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SMOKING PREDICTING PHYSICAL ACTIVITY IN AN AGING AMERICA

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Abstract: *Objectives:* Tobacco smoking and physical inactivity are among leading behavioral risk factors for ill health in older adults. This study considers how smoking is associated with physical activity. *Design:* Using a Life-Course model, data are analyzed regarding this relationship, controlling for, and interacted with, life-course and other factors. Daily smokers and sometimes smokers were hypothesized to engage in less leisure-time physical activity than those who never smoked, while those who stopped smoking were expected to do more than never smokers. Analyses were performed using SAS-Callable SUDAAN. *Setting and Participants:* Secondary data from ten years of a national sample of adults aged 18 and over of the National Health Interview Survey, 2001-2010, are used (N = 264,945, missing data excluded, of 282,313 total cases). *Measurements:* Daily smokers, occasional smokers, and smoking quitters are compared to never smokers with regard to requisite physical activity (150 minutes per week of moderate, 100 of vigorous, and/or 50 of strengthening activity). Life-course measures include birth cohorts, age, and year of survey, as well as gender, race/ethnicity, and education. *Results:* Overall, hypotheses are supported regarding daily smokers and quitters; but the hypothesis is strongly rejected among sometimes smokers, who are much more likely to do requisite physical activity. Findings differ by age, sometimes smokers age 65 and over being less likely to do physical activity. Findings among all men are similar to the overall findings, while those among all women are similar to those for older respondents. Associations of smoking status with physical activity vary greatly by race/ethnicity. *Conclusions:* Daily smokers may be most in need of both smoking cessation and leisure-time physical activity interventions. Smoking-cessation efforts may pay greater physical activity benefits among women and the aged, while smoking-reduction efforts may provide better outcomes among men. Smoking reduction efforts may pay more exercise benefits among African-Americans and Hispanics.

Key words: Smoking, physical activity, life-course, aging.

Introduction

Tobacco smoking and physical inactivity are among the leading behavioral risk factors for ill-health in adults aged 65 years or older (1-3). Approximately 8.9% of older adults in the United States are current cigarette smokers (4). Despite declines in the prevalence of smoking in industrialized nations, tobacco use still causes over 650,000 deaths annually in North America (5). Physical inactivity has more recently emerged as a public health concern, with 79% of U.S. adults not meeting physical activity and exercise guidelines. Older adults and smokers have decreased exercise capacity and are even less likely to exercise regularly (6-8). The combined effects of unhealthy behaviors such as smoking and insufficient physical activity are associated with greater likelihood of difficulty with activities of independent living in older adults (9, 10).

Our concern here is to consider the implications of smoking for participation in physical activity, and the relationships of these behaviors to one another among different population groups, especially among their older members. We apply a Life Course model to consider these issues. Although a Life Course model is often appropriately considered using longitudinal data, the repeated cross-sections for ten years of the National Health Interview Survey reported here produce a much larger sample size, allowing various breakdowns by important Life Course factors. Although this does not allow analysis of time order of measures, it does allow a new contribution in more-detailed analysis of the consequences of Life-Course factors, which we call "fossil" effects of the Life Course.

Literature review

Refraining from smoking or quitting reduces risks for cardiovascular disease, respiratory illness, and many types of cancers (11). Health benefits of quitting smoking are greater at younger ages, yet there are benefits to health, improved quality of life, and increased longevity even in older adults (10, 12). Engaging in physical activity can protect somewhat against the negative consequences to smoking and prevent falls, reduce morbidity, improve mood, maintain muscle and bone strength, and decrease pain symptoms in older adults (13, 14). Physical activity, nicotine replacement therapy, behavioral counseling, and other health promotion strategies may also aid attempts in smoking cessation (15-18).

The Life-Course model (19) explains later life as it is affected by earlier lifestyle behavior (20). This is particularly true with regard to birth cohorts (21), which have proved important in predicting involvement in health behaviors (22, 23). The life course also encompasses the life cycle,

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meaning that cohort must be distinguished from such other temporal concepts as the individual's age (19, 21). Further, life cycles may differ across cohorts (24). Age spans historic time (25), including interplay between individual lives and changing social structures over the course of time (26, 27), with trajectories and transitions that include those of health (28). Therefore, cohort, age, and historical time need to be distinguished from one another (27).

The life course necessarily involves other demographic factors such as gender, ethnicity, immigration status, marital status, and education. Women tend to smoke less than men (29, 30). Women, however, are more likely to relapse after smoking cessation (31). Women (32, 33) and ethnic minorities tend to undertake less physical activity (34-38). Ethnic minorities are also more likely to smoke than are non-Hispanic Whites (29). People who engage in regular physical activity have higher educational attainment (22, 38), while smokers tend to have less education (29, 39). Marital status also influences both physical activity and smoking (40, 41). These factors are not only inherent to the life course but will be intertwined with each other (29, 30) and the temporal factors of age, cohort, and history (39).

A major concern in this study is with how smoking status is associated with physical activity. Because smoking status tends to be long-established in older adults, smoking status is used to predict physical activity. The items involving smoking reference the past as well as the present; but those involving physical activity are focused on the year of the survey. Smoking cessation may result from a concern for developing a healthier lifestyle that also includes physical activity, but whether cessation leads to adopting physical activity or whether physical activity participation leads to cessation remains unanswered in the data. Nevertheless, the interpretations herein will focus on the likely effects of smoking status on participation in requisite physical activity. The results are intended to produce information useful in the design of interventions addressing the health behaviors of smoking cessation and physical activity, particularly in older age cohorts.

Another issue of concern involves how smoking status may interact with important life-course factors of gender, marital status, ethnicity, and education. Interventions to promote healthier behaviors are often targeted to the general population and do not reach people from diverse backgrounds (42). Detailed background information can help in developing culturally-appropriate strategies for health promotion interventions.

Hypotheses are specified only for smoking status. Objectives are to consider implications of each smoking status for participation in Requisite Physical Activity, and to consider how these implications may differ by gender, marital status, ethnicity, and education. Although some of these relationships have been found in the past, none were tested with the life-course model employed here:

H1: Those who smoke daily are expected to be less involved in physical activity than those who never smoked.

H2: Those who smoke sometimes are expected to be less involved in physical activity than those who never smoked—but to a lesser degree than those who smoke daily.

H3: Those who no longer smoke (e.g., had ceased smoking) are hypothesized to be more likely to undertake physical activity than those who never smoked, because both smoking cessation and physical activity represent efforts toward a healthier lifestyle.

Methods

Sample

Secondary data were drawn from the National Health Interview Survey (NHIS) Adult Sample, pooling interview data over the years 2001-2010 and providing a sample size of 282,313. The NHIS is a multi-stage cluster sample, weighted to the U.S. population aged 18 years and over (43, 44). Information on the survey and its methods are available from the National Center for Health Statistics (43). The Adult Health Behaviors section collects data on three types of leisure-time physical activity: moderate, vigorous, and strengthening. The Adult Sample is a sub-sample of about one-third of the total respondents in the household sample (the Person Sample). Some data (e.g., immigration status, education) are drawn from the Person Sample survey for the respondents in the Adult Sample. Prior analyses were sometimes plagued by sample sizes too small to ferret out the effects of changes in smoking behavior (45). In the current analysis, the large sample size allows consideration of effects among detailed demographic categories, as well as changes in smoking. Although the yearly samples are cross-sectional, a major smoking-status category is that of those who once smoked but do so no more, representing a definite change.

Measures

Data on physical activity are recorded as frequencies by varied time units: day, week, month, and year, not by a pre-specified single unit. The concern here is weekly frequency of activity: (1) at least 30 minutes of moderate activity for on average at least five days per week; (2) the same of vigorous activity for at least 20 minutes on average; and (3) strengthening activity for at least 10 minutes at least five days per week on average. The dependent variable, Requisite Physical Activity, is a binary variable indicating the meeting by the respondent of any of the moderate, vigorous, or strengthening criteria.

Data on smoking status derive from a series of survey items. In response to an item regarding "ever smoked 100 cigarettes," anyone reporting "no" is categorized by the NHIS as "never smoker." Those who answered "yes," are then asked "smoke frequency: everyday, some days, not at all," resulting in categorization as "current every day smoker," "current some day smoker," or "former smoker." We employ these NHIS

categories based on such self-report for analysis of smoking status.

Statistical Analysis

Analysis was conducted using the DESCRIPT, CROSSTAB, and RLOGIST procedures in SAS-Callable SUDAAN, to adjust standard errors for the complex sampling scheme (46, 47). Multivariate analysis employed RLOGIST to predict Requisite Physical Activity by respondents. Analysis considered the effects of birth cohort (seven cumulative dummy variables for eight cohorts), age factors (age rebased to age 50, the square of rebased age, and dummy variables for ages 45-64 and ages 65 and over), and year of survey (rebased to the mid-point of the study period, and that measure squared), rendering quadratic equations for age and year. The predictor variables involved smoking status: never having smoked, no longer smoking, smoking some days, and smoking every day. Three dummy variables were created, to show differences from never smoking for having quit smoking, for still smoking some, and for smoking daily. To consider life-course effects, the smoking variables were interacted with age and their effects separately considered nested within birth cohorts and within major age categories. The relatively few "other" respondents regarding ethnicity (e.g., Native Americans, N = 2,301) were represented by a dummy variable, so the referent category for ethnicity measures is "White non-Hispanic." To consider differences by several demographic variables, the smoking variables were interacted with: gender, marital status, ethnicity, and education.

The repeated cross-sectional nature of the data means that time order is often not clear. Analysis that cannot rely on longitudinal data must therefore attempt to ferret out the 'fossil' effects of life course, rather than more dynamically consider time order.

Results

Some of the variables, particularly the physical activity measure, had missing values. Accordingly, the usable sample size for multivariate analysis was 264,945, rather than the 282,313 respondents. All findings are reported for this usable sample size.

Table 1 reports the univariate statistics for the categorical variables in the analysis: the usable-sample number and percentage in the given category and the weighted percentage representing the overall population. As often noted, only a small proportion of the population engages in requisite physical activity, less than one quarter over the period 2001-2010 (note that the upper confidence level of the estimated mean is below 25 percent). Well over half of respondents reported having never smoked, while over 20 percent reported having ceased to smoke, but one in six reported smoking daily. The mean age was about 45, about one-third in midlife (aged 45 to 64), and one-sixth aged 65 or over (of those aged 18 years or older).

Table 1
Univariate estimates and confidence intervals

Variable	Sample	Parameter Estimates		
N = 264,945 excluding missing values	**Number**	**Percentage**	**Lower Confidence Level**	**Upper Confidence Level**
Outcome Variable:				
Requisite Physical Activity	61,651	24.18	23.90	24.48
Smoking Variables:				
Never Smoked	153,038	57.55	57.21	57.89
Stopped Smoking	56,549	21.58	21.33	21.83
Smokes Sometimes	11,735	4.21	4.11	4.31
Smokes Daily	43,639	16.66	16.42	16.01
Age Cohort Variables:				
Latest (after 1985)	9,765	5.45	5.24	5.66
Young Adult (1976-1985)	43,913	18.02	17.74	18.31
Post-Boomer (1966-1975)	50,907	18.52	18.32	18.73
Young Boomer (1956-1965)	52,235	20.53	20.32	20.75
Old Boomer (1946-1955)	43,856	16.75	16.55	16.95
Pre-Boomer (1936-1945)	29,694	10.22	10.05	10.40
Old (1926-1935)	21,298	6.74	6.60	6.88
Oldest Old (before 1926)	13,277	3.77	3.65	3.89
Age Category Variables:				
Midlife (Age 45-64)	85,900	33.12	32.83	33.42
Age 65 and Over	49,101	15.62	15.46	15.89
Background Characteristics:				
Married or Living Together	138,210	62.93	62.53	63.28
Male	116,374	48.19	47.94	48.44
White non-Hispanic	165,486	70.65	70.16	71.14
Hispanic	47.303	12.84	12.50	13.19
Black	38,942	11.45	11.09	11.82
Asian	11,013	4.11	3.97	4.25
Other non-White	2,301	0.95	0.84	1.06
Born in U.S.	216,096	84.40	84.07	84.72
Less Than High School Degree	48,869	15.78	15.48	16.09
High School Degree	73,888	28.53	28.21	28.86
Some College	74.550	29.46	29.18	29.75
College Degree	65,638	26.22	25.81	26.84
Continuous Variables:		**Parameter Estimates**		
		Mean	**Lower Confidence Level**	**Upper Confidence Level**
Age in Years		45.28	45.12	45.44
Rebased Age in Decades		-0.47	-0.49	-0.46
Rebased Age in Decades Squared		3.26	3.23	3.28
Rebased Year in Study Period		0.13	0.10	0.16
Rebased Year in Study Period Squared		8.25	8.19	8.31

SOURCE: NCHS, 20002-2011, for years 2001-2010; NOTE: Computation of confidence internals employed the CROSSTAB (for categorical variables) and DESCRIPT (for continuous variables) procedures in SUDAAN.

Table 2 shows cross-tabulations of some of the time factors (birth cohort and three broad age categories) with

Table 2
Physical activity and smoking status by age and cohort variables

N=264,945		Weighted Percentages (Parameter Estimates)				
Life-Course Variables	**Sample N**	**Requisite Physical Activity**	**Never Smoked**	**Ceased Smoking**	**Smokes Some**	**Smokes Daily**
Cohorts:						
Youngest	9.765	29.66	74.97	4.86	6.17	13.99
Young Adult	43,913	25.97	63.77	10.72	6.42	19.10
Post-Boomers	50,907	23.46	63.34	14.03	4.96	17.68
Young Boomer	52,235	23.76	55.61	19.46	4.22	20.71
Old Boomers	43,856	23.85	51.22	28.12	3.23	17.44
Pre-Boomers	29,694	24.24	45.75	38.22	2.57	13.45
Old	21,298	23.25	49.47	41.44	1.42	7.67
Oldest Old	13,277	16.63	59.26	36.71	0.78	3.26
Ages:						
18-44	136,566	24.96	63.76	12.40	5.46	18.39
Midlife	81.262	23.94	51.06	27.20	3.50	18.25
Age 65 and Up	54,485	22.16	50.94	39.80	1.59	7.67

SOURCE: NCHS, 20002-2011, for years 2001-2010.

undertaking requisite physical activity and with smoking status. The findings for physical activity replicate those found in the literature (22, 23) a drop from the youngest cohorts, a plateau across further birth cohorts, and a profound drop among the earliest cohort (those born before 1926).

Table 3 reports the basic multivariate analysis predicting requisite physical activity (using PROC LOGIST in SAS-Callable SUDAAN). Supporting the hypothesis, those who smoke daily are less likely to engage in requisite physical activity, about 90 percent as likely as those who never smoked. Also supporting the hypothesis, those who report smoking cessation are 14 percent more likely to engage in requisite physical activity than those who never smoked. It thus appears that smoking cessation (at some unknown time) aligns with a current lifestyle of physical activity. Very much contrary to hypothesis, however, those who report 'smoking sometimes' show as 27 percent more likely to undertake requisite activity than those who never smoked, and are also significantly more likely to undertake such activity than those who ceased smoking.

Other findings in Table 3 do not differ much from what was found in prior analyses. Cohorts, controlling for the other factors, show an initial decline in physical activity among younger adults, an increase among young boomers over post-boomers, a further increase for pre-boomers over old-boomers, and a large decline for the earliest (oldest) cohort, although there are fewer cohort differences than those previously reported in the literature (22). The current analysis also controlled for the age categories midlife and age 65 or over, which were not controlled for in that prior analysis, and are similar to those found in a later analysis (23). There was a strong trend toward less physical activity by respondent age, controlling for strong increases at midlife and at age 65, as well as controlling for the cohort effects. Men were much more likely to report physical activity than women, while those who were married or living together are slightly less likely to engage in such activity than the non-married (separated, divorced, widowed, or never married). Ethnic minorities were much less likely to report physical activity than were non-Hispanic Whites. Likelihood of physical activity increases with each level of education considered.

Further analysis interacts smoking status with life-course factors, both age- and cohort-related, and other important factors in life. In no case, does a variable not interacted show a coefficient more than marginally different from that reported in Table 3. Accordingly, summary findings are shown only for smoking status and variables interacted with it. Table 4 shows results of four analyses involving interactions or nesting of smoking measures with life course factors. (Tables reporting the actual logistic regression findings are available upon request.)

The first analysis shows smoking status interacted with respondent age (in decades, rebased to age 50). Findings for smoking status tend to fit better with hypotheses. Of the main effects for smoking status (estimated at age 50), daily smokers are only 70 percent as likely as those who never smoked to engage in requisite physical activity. Those who stopped smoking are 12 percent more likely than those who never smoked. Those who sometimes smoke are not shown to differ from those who never smoked (not supporting the hypothesis, but not contravening it). Interacted with age, only the effect for those who sometimes smoke differs significantly by age – for each decade of age, the likelihood is 94 percent of that for those who never smoked. Thus, the higher likelihood of activity

among those who smoke sometimes appears to be the province of the young, not of older respondents. Nesting the analysis within age categories (not shown), among those aged 65 or older, those who still smoke (and more strongly those who smoke daily) are significantly less likely than those who never smoked to undertake requisite physical activity. However, those who ceased smoking are not shown to differ from those who never smoked in this age group.

Beyond age, there was concern with birth cohort. Because eight cohorts were too many to report on and sometimes had relatively few members (less than one thousand in some cells crossed by smoking status), cohorts were grouped into those born after Boomers (three cohorts), Boomers (two cohorts), and those born before Boomers (three cohorts). To operationalize nesting within these three categories, the SUBPOPN statement was used, allowing correct variance calculations.

Summary findings for cohorts somewhat parallel those for age. Among the post-Boomer cohorts, those who sometimes smoke are much more likely (by 32 percent) to undertake requisite physical activity than those who never smoked, far exceeding the 14-percent higher likelihood of those who no longer smoked. Interestingly, those who smoked daily are not shown to differ from those who never smoked. Among Boomers, the likelihood of physical activity among those who smoke sometimes is not as high (28 percent), and does not so far exceed the likelihood among those who ceased smoking (17 percent), while those who smoke daily are only 88 percent as likely to perform physical activity as those who never smoked. In the pre-Boomer category, those who ceased smoking are only slightly more likely (by 7 percent) to do requisite activity than are those who never smoked, while those who smoke sometimes are not shown to differ from those who never smoked. Further, those who smoke daily are much less likely (only 66 percent as likely) to engage in requisite physical activity as those who never smoked. Thus, although the results often do not support the hypotheses, the high likelihood of physical activity among those who smoke sometimes occurs among those who were born later (so are mostly younger) and disappears among those who were born earlier (so are older). Further, the likelihood of such activity is much lower among daily smokers who were born earlier.

The next summary in Table 4 reports smoking status nested within gender. Findings for smoking status all differ significantly between females and males. Among males, the findings for smoking status are similar to those overall, but more pronounced: those who 'smoke sometimes' are even-more likely to engage in physical activity than those who never smoked. Among females, however, the pattern fits closer what was hypothesized: those who smoke daily are much less likely (72 percent as likely) to do physical activity than those who never smoked; those who stopped smoking are more likely (20 percent more) than those who never smoked. Those who still smoke sometimes do not differ from those who never smoked.

Analysis of smoking status by marital status showed no differential relationships to physical activity. Nor did analysis include the interaction of gender with marital status. Accordingly, summary results are not reported.

Table 3

Sudaan logistic regression analysis: Participation in requisite physical activity at least five days a week by smoking status

	Odds Ratios & 5% Confidence Limits		
	Ratio	**Lower**	**Higher**
Intercept	0.16**	0.14	0.19
Smoking Factors:			
Smokes Every Day[1]	0.90**	0.87	0.93
Smokes Sometimes[1]	1.27**	1.21	1.33
No Longer Smokes[1]	1.14**	1.11	1.17
Life-Course Time Factors:			
Young Adult[2]	0.88**	0.82	0.95
Post-Boomer[2]	1.02	0.96	1.08
Young Boomer[2]	1.09**	1.03	1.15
Old Boomer[2]	1.03	0.97	1.09
Pre-Boomer[2]	1.08*	1.01	1.15
Old[2]	0.98	0.90	1.06
Older Old[2]	0.69**	0.63	0.76
Aged 45 Years or Older[3]	1.13**	1.07	1.19
Aged 65 Years or Older[3]	1.12**	1.04	1.20
Rebased Age in Decades	0.89**	0.85	0.93
Rebased Age Squared	1.02**	1.01	1.03
Rebased Year in Study Period	1.00	1.00	1.01
Rebased Year Squared	1.01**	1.01	1.01
Gender & Marital Status:			
Male (vs. female)	1.22**	1.19	1.25
Married or Living Together/Not	0.95**	0.93	0.98
Other Background Factors:			
Hispanic4	0.77**	0.73	0.80
African American[4]	0.70**	0.67	0.73
Asian4	0.81**	0.76	0.87
Other Nonwhite[4]	1.02	0.89	1.16
U.S. Born	1.13**	1.08	1.17
At Least High School Degree[5]	1.21**	1.16	1.26
At Least Some College[5]	1.25**	1.21	1.29
At Least College Degree[5]	1.22**	1.18	1.26
Degrees of Freedom	26		
N	264,945		
Wald F	131.96**		
Hosmer-Lemeshow Test6	12.684		

Source: NCHS, 2002-2011, for years 2001-2010. NOTE: 1. The referrent category is 'never smoked.'; 2. Each category is compared to previous category, e.g., 'post-boomer' (born 1966-1975) is compared to 'young adult' (born 1976-1985), the latter to 'youngest' (born after 1985); 3. Each category is compared to the prior, i.e., 'age 45 or older' (operationalizing Midlife) to 'under age 45,' and 'age 65 or older' to 'age 45 or older.'; 4. The referent category is non-Hispanic White; 5. Each category is compared to the prior, e.g., 'at least high school degree' to 'less than high school degree,' 'at least some college to 'at least high school degree.'; 6. The p-value (0.12) of the Hosmer-Lemeshow Test is not significant at the .05 level, indicating an adequate model. Legend: * indicates significance at the .05 level, 2-tailed test. ** indicates significance at the .01 level, 2-tailed test.

Table 4
Summary results for Sudaan Logistic regression analyses: Participation in requise physical activity by smoking status interactions

	Smokes Daily	Smokes Sometimes	No Longer Smokes
Age Interaction:			
At Age 50	Negative p>.01	Non-significant	Positive p>.01
Interacted with Age	Non-significant	Negative p>.01	Non-significant
Nested by Birth Cohort:			
Post-Boomer (younger)	Non-significant	Positive p<.01	Positive p<.01
Boomer Cohorts	Negative p<.01-	Positive p<.01	Positive p<.01
Pre-Boomer (older)	Negative p<.01	Non-significant	Positive p<.01
Nested by Gender:			
Female	Negative p<.01	Non-significant	Positive p<.01
Male	Negative p<.01	Positive p<.01	Positive p<.01
Nested by Ethnicity:			
White Non-Hispanic	Negative p<.01	Positive p<.01	Positive p<.01
Hispanic	Non-significant	Positive p<.01	Positive p<.01
Black	Non-significant	Positive p<.01	Positive p<.05
Asian	Negative p<.01	Non-significant	Positive p<.01

Legend: Positive indicates an odds ratio significantly greater than 1.0. Negative indicates an odds ratio significantly less than 1.0.

The fourth analysis summarized in Table 4 reports smoking status interacted with ethnicity. Among White non-Hispanic respondents, the general findings for smoking status from the main analysis in Table 3 still hold. Among those who still smoke, African-Americans and Hispanics are more likely to undertake requisite physical activity than do those who never smoked. Among those who have ceased smoking, all three minority groupings, like non-Hispanic Whites, show greater likelihood of physical activity than those who never smoked. Among Asians, as among non-Hispanic Whites, daily smokers show lower likelihood of requisite physical activity than those who never smoked. In sum, associations of smoking status with physical activity vary slightly by ethnicity for daily smokers, suggesting that different health promotion strategies are needed for different ethnic groups.

Discussion

Less than one in four adults in the U.S. perform requisite physical activity—an average of at least of five times a week for at least 30 minutes of moderate exercise, 20 minutes of vigorous exercise, or 10 minutes of strengthening exercise. Older Americans, however, tend to equal that record except among the oldest old. Meanwhile, although over half of adults in the U.S. never smoked, over one in five still do, with a similar proportion having ceased smoking. It is not clear why those who smoke sometimes are more likely to engage in Requisite Physical Activity than those who never smoked. Although older Americans are more likely to have ever smoked, they are also much more likely to have stopped, so less likely to currently smoke. Although the very oldest cohort is, at 59 percent, almost as unlikely to have never smoked as young adults, this may be a survivor effect. The disproportionate numbers of the oldest cohort who did smoke likely having already died—see Lalluka and associates (48) regarding excess mortality among less-physically-active smokers. In any case, risky lifestyles are too common in American adults, including the aged. This calls for health promotion efforts targeting behavior domains of exercise and smoking, but with tailored strategies for different populations.

Conclusions

In general, heavy, daily smokers may be most in need of both smoking cessation and leisure-time physical activity interventions. Although it is not established that smoking cessation leads to more exercise in smokers, there is some evidence that physical activity and exercise may aid in smoking cessation (18). Multi-component interventions have been used to prevent health problems associated with two or more risk behaviors such as smoking and physical inactivity (49). These interventions, then, may have the potential to encourage change in multiple health behavior domains and allow for success in several health promotion goals.

Smoking and insufficient physical activity remain as significant health problems for all age groups. For older adults from the current study, smoking cessation may contribute to undertaking greater exercise, while reducing smoking to less than daily may pay more benefits among the young adults. Similar patterns emerge among broad birth-cohort groups, but health promotion efforts might consider not just age but also sub-cultural differences based on when American adults were born and what historical periods they lived through at what ages.

Smoking-cessation efforts may pay greater benefits with regard to physical activity among women, while smoking-reduction efforts may fit with better exercise outcomes among men. Smoking reduction efforts may pay more exercise benefits among African-Americans and Hispanics. Unfortunately, respondent numbers are too small to allow consideration of specific breakdowns of Hispanic or Asian respondents.

Limitations

The NHIS survey is entirely self-report, so relies on the accuracy of such reporting. In particular, both physical activity and smoking status represent issues where respondents may wish to report more "acceptable" behavior, so not be fully accurate in reporting. This is a problem inherent in the use of self-report data so a limitation in any analysis of such data.

It cannot be strongly assumed that smoking status always predicts physical activity, and not the other way around. This is particularly true where smoking status reflects change (smoking

cessation) or may do so (smokes sometimes rather than daily). Nevertheless, interpretation here makes this assumption.

Even with over a quarter-million cases, detailed categories often lack sufficient cases to allow consideration especially of their interactions with smoking-status categories. Although some smoking status categories can be collapsed (as sometimes smokes with smokes daily), this both limits interpretation of results and also does not always yield sufficient numbers of cases to allow the analysis in the first place.

Consideration of ages and birth cohorts across the life-course creates problems of its own. At the younger end, behaviors such as smoking may not have existed long enough to suggest effects on physical activity. At the older end, survivor effects may exist. Daily smokers will have disproportionately died, so that the very oldest living respondents may show disproportionately fewer daily smokers.

Compliance: De-identified data derive from a national governmental survey, and therefore comply with all U.S. laws and are not subject to human subjects review.

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