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Health Behavior Change Following Chronic Illness in Middle and Later Life

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Objectives. Understanding lifestyle improvements among individuals with chronic illness is vital for targeting interventions that can increase longevity and improve quality of life.

Methods. Data from the U.S. Health and Retirement Study were used to examine changes in smoking, alcohol use, and exercise 2–14 years after a diagnosis of heart disease, diabetes, cancer, stroke, or lung disease.

Results. Patterns of behavior change following diagnosis indicated that the vast majority of individuals diagnosed with a new chronic condition did not adopt healthier behaviors. Smoking cessation among those with heart disease was the largest observed change, but only 40% of smokers quit. There were no significant increases in exercise for any health condition. Changes in alcohol consumption were small, with significant declines in excessive drinking and increases in abstention for a few health conditions. Over the long term, individuals who made changes appeared to maintain those changes. Latent growth curve analyses up to 14 years after diagnosis showed no average long-term improvement in health behaviors.

Discussion. Results provide important new information on health behavior changes among those with chronic disease and suggest that intensive efforts are required to help initiate and maintain lifestyle improvements among this population.

Key Words: Chronic disease—Disease management—Health behavior—Rehabilitation—Secondary prevention.

THE importance of modifiable risk factors for prevention of disease and premature mortality is widely recognized by researchers and public health professionals. Findings indicate that smoking, physical activity, and alcohol consumption are among the most important behavioral determinants of health (Johansson & Sundquist, 1999; Khaw et al., 2008). An equally important concern, but one that has received less attention, involves changes made once a disease has already been diagnosed.

Five of the leading causes of death for adults in the United States are heart disease, cancer, cerebral vascular disease (stroke), respiratory disease (chronic obstructive pulmonary disease), and diabetes (Heron, 2011), which are considered preventable because they are substantially influenced by modifiable behaviors (Bornstein, 1994; Knoops et al., 2004; Stampfer, Hu, Manson, Rimm, & Willett, 2000). The diagnosis of one of these chronic conditions represents a potential "wake-up call," an opportunity to make critical lifestyle changes that has been referred to as secondary prevention (Ades, 2001), therapeutic adherence (Bosworth, Weinberger, & Oddone, 2006), or a teachable moment (McBride et al., 2008). Healthy behaviors following the onset of disease are critical because they can lower the risk of recurrence, reduce severity of disease, increase functioning, and extend longevity (Aldana et al., 2003; Jolliffe et al., 2001; Speck, Courneya, Masse, Duval, & Schmitz, 2010; Williamson et al., 2000). Smoking cessation, for example, can cut the risk of subsequent heart attack in half (Ronnevik, Gundersen, & Abrahamsen, 1985).

Temporary changes in behavior are unlikely to have substantial effects (Dunbar-Jacob & Schlenk, 1996), however, and permanent changes are necessary to have a meaningful effect on health. Intervention studies have demonstrated that individuals can make short-term changes in behavior (Conn, Hafdahl, Brown, & Brown, 2008; Dornelas, Sampson, Gray, Waters, & Thomson, 2000), but less is known about the extent to which these short-term changes are maintained over longer periods (Jeffery et al., 2000; Rothman, 2000). A recent meta-analysis (Fjeldsoe, Neuhaus, Winkler, & Eakin, 2011) found that only a third of studies reported long-term maintenance of behavior changes, with only a third of studies reporting maintenance up to three months and only 10% of studies reporting maintenance up to a year.

Although major theories of behavior change do not include explicit predictions about behavior change in the context of chronic illness, the basic tenets of several health behavior models suggest that the onset of chronic illness should motivate lifestyle changes. Diagnosis of a serious health condition by a physician should minimally lead to recognition of a problem, an initial stage of change (Prochaska & Prochaska, 2005). If the perceived susceptibility to disease is high, the illness is seen as serious, and

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the benefits of change are clear, then health behaviors are expected to improve (Rosenstock, 1966). Subjective norms in favor of changing behavior (Ajzen & Albarracín, 2007) are likely to be salient when a chronic illness has been diagnosed and also should lead to healthier behavior. All of these theoretical notions would suggest that lifestyle changes are probable after a diagnosis of a serious illness.

Other aspects of health behavior models, however, suggest that changes in lifestyle after the diagnosis of a chronic disease may be difficult to make. The Theory of Planned Behavior posits frequency and recency of past behavior as one predictor of later behavior through their effects on attitudes and behavioral intentions (Ajzen, 2002). Repeated behavior may develop into habit, distinct from mere frequency, that directly affects later behavior, however (Verplanken, 2006). Moreover, habitual behavior may influence subsequent health behavior even when past behavior is inconsistent with beliefs and intentions (Ouellette & Wood, 1998; Verplanken, Aarts, van Knippenberg, & Moonen, 1998). Unhealthy behaviors which have been repeated over a lifetime are likely to have become entrenched habits by middle and older age, making them difficult to change even in the face of imminent threats to one's health. In addition to directly inhibiting behavior change, such entrenched behavior also may lead to beliefs that behavior change is beyond an individual's volitional control (Fishbein & Cappella, 2006) or the ability to make the change (Bandura, 2006).

At present, however, we do not have complete knowledge of how often individuals change their health behaviors in response to a newly diagnosed condition, whether these changes are maintained or whether certain health conditions are more likely to lead to changes. Several studies have suggested that individuals may make changes after a recently diagnosed chronic health condition (Hawkes, Lynch, Youlden, Owen, & Aitken, 2008; Patterson et al., 2003; Satia et al., 2004; Steptoe, Sanderman, & Ward, 1995), although many studies have only examined short-term changes and some have relied on retrospective accounts that may be subject to reporting biases, such as social desirability. Only a handful of studies have examined prospective changes over a longer period of time. Individuals diagnosed with a serious health condition were more likely to have quit smoking than those who had not been diagnosed with illness two (Keenan, 2009) and six years later (Falba, 2005). A study of diabetics and stroke survivors (Platt, Sloan, & Costanzo, 2010) reported fewer steady and sporadic drinkers 14 years after diagnosis.

Most studies have focused on a particular health condition, but the few studies that have included more than one disease group suggest differences in behavior change after diagnosis. Individuals with heart disease and stroke were found to have a greater likelihood of smoking cessation (Twardella et al., 2006) and increasing exercise (van Gool, Kempen, Penninx, Deeg, & van Eijk, 2007) than those with diabetes. And those with heart disease and stroke were somewhat more likely to reduce daily alcohol consumption than those with other conditions (Perreira & Sloan, 2001). The impact of chronic conditions on quality of life is not the same across conditions (Saarni et al., 2006), and thus, behavior change may differ because of varying perceptions of the illness as threat to health or quality of life.

The existing literature provides an incomplete picture of the extent to which long-term changes are made following a newly diagnosed condition and whether individuals are more likely to make lifestyle improvements in response to certain health conditions. A better understanding of these issues is important to evaluate the theoretical processes involved in illness perception and behavior change as well as to better assess the adequacy of secondary prevention efforts. The present study will add to the literature in three important ways. First, the prospective study design assesses health behaviors prior to the diagnosis of the condition and thereby avoids faulty recall and social desirability biases. Second, unlike the majority of studies that examine behavior change over 12 months or less, the present study will use analysis of individual growth curves to examine patterns of behavior change up to 14 years after initial diagnosis. This will provide essential information about whether individuals tend to make permanent lifestyle changes. And finally, this study will compare lifestyle changes among five of the most serious chronic conditions, an improvement over many earlier studies that examine health conditions in isolation. This will provide insight into whether behavioral processes are similar or different across conditions and where improvements in chronic disease management are most needed.

Method

Sample

The Health and Retirement Study (HRS) is an ongoing biannual longitudinal study of 11,191 U.S. residents aged 50 years or older that began in 1992. The study sample consisted of individuals aged 50–85 years (M = 56.35, SD = 4.37) who began the study without heart disease, cancer, stroke, respiratory disease, and diabetes. At baseline, 50.5% of the sample was male and 74.9% had at least a high school diploma. Further details of the HRS design, sampling procedures, data collection, and response rates at each wave are available in Heeringa and Connor (1995).

Design

The present study includes HRS interviews conducted between 1992 and 2006, spanning as many as 14 years. As indicated for specific measures below, analyses were based on all available waves for which the items were worded consistently. We defined preillness diagnosis and postillness diagnosis time points individually for each case, and the

number of postdiagnosis time points available for an individual respondent varied according to the wave of diagnosis and subsequent available data. The prediagnosis time point was defined as the last wave of interview prior to diagnosis. The initial postdiagnosis time point was defined as the same wave at which respondents reported a new condition and thus occurred between 0 and 2 years after the diagnosis.

A set of healthy respondents (N = 1,364) served as a basis of comparison of change in health behavior over a two-year period, although our primary focus was on changes between pre- and postdiagnosis for those with chronic disease. These individuals reported none of the seven health conditions measured in the HRS (heart disease, diabetes, cancer, stroke, lung disease, arthritis, and hypertension). Because the availability of longitudinally comparable measures of alcohol and exercise began in Wave 3 of the HRS, Waves 3 and 4 were used to assess changes over a two-year period for healthy controls.

Measures

Chronic illness was assessed with the question "Has a doctor ever told you that you had . . . " for the following list of conditions: "a heart attack, coronary heart disease, angina, congestive heart failure, or other heart problems?"; "diabetes or high blood sugar?"; "cancer or a malignant tumor of any kind except skin cancer?"; "stroke?"; and "chronic lung disease such as chronic bronchitis or emphysema?". Each chronic health problem was examined separately regardless of the number of comorbid conditions present. Forty-nine percent of participants diagnosed with one of the five conditions reported another condition (M = 0.70 for the number of conditions).

The primary dependent variables in this study were the frequency and quantity of smoking (available for years 1992–2006), alcohol consumption (i.e., beer, wine, or liquor; available for years 1996–2006), and physical activity (i.e., vigorous activity ≥ 3 times per week; available for years 1996–2006). Because abstinence, moderate drinking, and heavy drinking have different implications for health and because recommendations may vary by health condition, we followed the general recommendations found in the *Dietary Guidelines for Americans* (United States Department of Agriculture and United States Department of Health and Human Services, 2005) to categorize alcohol consumption into four categories: less than moderate (never drinks to <1 drink per week), moderate (≥1 per week to 1 drink per day on average for women and ≥1 per week to 2 drinks per day on average for men), occasionally excessive (≤1 drink per day on average but with ≥4 drinks on any occasion within the previous 3 months for women and ≤2 drinks per day on average but with ≥4 drinks on any occasion within the previous 3 months for men), and excessive (>1 drink per day on average for women and >2 drinks per day on average for men).

Functional limitations were measured with 11 yes/no items for activities of daily living and instrumental activities of daily living (e.g., difficulty walking across a room, difficulty preparing a hot meal) assessed at the interview following a new diagnosis ("Because of a health problem do you have any difficulty . . . ?"). Participants who indicated "yes" to any of the questions were considered to have some functional impairment.

Analysis Overview

Rao–Scott chi square (Rao & Scott, 1981) was used to compare pre- and postdiagnosis proportions comparing discordant cells (i.e., 0–1 vs 1–0 responses; Agresti, 2002). Paired t tests were used to compare pre- and postdiagnosis means for continuous variables. Logistic regression models predicting group differences in health behaviors postdiagnosis, controlling for prediagnosis differences, were used to assess differences in behavior change over the initial two-year period following diagnosis by sex, age, education, and functional limitations. Growth curve analyses were estimated with Mplus Version 6 (L. K. Muthén & Muthén, 1998–2010) using maximum likelihood estimates for missing data with robust standard errors (B. Muthén, du Toit, & Spisic, 1997; Yuan & Bentler, 2000). All analysis were weighted (nonresponse and poststratification) and adjusted for complex sampling designs using SUDAAN 10.0 (Research Triangle Institute, 2008), SAS 9.2 PROCSURVEY, or Mplus.

Results

Health Behavior Change Over the First Two Years

Table 1 presents weighted percentages and unweighted counts at pre diagnosis and postdiagnosis (between 0 and 2 years following diagnosis) for each health condition.

Smoking.—Every new diagnosis of a chronic illness was associated with a significant reduction in smoking prevalence. Those who were diagnosed with heart disease, cancer, or stroke experienced the largest decrease. For example, the prevalence of smoking among those with heart disease declined from 24.5% to 14.9%, indicating that approximately 40% of smokers with heart disease ceased smoking. In contrast, among those with lung disease, the decline was only 8.5%, from 43.8% to 35.3% (i.e., only approximately 19% ceased). We also investigated whether those who continued to smoke decreased the number of cigarettes smoked per day. There was a significant decline in the number of cigarettes smoked following diagnosis in all disease categories: from 19.7 to 10.5 for heart disease, from 18.8 to 12.8 for diabetes, from 19.7 to 11.5 for cancer, from 19.2 to 13.9 for stroke, and from 19.9 to 14.5 for lung disease (all p values < .05).

To examine whether there were differences in health behavior change associated with sociodemographic variables and functional limitations, we used logistic regression to test for significant differences in sex, age (50–64 years old vs 65 years and older), education (less than high school diploma vs high school diploma or more education), and

Table 1. Health Behavior Changes Following Diagnosis With a New Chronic Condition Among Persons Aged 50 Years and Older, Health and Retirement Study

	Total		Sex				Age				Education				Functional limitations			
			Men		Women		50–64		65+		<HS		HS+		None		1 or more	
Chronic illness	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Health behavior (%)																		
Heart disease, *n*	1,996		1,116		880		1,223		773		656		1,340		866		440	
Current smoker	24.5	14.9***	25.6	15.3	23.2	14.5	28.5	17.8	16.6	9.2	33.0	20.5	21.3	12.8	18.9	11.7	25.6	14.4
Exercise	47.6	44.0	53.0	50.2	40.4	35.7**	49.5	44.2	43.2	43.4	36.0	35.1	52.4	47.6	52.0	50.1	37.8	35.7***
Alcohol																		
Less than moderate	67.2	69.2	59.3	62.4	76.3	77.1	67.4	69.7	67.0	68.8	81.6	83.8	61.8	63.8**	63.9	65.5	74.3	77.3*
Moderate	20.3	19.6	23.3	21.6	16.9	17.3	19.8	20.2	20.9	18.8	7.8	8.6	25.0	23.7**	23.1	22.3	14.3	13.7
Excessive	5.9	5.4	7.3	6.1	4.4	4.6	5.1	4.5	6.8	6.3	4.6	4.5	6.4	5.7	6.0	5.7	5.8	4.8
Occasionally excessive	6.5	5.8	10.1	10.0	2.4	1.0***	7.7	5.6	5.3	6.1	5.9	3.0	6.8	6.9*	7.0	6.6	6.6	4.2
Diabetes, *n*	1,549		812		737		990		559		559		990		747		328	
Current smoker	20.0	15.7***	21.7	17.5	18.2	13.9	22.3	17.8	15.1	11.4	25.3	19.5	17.3	13.9	15.9	13.0	21.0	17.2
Exercise	41.7	42.5	45.2	46.1	38.1	38.7	39.9	42.6	46.5	42.3	39.1	35.4	42.9	45.7*	46.4	48.4	29.6	27.0**
Alcohol																		
Less than moderate	73.4	75.9	63.2	65.5	83.0	85.7***	71.8	74.2	75.4	78.1	81.1	83.5	70.1	72.7	68.6	72.6	84.5	83.2
Moderate	14.9	14.6	17.6	19.8	12.4	9.7***	14.8	14.5	15.0	14.7	10.1	10.0	16.9	16.6	17.8	16.4	8.0	10.5
Excessive	5.1	4.3*	5.9	5.7	4.4	2.9	5.5	4.8	4.6	3.5	4.8	3.2	5.3	4.7	6.2	4.7	2.8	3.2
Occasionally excessive	6.6	5.2	13.4	9.0	0.2	1.7*	7.9	6.5	4.9	3.7	4.1	3.3	7.7	6.1	7.4	6.2	4.7	3.0
Cancer, *n*	1,333		816		517		753		580		388		945		670		316	
Current smoker	23.1	15.5***	22.2	14.7	24.0	16.6	25.6	16.7	18.2	13.4	28.6	24.2	21.3	12.6***	18.1	11.3	26.0	18.2
Exercise	51.1	43.8*	57.8	49.0	41.6	36.4	50.2	45.5	53.4	39.6	49.4	34.5	51.6	46.9*	51.7	49.1	48.4	28.8***
Alcohol																		
Less than moderate	59.8	63.6**	50.2	53.8	73.4	77.4***	57.6	65.6	62.4	61.3**	67.4	72.1	57.3	60.8	56.4	59.9	67.6	72.2
Moderate	22.6	22.6	25.6	26.7	18.4	16.9*	24.5	21.4	20.5	24.1	15.3	17.1	25.1	24.5	24.6	24.8	18.4	17.8
Excessive	7.2	5.9	8.4	6.9	5.5	4.6	8.5	7.3	5.6	4.4	9.7	5.8	6.4	6.0	8.4	6.8	4.3	3.6
Occasionally excessive	10.4	7.8*	15.8	12.5	2.7	1.1***	9.4	5.7	11.5	10.2*	7.6	5.0	11.3	8.7	10.7	8.5	9.7	6.3
Stroke, *n*	650		369		281		360		290		232		418		195		271	
Current smoker	30.1	23.5***	31.1	22.7	29.0	24.3	34.6	26.7	22.3	18.1	37.0	27.6	27.0	21.7	27.4	22.8	29.8	23.6
Exercise	39.3	23.9***	50.0	27.2	29.4	20.8	37.3	22.7	44.4	26.8	30.4	20.2	43.3	25.5	46.5	27.0	32.8	21.1
Alcohol																		
Less than moderate	73.8	81.3***	63.7	76.8	84.5	86.2	74.9	84.8	72.6	77.6	80.6	84.0	70.9	80.2	71.3	77.8	75.6	84.2
Moderate	11.9	10.6	15.0	12.1	8.5	9.0	10.6	9.1	13.2	12.2	4.1	8.5	15.1	11.5	15.6	14.1	8.8	7.7
Excessive	6.6	4.2	7.0	4.7	6.2	3.6	7.1	3.0	6.1	5.5	7.6	2.7	6.2	4.7	7.6	5.3	5.8	3.3
Occasionally excessive	7.8	3.9***	14.3	6.4	0.9	1.2	7.5	3.1	8.1	4.7	7.7	4.8	7.8	3.5	5.5	2.8	9.8	4.8
Lung disease, *n*	996		501		495		655		341		384		612		396		225	
Current smoker	43.8	35.3***	48.6	39.7	39.6	31.5	48.2	39.0	33.0	26.2	50.4	40.5	39.9	32.1	38.8	32.4	42.2	30.9
Exercise	38.0	31.9*	42.1	32.4	34.9	31.6	40.8	33.4	29.6	27.5	35.3	31.8	39.5	32.0	42.3	37.7	29.4	20.0*
Alcohol																		
Less than moderate	68.3	75.3***	55.1	66.3	78.9	82.4	67.7	75.9	69.1	74.5	73.2	83.7	66.0	71.2*	66.7	71.9	71.3	81.8*
Moderate	16.1	12.6*	21.5	14.1	11.9	11.4	16.3	11.3	15.9	14.1	13.1	8.7	17.6	14.4	15.4	13.9	17.4	9.9
Excessive	7.9	4.9**	9.8	6.1	6.4	4.0	6.6	5.1	9.5	4.7	8.2	2.8	7.7	5.9	9.2	6.1	5.4	2.7
Occasionally excessive	7.6	7.2	13.7	13.5	2.8	2.3**	9.4	7.6	5.5	6.8	5.5	4.8	8.7	8.4	8.6	8.1	5.8	5.6

Notes. <HS refers to less than high school diploma, and HS+ refers to high school diploma or more education. Tests of group differences by sex, age, level of education, and functional limitations were conducted using logistic regression in which posttest differences were predicted by group membership controlling for pretest differences. Significant differences for these tests indicate greater change from pretest to posttest in one of the groups. Pre values are based on the last wave of interview for which respondents reported no diagnosis of the condition. Post values are based on the same wave of the interview in which respondents reported diagnosis of the condition (0–2 years). Smoking data were available for Waves 1 through 9. Exercise data were available for Waves 3 through 6. Alcohol data were available for Waves 3 through 9. Functional limitation data were available for Waves 3 through 7.

*$p < .05$; **$p < .01$; ***$p < .001$.

functional limitations (0 limitations vs ≥1 limitations). Overall, no group differences were observed except that more educated cancer patients were more likely to quit smoking than less educated cancer patients ($p < .001$).

Exercise.—There were no significant improvements in the percentage reporting regular vigorous exercise (at least 3 times per week) following diagnosis of any chronic condition (Table 1). In fact, the percentage exercising declined significantly for those with cancer, lung disease, and stroke. Changes in exercise did not differ by sex, age, or education with two exceptions. Women with heart disease showed a greater drop in exercise level than men ($p < .01$). Diabetic participants with more education increased their level of activity by approximately 7%, whereas those with less education decreased their physical activity by approximately 9% ($p < .05$). Those with heart disease, diabetes, cancer, and lung disease significantly reduced their activity level if they reported functional limitations (all $p < .05$).

Alcohol consumption.—There was an increase in the percentage of individuals who do not drink or drink infrequently (less than moderate consumption) following diagnosis (Table 1), although this change was only significant for those with cancer (from 59.8% to 63.6%, $p < .01$), stroke (from 73.8% to 81.3%, $p < .001$), and lung disease (from 68.3% to 75.3%, $p < .001$). The percentage of participants who drank moderately declined significantly for those with lung disease but not for other chronic conditions (from 16.1% to 12.6%, $p < .05$). The percentage of those who drank excessively significantly declined only among those with diabetes and lung disease. Occasionally-excessive drinking declined significantly for those with cancer and stroke. We also assessed changes in the average number of drinks per day. Among those who were currently drinking, those with heart disease (from 0.9 to 0.7), diabetes (from 0.6 to 0.5), cancer (from 0.9 to 0.8), stroke (from 0.8 to 0.5), and lung disease (from 0.9 to 0.6) significantly decreased the average number of daily drinks (all p values < .05).

There were several significant sex differences in alcohol consumption. Women with diabetes and cancer were more likely to become infrequent drinkers ($p < .001$ and $p < .001$, respectively) and less likely to become moderate drinkers following diagnosis ($p < .001$ and $p < .05$, respectively) than were men. There also was a greater percentage decline in the occasionally excessive category for women than there was for men with heart disease ($p < .001$) and lung disease ($p < .001$). Older adults with cancer were more likely to become infrequent drinkers after diagnosis ($p < .01$) and less likely to be occasionally excessive drinkers after diagnosis ($p < .05$) than were younger adults. Those with higher education who were diagnosed with heart disease and lung disease were more likely to become infrequent drinkers ($p < .01$ and $p < .05$, respectively) than those with lower education. Those with functional limitations with heart disease and lung disease were more likely to become infrequent drinkers than those without limitations ($ps < .05$).

Healthy controls.—As a basis of comparison, we computed the percentage of individuals with no chronic condition who changed their behavior over a two-year period. We then conducted significance tests to compare pre- with postdiagnosis changes among those with each of the diagnosed chronic conditions to changes among the healthy group over a two-year period. Respondents in each of the chronic condition groups experienced a significantly greater change ($p < .001$) in exercise than the healthy control group. For example, the healthy control group was nearly unchanged over two years (from 59.9% to 59.1%), whereas the heart disease group decreased more substantially (from 46.7% to 42.5%). The percentage of smokers decreased significantly more in the heart disease (from 20.8% to 14.8% vs 23.1% to 20.6%, $p < .001$), diabetes (19.6% to 15.7% vs 23.4% to 21.2%, $p < .05$), and cancer (23.7% to 16.1% vs 22.8% to 20.8%, $p < .001$) groups than in the healthy control group.

Attrition.—In order to explore the pattern of attrition, we compared those included in our analyses with those who dropped from the study due to refusal, health, or death. The analyses cannot provide information about bias in conclusions regarding health behavior change, however. Those excluded from the study had not reported a diagnosis of one of the conditions, and thus, their health status at the time of attrition was unknown. Some of these individuals may have left the study healthy with respect to the five chronic health conditions, but some who dropped out of the study may have, in fact, died from one of the conditions, such as a heart attack, yet to be diagnosed.

Those who dropped out of the study were more likely to smoke initially than those who were known to develop diabetes later (26.4% vs 20.0%, $p < .001$), but they were less likely to smoke than those eventually diagnosed with stroke (24.1% vs 30.1%, $p < .05$) and lung disease (22.3% vs 43.8%, $p < .001$). The attrition group was less likely to exercise initially than those with heart disease (42.5% vs 47.6%, $p < .05$) or cancer (39.5% and 51.1%, $p < .001$). They were less likely to abstain from alcohol than those with diabetes (68.1% and 73.4%, $p < .05$) but more likely to abstain from alcohol than those later diagnosed with cancer (71.3% and 59.8%, $p < .001$). Other comparisons (eight significance tests in all) were nonsignificant.

Overall, these analyses suggest no consistent differences in initial health behaviors between the disease group and the attrition group, with the majority of the comparisons showing nonsignificant differences and the remainder showing a mixed pattern of healthier and unhealthier behavior when comparing the two groups.

Table 2. Growth Curve Models for Health Behavior Changes After Diagnosis With a New Chronic Condition Among Persons Aged 50 Years and Older

	Health behavior					
	Smoking		Drinking		Exercise	
Chronic illness	Unadjusted	Adjusted	Unadjusted	Adjusted	Unadjusted	Adjusted
Heart Disease, *n*	1,953	1,940	736	736	1,364	1,037
Intercept mean/probability[a]	0.149	0.149	0.654***	0.653***	0.459	0.459
Slope mean	0.513	0.120	0.008	0.008	−0.304***	−0.350***
Intercept variance	177.293***	120.200***	1.090***	1.039***	5.991***	4.285***
Slope variance	1.228*	1.015**	0.026	0.024	0.401*	0.340
Diabetes, *n*	1,542	1,075	560	558	1,056	614
Intercept mean/probability[a]	0.157	0.142	0.487***	0.489***	0.421	0.425
Slope mean	0.363	0.347	−0.001	0.001	−0.142*	−0.258
Intercept variance	193.566**	247.978	0.471***	0.428***	4.514***	1.980*
Slope variance	1.568	3.207	0.009	0.008	0.157	0.289
Cancer, *n*	1,297	986	607	606	876	749
Intercept mean/probability[a]	0.156	0.134	0.714***	0 .716***	0.440	0.440
Slope mean	0.645	1.800	0.023	0.024	−0.012	−0.038
Intercept variance	407.288*	585.008	1.203***	1.120***	5.947**	4.524**
Slope variance	2.325	9.901	0.005	0.003	0.363	0.145
Stroke, *n*	642	466	214	214	444	360
Intercept mean/probability[a]	0.233	0.230	0.509***	0.511***	0.233	0.233
Slope mean	−0.277	−1.791	0.048	0.039	−0.198	−0.100
Intercept variance	90.420	102.665	0.772***	0.688**	2.011*	1.492*
Slope variance	1.311	3.509	0.007	0.026*	0.365	0.027
Lung Disease, *n*	984	982	343	343	707	372
Intercept mean/probability[a]	0.353	0.353	0.614***	0.615***	0.326	0.321
Slope mean	−0.557	−0.144	0.000	0.002	−0.143	−0.153
Intercept variance	60.352	118.773***	0.857**	0.742**	4.081*	2.488*
Slope variance	0.582	1.038*	0.045	0.036	0.108	0.011

[a]For models with binary variables, we report the baseline expected probability rather than the mean. Because of necessary scaling constraints for growth models with binary models, no significance tests are available for the intercept mean. Adjusted models included sex, age, education, and functional limitations as predictors of slopes and intercepts. Beta coefficients for covariate effects are not shown.

* $p < .05$; ** $p < .01$; *** $p < .001$.

Long-term Changes

Relapse.—In supplementary materials available online (http://psychsocgerontology.oxfordjournals.org/), Supplementary Figures 1 through 5 graphically illustrate long-term changes in behavior for smokers, individuals who did not exercise or individuals who were excessive drinkers as percentages at each wave following diagnosis. The figures show very similar patterns across health conditions and behaviors. Immediately following diagnosis, approximately 30% to 40% of the participants reported healthy behavior and a similar percentage maintained this behavior over subsequent years. Of those who initially had unhealthy behaviors but improved their behavior after diagnosis, approximately 8%–15% relapsed within the next two years. The majority of those who made improvements, however, maintained healthy behavior over the remaining years. For those with unhealthy behaviors following diagnosis, approximately 8%–15% adopted healthy behaviors in the following two-year period. Thus, although a small proportion showed improvements or relapse, there was little long-term change on average.

Latent growth curve models.—To investigate long-term changes in health behaviors following diagnosis of chronic illness, we tested a series of latent growth curve models using the first time point equal to the interview immediately following a new diagnosis and using last available record for that individual as the final time point. The proportion of missing data (low covariance coverage) differed by condition and behavior and limited the number of waves included. Nearly all models involved trajectories over 10 years, although models of alcohol use extended to 14 years after diagnosis for heart disease and lung disease. Due to limited availability of the exercise variable (beginning in 1996), only 6 years were available for exercise models for diabetes and lung disease. For the adjusted models, all covariates were centered at their mean value to improve interpretation of the intercept.

Table 2 presents results from unadjusted models, which included no covariates, and adjusted models, which included sex, age, education, and functional limitations as predictors of slopes and intercepts. Because of space limitations, beta coefficients for the covariate effects are not shown but are available from the first author. The results for the unadjusted models show no average change for smoking, drinking, or exercise with just two exceptions. Individuals with heart disease and diabetes showed a significant average decline in exercise over time (−0.304, $p < .001$, and −0.142, $p < .05$, respectively). Models controlling for covariates showed a very similar pattern of results for average change, with all

but one average slope coefficient remaining nonsignificant. The significant decline in exercise for individuals with diabetes was no longer significant after including covariates, which appeared to be due to a significant effect of functional limitations on the slope. Overall, the results suggest little evidence of long-term improvement in health behaviors.

Attrition.—Latent growth curve models using all available data assume that the data are at least missing at random (Little & Rubin, 2002), and the pattern of missing data from this study may not meet this criterion (i.e., nonignorable missingness). We therefore investigated whether our results would have differed if we did not include individuals who later dropped from the study. All growth curve models were retested using only respondents who had completed the study by requiring responses to be present at the first and last possible interviews following diagnosis (i.e., only intermittently missing data were allowed). Results indicated that, for all health behaviors and all health conditions, there were no differences in the direction or significance of the average slope estimates when comparing the analysis using only intermittent missing data with the analysis that included those who dropped from the study. We therefore report results that include individuals who dropped from the study to make use of all available data.

Discussion

The purpose of this study was to investigate long-term changes in health behavior, ranging from 2 to 14 years after chronic illness. The present paper joins a handful of prospective studies that have investigated health behavior over several years (Falba, 2005; Keenan, 2009; Twardella et al., 2006; van Gool et al., 2007) but provides a more comprehensive look at changes in smoking, exercise, and alcohol consumption among individuals newly diagnosed with heart disease, diabetes, cancer, stroke, and lung disease.

Results indicated that, by far, the most common change in behavior was smoking cessation, with cessation most likely occurring for patients with heart disease. Although cessation rates were equal to or greater than those found in smoking intervention studies (Katz, Muehlenbruch, Brown, Fiore, & Baker, 2002), 60% or more of smokers did not quit after the diagnosis of illnesses in which smoking is a crucial determinant of health outcomes. Leventhal and colleagues (Leventhal, Leventhal, & Breland, in press; Leventhal, Weinman, Leventhal, & Phillips, 2008) have suggested that individuals may not make necessary behavior changes because they misattribute symptoms to old age. This misattribution process seems less likely with major chronic conditions diagnosed by a physician. Misattribution should be more likely to occur with less serious illnesses, undiagnosed conditions, or conditions with a diffuse symptom pattern (Cameron, Leventhal, & Leventhal, 1995; Horowitz, Rein, & Leventhal, 2004). Contrary to what would be expected if a misattribution process was involved, individuals with lung disease had the highest prevalence of smoking before diagnosis and were the least likely to quit after diagnosis. Such a result may instead reflect a more intransigent addiction that has developed over many years. In later stages of life, past behavior in the form of firmly established habits may affect subsequent behavior more than the perceived threats to health or the perceived benefits of behavior change.

Exercise patterns changed little overall and even declined for some chronic conditions, perhaps at least partially due to functional limitations. Given the clear benefits of increased physical activity for each of the chronic conditions included in our analyses, these findings suggest an important shortcoming in efforts to improve health behavior following diagnosis. Although physical limitations may have been a mitigating factor, it may also be that common misconceptions still exist that those with heart attack or stroke should not exercise. With careful screening and supervision by a physician, increased activity is nearly always indicated unless the patient is clinically unstable or ischemia is present (Deedwania, Amsterdam, & Vagelos,1997), is less risky than sedentary behavior (Hamer & Stamatakis, 2009), and substantially reduces mortality. Goal setting with clinicians might be one effective way to ensure more change (MacGregor et al., 2006). Hospitalizations and subsequent contact with medical professionals that are triggered by a medical condition represent teachable moments in which patients may be more motivated to participate in programs than they would otherwise (Gorin, Phelan, Hill, & Wing, 2004; McBride et al., 2008).

Alcohol consumption tended to decline following diagnosis in many cases. Although the overall decline in consumption was partly due to less excessive or occasionally excessive drinking, which should be beneficial (King, Mainous, & Geesey, 2008; Kuntsche, Rehm, & Gmel, 2004; Sacco et al., 1999), it was also due to increases in abstinence and the reduction of moderate consumption, which are generally found to be associated with poorer health. One exception is that diabetics are cautioned to avoid alcohol consumption during periods of high blood glucose (American Diabetic Association, 2010). Reductions in moderate consumption may be based on the belief that reduced alcohol consumption is always healthier.

There were few significant and consistent sociodemographic differences in behavioral changes after diagnosis. Women and younger participants were somewhat more likely to decrease exercise and alcohol use. Education had the most consistent effect. Higher education was associated with smoking cessation, increased exercise, and decreased alcohol consumption. To the extent that sociodemographic differences were observed in general, they may be due to differences in motivation, social norms, and education that make improvements in some behaviors more likely for some groups than others (Kaplan, Newsom, McFarland, & Lu, 2001).

Although analyses indicated a few group differences, further investigation is needed to uncover the many possible social, psychological, health care, and physical factors that may be associated with greater likelihood of lifestyle improvement.

Examination of longer term changes, spanning as much as 14 years, showed remarkably similar patterns across diseases and behaviors, particularly noteworthy given the independence of health behaviors observed in the general population (Newsom, McFarland, Kaplan, Huguet, & Zani, 2005). The majority did not change initially, but those who did change overwhelmingly maintained their improved behavior. Although intervention studies often report initial changes with high percentages of reversion to unhealthy behavior in the long term (Rothman, 2000), it is possible that relapses had already occurred prior to the first interview after diagnosis, two years later. Even if short-term changes were more likely to be made following diagnosis, it is only the long-term changes that will affect health.

The present investigation draws on a number of strengths, including a representative sample and a prospective design, but several limitations should be noted. Our measures of health conditions and health behaviors were derived from self-report. To the extent that there is underreporting of health conditions (Manuel, Lim, Tanuseputro, & Stukel, 2007), any bias would likely be in the direction of overestimation of behavior change because individuals with less serious illness (e.g., ischemia without a myocardial infarction) would not have been included and would be less likely to receive rehabilitation counseling or would have less motivation to change. Several studies have shown that self-report of chronic conditions is accurate (Giles, Croft, Keenan, Lane, & Wheeler, 1995; Manson et al., 1991; Rimm et al., 1991; Vargas, Burt, Gillum, & Pamuk, 1997), however. Our study concerns new diagnosis of major health conditions, and it is unknown the extent to which individuals make lifestyle changes prior to diagnosis. Some individuals may adopt healthier behavior after more minor conditions are diagnosed or indicators, such as hypertension or high cholesterol, are identified. Inclusion of medical records of pre diagnosis risk factors along with subsequent diagnosis of major conditions in future studies would provide important new information about whether or when individuals change behavior at earlier points of disease development.

Our results should not be taken as an indication that changes in health behaviors never occur in middle and later life. Individuals with chronic conditions are less likely to engage in health behaviors than the general population, and this may lead to greater difficulties in improving lifestyles. Moreover, the conditions we studied may vary in their severity, symptoms, and real or perceived risk of mortality, so there may have been greater behavior change among certain subgroups within the conditions we studied that we were not able to investigate. Finally, more in-depth measurement of health behaviors may have revealed more fine-grained behavior improvements. For example, individuals may have increased short duration or more moderate forms of exercise, such as gardening or taking the stairs.

In conclusion, our results suggest that the vast majority of individuals do not make major lifestyle changes following diagnosis of a serious chronic disease, either in the short-term or in the long-term. Although individuals diagnosed with a chronic condition showed greater improvements in behavior than healthy controls in some behaviors (Blanchard et al., 2003), messages about lifestyle change seem to be primarily received for smoking cessation, despite ample evidence that exercise and healthy changes in alcohol consumption can improve quality of life, reduce risk of recurrence or complications, and increase longevity among those with chronic disease (Wannamethee, Shaper, & Walker, 2000). The imminent societal costs in the absence of proper disease management in the face of a growing number of individuals with chronic illness (Huang, Basu, O'Grady, & Capretta, 2009) should underscore the urgency for developing behavioral and health care system interventions that will facilitate lifestyle improvements among those with chronic illness.

Supplementary Material

Supplementary material can be found at: http://psychsocgerontology.oxfordjournals.org/

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