among adults, only 10.8% met recommendations for all five factors, and less than half (37.5%) met recommendations for four or more. Seniors were similar to adults in meeting recommendations for all five healthy lifestyle factors (12.8%), but nearly half (49.0%) met recommendations for four or more. In aggregate, considering four behavior-related healthy lifestyle factors, only 14.5% of the population met recommendations for all four factors and less than half (44.3%) met recommendations for three or more.

We constructed a cluster pattern grid describing all possible ways in which the population of adolescents, adults, and seniors met recommended guidelines for healthy lifestyle factors. The adolescent data are included in this cluster grid and we report on nonsmoking, high-quality diet consumption, healthy weight, and physical activity, since the alcohol-related items were not included in the adolescent questionnaires. Table 4 presents the cluster grid and shows, for example, that only 1.1% of the population smokes while meeting all other healthy lifestyle factor recommendations. The most prevalent combination of meeting recommended guidelines was nonsmoking and high-quality diet consumption (20.3%).

Prediction of Meeting Recommended Healthy Lifestyles Guidelines

A proportional odds model predicting the number of healthy lifestyle factors was fit for each subgroup. The ordinal dependent variable was the sum of healthy lifestyle factors with possible values of zero to two, three, or four to five (four for adolescents) factors. For each model, a chi-square score test supported the

Table 4. Descriptive cluster pattern of meeting four healthy lifestyle factors among adolescents, adults, and seniors

Number of healthy lifestyle factors recommendations met	Nonsmoking	High diet quality	Normal BMI	Physically active	Percent of population
4	Yes	Yes	Yes	Yes	14.5
3	No	Yes	Yes	Yes	1.1
3	Yes	No	Yes	Yes	5.7
3	Yes	Yes	No	Yes	12.0
3	Yes	Yes	Yes	No	11.0
2	Yes	Yes	No	No	20.3
2	Yes	No	Yes	No	7.1
2	Yes	No	No	Yes	4.3
2	No	Yes	Yes	No	1.8
2	No	Yes	No	Yes	1.6
2	No	No	Yes	Yes	0.9
1	Yes	No	No	No	11.6
1	No	Yes	No	No	3.0
1	No	No	Yes	No	1.9
1	No	No	No	Yes	1.3
0	No	No	No	No	2.0
Totals by behavior	86.5%	65.3%	43.9%	41.3%	100.0

BMI, body mass index.

Table 5. Model estimates and probabilities for adolescents

Variable	Parameter estimate (standard error)	Odds ratio or odds multiplier (95% CI)
4 healthy lifestyle factors (Intercept 1)[a]	−1.46 (0.26)	Odds ratio = 0.23 (0.14–0.39)
3 healthy lifestyle factors (Intercept 2)	0.19 (0.26)	Odds ratio = 1.21 (0.73–2.00)
Female	−0.06 (0.15)	Odds multiplier = 0.94 (0.70–1.26)
Nondepressed[a]	0.76 (0.25)	Odds multiplier=2.15 (1.30–3.53)

Significant predictor variable	Probabilities of 0–2, 3, or 4 healthy lifestyle factors based on model estimates (males)		
Depression status	**0–2 healthy lifestyle factors**	**3 healthy lifestyle factors**	**4 healthy lifestyle factors**
Nondepressed	28%	39%	33%
Depressed	45%	36%	19%

[a]Significant at $p < 0.05$.
CI, confidence interval.

appropriateness of the proportional odds model; we did not reject the assumption of a common β for each logit ($p = 0.15$ for each model).

In the adolescent model, the intercepts for three and four factors indicated that adolescents in the reference categories (male and depressed) were equally likely to meet three to four healthy lifestyle factor guidelines as they were zero to two (odds ratio [OR]=1.21, nonsignificant), but were significantly less likely to meet all four recommended factors than to meet zero to three (OR=0.23). Depression was the only significant predictor in this model; gender had no significant effect. Nondepressed adolescents were associated with 2.15 times increased odds of engaging in four versus zero to three healthy lifestyle factors and three to four versus zero to two factors. Model estimates are shown in the top portion of Table 5, while the lower portion displays the probabilities of engaging in healthy lifestyle factors (computed from model estimates).

In the adult model, age, education, and presence of chronic disease were all associated with meeting healthy lifestyle factor guidelines; gender had no significant effect. Adults in the reference groups (male, aged 18 to 49, no college degree, and with chronic disease) had significantly higher odds of meeting three to five versus zero to two healthy lifestyle factors (OR=1.48), but had significantly lower odds of meeting four to five versus zero to three healthy lifestyle factors (OR=0.30). Older adults aged 50 to 64 had 1.46 times increased odds of meeting recommended guidelines. Having a college degree increased odds 1.65 times, and absence of chronic disease increased odds 1.92 times. Model estimates are shown in the top portion of Table 6, while the lower portion displays the

Table 6. Model estimates and probabilities for adults

Variable	Parameter estimate (standard error)	Odds ratio or odds multiplier (95% CI)
4–5 healthy lifestyle factors (Intercept 1)[a]	−1.22 (0.18)	Odds ratio=0.30 (0.21–0.42)
3 healthy lifestyle factors (Intercept 2)[a]	0.39 (0.18)	Odds ratio=1.48 (1.04–2.09)
Female	0.15 (0.16)	Odds multiplier=1.16 (0.85–1.58)
Aged 50–64[a]	0.38 (0.18)	Odds multiplier=1.46 (1.04–2.05)
College degree[a]	0.50 (0.16)	Odds multiplier=1.65 (1.21–2.25)
No chronic disease[a]	0.65 (0.17)	Odds multiplier=1.92 (1.38–2.66)

Significant predictor variables			Probabilities of 0–2, 3, or 4–5 healthy lifestyle factors based on model estimates (males)		
Age	**Education (college degree, yes or no)**	**Chronic disease (yes or no)**	**0–2 healthy lifestyle factors**	**3 healthy lifestyle factors**	**4–5 healthy lifestyle factors**
18–49	No	No	26%	38%	36%
18–49	No	Yes	40%	37%	23%
18–49	Yes	No	18%	34%	48%
18–49	Yes	Yes	29%	38%	33%
50–64	No	No	19%	35%	45%
50–64	No	Yes	32%	38%	30%
50–64	Yes	No	13%	30%	58%
50–64	Yes	Yes	22%	37%	41%

[a]Significant at $p < 0.05$.
CI, Confidence interval.

Table 7. Model estimates and probabilities for seniors

Variable	Parameter estimate (standard error)	Odds ratio or odds multiplier (95% CI)
4–5 healthy lifestyle factors (Intercept 1)	−0.11 (0.13)	Odds ratio=0.90 (0.69–1.16)
3 healthy lifestyle factors (Intercept 2)[a]	1.79 (0.15)	Odds ratio=5.97 (4.42–8.06)
Female	−0.09 (0.15)	Odds multiplier=0.91 (0.68–1.23)
College degree[a]	0.48 (0.17)	Odds multiplier=1.61 (1.16–2.23)

Significant predictor variable	Probabilities based on model estimates (males)		
Education (college degree, yes or no)	**0–2 healthy lifestyle factors**	**3 healthy lifestyle factors**	**4 healthy lifestyle factors**
No	14%	38%	47%
Yes	9%	31%	59%

[a]Significant at $p < 0.05$.
CI, confidence interval.

probabilities of engaging in healthy lifestyle factors (computed from model estimates).

In the senior model, education was the only predictor variable significantly associated with the odds of the meeting healthy lifestyle factor guidelines; gender did not have a significant effect. Again, seniors in the reference group (male, without college degree) had significantly higher odds of meeting recommended guidelines for three to five healthy lifestyle factors relative to zero to two (OR=5.97), but were equally likely to meet four to five as to meet zero to three factors (OR=0.90, nonsignificant). Seniors with a college degree had 1.61 times higher odds of meeting guidelines relative to seniors without a college degree. Model estimates are shown in the top portion of Table 7, while the lower portion displays the probabilities of engaging in healthy lifestyle factors (computed from model estimates).

Discussion

The main findings of this study include the observation that only 14.5% of members aged ≥13 years of a large Midwestern health plan meet recommended guidelines for a comprehensive set of four healthy lifestyle factors, including not smoking, being physically active, consuming high-quality diet foods, and being at healthy weight. Among adults and seniors, when the addition of no or moderate levels of alcohol use is considered, only 10.8% and 12.8%, respectively, meet recommended guidelines for a comprehensive set of five healthy lifestyle factors. Given these findings, it is clear that several of the most important healthy lifestyle factors responsible for reducing significant morbidity and mortality[2,21] often do not occur simultaneously among members of a health plan population. It also demonstrates the challenges that exist for healthcare and public health systems to improve upon the prevalence of healthy lifestyle factors within individuals and the population.

These results appear to corroborate the findings of several other studies, including studies by Berrigan et al.,[7] Ford et al.,[8] and Fine et al.[9] Berrigan et al.[7] documented an adherence rate to five behaviors (physical activity, tobacco use, alcohol consumption, fruit and vegetable consumption, and dietary fat intake) of 5.9% among U.S. adults based on data from National Health and Nutrition Examination Survey (NHANES) III (collected between 1988 and 1994). On the other hand, Ford et al.,[8] using the same NHANES III data set as Berrigan et al.,[7] reported that 6.8% of the U.S. adult population engaged in four healthy lifestyles, including not smoking, adequate fruit and vegetable intake, adequate physical activity, and normal body weight. Considered in the context of the present study, the relatively small differences among these three studies appear mostly related to slight differences in the definition of the variables studied, the variables selected for each specific analysis, the inclusion of body weight as opposed to behaviors only, and the timing of the data collection (NHANES III data collected in 1988 to 1994 vs the data used in this report, which was collected in 2002). If, as an example, we compare the Ford et al. adult-only (ages 21 to 65 years)[8] study results to our adult-only (18 to 65 years) results, nonsmoking rates were ~69% versus 85.1%, physical activity rates were ~39% versus 39.3%, and normal weight rates were ~43% versus 39.3%, respectively.

In addition, Fine et al.[9] looked at the prevalence of multiple behavioral risk factors, including smoking, overweight and obesity, physical inactivity, and risky drinking, among U.S. adults aged ≥18 using data from the National Health Interview Survey, representing the U.S. population. In their study, they reported both the presence and the absence of the risk factors. Comparing common variables from our combined adult and senior subgroup rates (estimates from Table 3) with the reported rates by Fine et al.,[9] relatively comparable health plan–specific and national rates are noted. Nonsmoking rates were ~89% versus 77%, normal weight

rates were ~39% versus 42%, physical activity rates were ~40% versus 34%, and moderate or no-alcohol use rates were ~92% versus 79%, for the present study as compared to the results of Fine et al.,[9] respectively. Differences in these may be attributed to similar factors as noted above, as well as the fact that our sample comes from a relatively homogenous population all covered under a single health plan, as opposed to a more heterogeneous sample representative of adults across the United States.

Other studies that report on adherence to multiple healthy lifestyle factors among adolescents do not appear to be readily available in the literature. Judging the proportion of adolescents who meet single healthy lifestyle factor recommendations (Table 2), physical activity and high-quality diet consumption are the two behaviors that underscore the need for improvement. Pate et al.[28] noted that among teenagers, low levels of physical activity were associated with cigarette smoking, lower fruit and vegetable consumption, and several other negative health behaviors that were not considered here. It may be possible that interventions designed to increase low physical activity levels among adolescents have the potential to effectively reduce other concomitant negative health behaviors, but additional research is needed in this area.

The cluster pattern presented in Table 4 clearly indicates that weight (BMI) and physical activity, singly and in combination, provide the largest opportunity for improvement in the prevalence of adherence to multiple healthy lifestyle factors. For the health plan, up to an additional 43.3% of the adolescent, adult, and senior population would meet all four healthy lifestyle factors recommendations if these two factors were met singly, or in combination. Hence, this comprehensive lifestyle-related health measure, based on a person-centered metric of multiple healthy lifestyle factors, may assist in shaping health plan policy and making resource allocation decisions related to improving the health status of the enrolled population.

We also considered the impact of demographics and other subject characteristics on the likelihood of meeting the recommendations for multiple healthy lifestyle factors. Among adolescents, only depression was found to be a significant predictor variable, that is, those who reported not being depressed had 2.15 times higher odds of adhering to a higher number of healthy lifestyle factors than those who reported a depression diagnosis. Other research[9,29] has indicated a negative impact of emotional distress or depression on the number of behavioral risk factors among adults. Regardless of whether these observations relate to adolescents or adults, in order to increase adherence to the number of healthy lifestyle factors in the context of mood disorders, emotional distress, or depression, more research needs to be conducted that supports the design and development of effective behavior change programs.

Age, education, and the presence of chronic disease significantly affected adherence to multiple healthy lifestyle factors among adults. First, adults aged 50 to 64 years, were more likely to adhere to multiple healthy lifestyle factors, as compared to young adults aged 18 to 49 years. Second, having a college degree increased chances of adherence to multiple healthy lifestyle factors by as much as 65%. Finally, the absence of chronic disease was associated with 90% higher odds of adherence to multiple healthy lifestyle factors as compared to being afflicted with a chronic condition. These findings corroborate the results of Fine et al.[9] who showed similar impacts of age, education, and the presence of heart disease and/or diabetes on the presence, rather than the absence, of three or four risk factors. Based on these data, reaching young adults at lower educational attainment levels with effective messages about healthy lifestyle factors before the onset of chronic disease is clearly a reasonable strategy to consider. This may be especially true considering the infrequent interaction that young presymptomatic adults have with the healthcare delivery systems.[30] Frequent and personalized behavior change messaging[31] in multiple settings that has a meaningful context for targeted subpopulations may hold promise to effectively increase adherence to multiple healthy lifestyle factors across the population.

Among seniors, only education remained a significant predictor for a higher number of healthy lifestyle factors. Since chronic disease is more prevalent in this age group than any other, it may be that population segmentation based on educational attainment is appropriate, as it may relate to outreach strategies designed to reach seniors with messaging about adherence to various healthy lifestyle factors in the context of self-management of chronic conditions.

The cross-sectional nature of the present study does not allow the results to be interpreted in the context of causality; hence, the study is limited in this regard. In addition, other well-known limitations that apply to this study include the self-report nature of the data that may be subject to recall bias. Furthermore, some variables, such as tobacco and alcohol use, may be reported with less accuracy.[32] Another potential limitation in our study is the notion that we include diet quality, physical activity, and BMI (all measures related to energy balance) in the comprehensive lifestyle-related health measure, whereas only including not smoking and no/moderate alcohol use as the balance of this measure may disproportionately reflect a focus on energy balance. The fact that the population studied is representative of a single, relatively homogenous population in the upper Midwest also limits generalizability of results.

However, the limitations of this study should be balanced against its strengths. The present study was able to include three subpopulations (adolescents, adults, and seniors) from among the health plan mem-

bership, and report on their adherence to multiple healthy lifestyle factors. In addition, the study provides insight into the prevalence, clustering, and covariates of meeting recommendations for multiple healthy lifestyle factors in individuals, an outcome measure that provides more comprehensive information about the health status of the population than separate single risk factor reporting will provide. Furthermore, adherence to multiple healthy lifestyle factors within individuals represent a more person-centered approach to outcomes measurement,[33] conveys meaningful clinical information, and may be more aligned with the objectives of population health than monitoring single risk factors *per se*. The results of this study also indicate that the notion of a comprehensive lifestyle-related health measure holds promise as a meaningful summary metric, particularly when applied in the context of health promotion, disease prevention, and health policy issues.

Finally, this study provides multiple suggestions for additional research. Studies focused on the reliability, validity, predictive strengths, and applied effectiveness of multiple healthy lifestyle factor summary measures represent important next steps in this area. Additionally, the consideration of other lifestyle factors to the summary measure (e.g., sleep) and the impact of race/ethnicity and geographic variation on the summary measure are of immediate interest. Finally, additional research is warranted that would further explore the multiple healthy lifestyle factor profiles of subpopulations, including young adolescents (aged 13 to 15), older adolescents (aged 16 to 18), young adults, older adults, and older seniors (>75 years).

The research reported here was supported in part by the Robert Wood Johnson Foundation (grant 046929) and the HealthPartners Center for Health Promotion.

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