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Lifestyle-Related Risk Factors and Risk of Future Nursing Home Admission

Elmira Valiyeva, PhD; Louise B. Russell, PhD; Jane E. Miller, PhD; Monika M. Safford, MD

Background: While risks of disease, hospitalization, and death attributable to lifestyle-related factors such as smoking, inactivity, and obesity have been well studied, their associations with nursing home admission are less well known. These risk factors are usually established by middle age, but nothing is known about how they relate to long-term risk of nursing home admission in this age group.

Methods: Cox proportional hazards regressions were used to analyze risk of nursing home admission over 2 decades of follow-up (1971-1975 to 1992) in a nationally representative, longitudinal survey of community-dwelling adults aged 45 to 74 years at baseline. Middle-aged (45-64 years at baseline) and elderly persons (aged 65-74 years at baseline) were analyzed separately: 230 (6.5%) of 3526 middle-aged respondents and 728 (24.7%) of 2936 elderly ones had 1 or more nursing home admissions. Baseline risk factors included smoking, inactivity, obesity, elevated blood pressure, elevated total cholesterol level, and diabetes mellitus, which were defined according to national guidelines.

Results: All lifestyle-related factors, except total cholesterol level, were associated with higher risk of nursing home admission during follow-up in one or both age groups. Risk ratios were higher in middle-aged than in elderly persons. In those aged 45 to 64 years at baseline, diabetes more than tripled the risk of nursing home admission (relative risk, 3.25; 95% confidence interval, 2.04-5.19); smoking, inactivity, and elevated systolic blood pressure had relative risks of 1.56, 1.40, and 1.35, respectively. Obesity was a risk factor for those aged 65 to 74 years at baseline, but not for the middle-aged subjects. Persons with 2 lifestyle-related factors were at greatly increased risk, especially if 1 was diabetes.

Conclusions: Lifestyle factors are important contributors to the long-term risk of nursing home admission. Modifying lifestyle, especially in middle age, may reduce the risk of admission.

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HEALTHY PEOPLE 2010¹ SETS goals for modifying lifestyle-related risk factors, such as smoking and inactivity, which contribute to poor health. Clinical preventive services directed at these risk factors are "a ubiquitous part of primary care practice."² The US Preventive Services Task Force, the National High Blood Pressure Education Program, the National Cholesterol Education Program, and other national groups have published guidelines to help clinicians provide effective preventive services to their patients.¹⁻⁵ While risks of disease, hospitalization, and death attributable to these factors have been well studied, their associations with nursing home admission are less well known.^{6,7} If these associations are substantial, they could provide clinicians and patients with additional reason to modify lifestyle-related risk factors.

Nursing home admission is relatively infrequent among community-dwelling adults, especially in middle age.⁸ Yet lifestyle risk factors are usually established by middle age or earlier, making it important to know, while they are still modifiable, the long-term risks they represent. The National Health and Nutrition Examination Survey (NHANES I)⁹ Epidemiologic Follow-up Study (NHEFS)¹⁰ represents a unique opportunity to examine this issue in a nationally representative sample of middle-aged as well as elderly community-dwelling adults. The NHEFS tracked outcomes, including nursing home admission, through 1992. With nearly 20 years of follow-up, it is possible to examine the associations of risk factors at baseline with the long-term risk of nursing home admission. No similar prospective studies of nationally representative samples have been conducted or are planned.

We report a Cox proportional hazards analysis of nursing home admission for NHEFS adults aged 45 to 74 years at baseline, focusing on lifestyle-related risk factors identified by major national prevention guidelines: smoking, inactivity, obesity, elevated blood pressure, elevated cholesterol level, and diabetes mellitus. To investigate differences by age, we analyze age groups 45 to 64 years and 65 to 74 years separately.

METHODS

The NHEFS traced 14 407 NHANES I adults, aged 25 to 74 years at baseline (1971-1975) and representative of the noninstitutionalized US population, through 1992. Baseline data came from physician examination, laboratory tests, and medical history interview. The National Center for Health Statistics (NCHS) conducted follow-up surveys in 1982 through 1984, 1986, 1987, and 1992 to collect information on health-related outcomes, including nursing home admission. Almost 93% of the original cohort was traced through 1992.¹⁰

We evaluated participants aged 45 to 74 years at baseline who were traced after baseline and had complete information, 81% of this age group. Adults aged 25 to 44 years had too few nursing home admissions to support analysis. Inclusion rates were similar for men and women but higher for the middle-aged (86%) than for elderly (76%) participants.

Information on dates, reasons, and facility name and location for overnight stays in health facilities during follow-up came from participants or, for deceased or incapacitated persons, from proxy respondents.¹⁰⁻¹² With respondents' permission, facilities were then asked for information from their records about all stays since the last follow-up. We used all stays that were matched with nursing home records so that they could be assigned accurate admission and discharge dates, an approach shown to have minimal bias^{13,14}; matched stays made up 74% of stays.

Periods at risk of nursing home admission (termed *spells*) were defined in days for each person. Each spell between baseline and first nursing home admission, between nursing home stays, or between the last stay and the time the respondent was last observed, constituted a separate observation. Just over 3% of persons aged 45 to 64 years and 10% of those aged 65 to 74 years contributed more than 1 spell to the analysis. Statistical methods corrected for multiple spells per respondent. When an individual was admitted to the hospital from, and returned directly to, a nursing home, the return was considered part of the original stay, not a new admission. Spells that did not end in a nursing home stay could end in death, loss to follow-up, or end of the survey period.

Risk factors were defined at baseline. We focused on 6 major modifiable risk factors in 2 categories: cigarette smoking, physical inactivity, and obesity, which can be considered lifestyle choices; and systolic blood pressure, total cholesterol level, and diabetes, which are in part results of those choices. Age, female sex, black race, underweight, and 6 chronic conditions present at baseline were included as control variables.

Smoking was defined as current cigarette smoking at baseline. Half of NHANES I participants were questioned about smoking at baseline. For the other half, we used information collected retrospectively at the first NHEFS follow-up (1982-1984). For 3 categories of smoker (current, former, and never), this approach has been shown to match for 89% of subject respondents and 83% of proxy respondents.¹⁵

Participants were defined as "inactive" based on 2 questions: (1) "In your usual day, aside from recreation, are you physically very active, moderately active, or quite inactive?" and (2) "Do you get much exercise in things you do for recreation (sports, or hiking, or anything like that), or hardly any exer-

cise, or in between?" Respondents who answered "very active" to the first and/or "much exercise" to the second made up the reference group.

Dichotomous variables were defined for blood pressure, cholesterol, and body mass index (BMI), calculated as weight in kilograms divided by the square of height in meters, based on national recommendations. Following the Joint National Commission's recommendation that diagnosis and treatment be based on systolic pressure,⁴ hypertension was defined as a systolic pressure of 140 mm Hg or higher. Elevated cholesterol level was defined as total serum cholesterol of 240 mg/dL (6.2 mmol/L) or higher.³ Obesity was defined as BMI of 30 or greater.¹⁶ Lower values of each variable were the reference categories.

Indicators of chronic conditions present at baseline (diabetes, heart attack/heart failure, stroke, malignant tumor, arthritis, chronic lung disease, and fracture of the hip, spine, or wrist) were based on responses to the question "Has a doctor ever told you that you have had [condition]?" in the NHANES I medical history interview. Age in years was measured at the start of each spell. Socioeconomic status, represented by years of completed education at baseline,¹⁷ did not alter the relationships between risk factors and nursing home admission, so we present results without socioeconomic status.

A time trend was included to control for a possible undercount of nursing home admissions early in the follow-up. Comparison of NHEFS hospitalization rates with the National Hospital Discharge Survey indicated that NHEFS undercounted hospital stays in the early years,¹⁸ although by 1987 rates were about the same for the 2 sources.

Multivariable Cox proportional hazards regression models were used to relate risk of admission to baseline risk factors.¹⁹ We used SAS-callable SUDAAN software (version 9.0; Research Triangle Institute, Research Triangle Park, NC) to estimate the regressions while correcting for clustering, stratification, and unequal weighting in NHANES I sample design, and nonindependence of spells contributed by the same person. Observations were weighted using weights provided by NCHS, trimmed at the 95th percentile.²⁰

The Cox models were used to estimate relative risks (RR) of nursing home admission for each risk factor, controlling for all other risk factors. Since many patients have more than 1 risk factor, we also report risk ratios for pairs of risk factors. The relative risk for a single risk factor was derived by exponentiating its coefficient. The relative risk for 2 risk factors was calculated by exponentiating the sum of their coefficients; the confidence interval (CI) was calculated using the standard error of this sum, which depends on the variances and covariance of the component coefficients.²¹

RESULTS

Table 1 lists weighted means of baseline risk factors and unweighted sample sizes by age. Overall, 14.8% of respondents had at least 1 admission during follow-up, with a higher rate among those aged 65 to 74 years at baseline: 230 (6.5%) of 3526 middle-aged respondents and 728 (24.7%) of 2936 elderly ones had 1 or more nursing home admissions. Among persons admitted at least once, 18.8% had 2 or more admissions. The maximum number of admissions of admissions per respondent was 6.

PREVALENCE OF MODIFIABLE RISK FACTORS

Except for diabetes, all risk factors were common in both age groups (Table 1). More than half of respondents aged

Table 1. Weighted Means* of Baseline Risk Factors of NHEFS Participants by Age at Baseline

Risk Factor	Age at Baseline, y	
	45-64	65-74
Modifiable risk factors		
None	8.5	4.9
Current smoker	38.2	19.0
Inactive	51.2	64.2
BMI ≥ 30	18.3	18.3
Systolic blood pressure ≥ 140 mm Hg	43.0	65.9
Total cholesterol ≥ 240 mg/dL (≥ 6.2 mmol/L)	42.2	47.7
Diabetes	4.9	8.7
Control variables		
Age, y	54.1	69.0
Female	52.4	59.2
Black race	8.5	7.7
BMI < 19	4.0	3.8
Heart attack/heart failure	6.3	12.9
Stroke	3.1	4.9
Cancer	2.9	5.3
Arthritis	33.9	49.7
Chronic lung disease	21.3	24.4
Fracture	7.8	10.7
Respondents, No.	3526	2936
Respondents with ≥ 1 admission, No. (%)	230 (6.5)	728 (24.7)
Spells, No.†	3660	3303
Spells ending in admission, No.	282	900
Person-years of observation, No.	58 027	37 420
Median person-years of observation, No.	18.6	14.1

Abbreviations: BMI, body mass index (calculated as weight in kilograms divided by the square of height in meters); NHEFS, National Health and Nutrition Examination Survey I Epidemiologic Follow-up Study.¹⁰

*Weighted means are based on 1 observation per respondent. Unless otherwise indicated, data are reported as percentages of participants.

†See "Methods" section for definition of *spells*.

45 to 64 years at baseline were inactive; more than 40% had hypertension or hyperlipidemia; and 38% were smokers. Among persons aged 65 to 74 years, two thirds were inactive or had elevated blood pressure, and nearly half had elevated cholesterol levels; only 1 in 5 smoked. About 18% of each age group was obese. Nearly two thirds of persons aged 45 to 64 years and three quarters of persons aged 65 to 74 years had more than 1 risk factor; only 8.5% and 4.9%, respectively, had none.

ASSOCIATION OF RISK FACTORS WITH NURSING HOME ADMISSION

Five of the 6 lifestyle-related risk factors were associated with higher rates of nursing home admission in the regressions (**Table 2**). In both age groups, persons who smoked at baseline were more likely to be admitted (RR, 1.56 for 45- to 64-year-olds; 95% CI, 1.23-1.99; RR, 1.32 for 65- to 74-year-olds; 95% CI, 1.08-1.61). Inactivity was associated with increased risk among the middle-aged (RR, 1.40; 95% CI, 1.05-1.87) but not the elderly respondents. Obesity was associated with higher risk in both age groups (RR, 1.35; 95% CI, 0.96-1.89 and RR, 1.31;

Table 2. Multivariable Hazards Analysis of Nursing Home Admission by Risk Factor and Age at Baseline of NHEFS Participants*

Risk Factor	Age at Baseline, y†	
	45-64	65-74
Smoker	1.56 (1.23-1.99)	1.32 (1.08-1.61)
Inactive	1.40 (1.05-1.87)	1.14 (0.92-1.42)
BMI ≥ 30	1.35 (0.96-1.89)	1.31 (1.07-1.60)
Systolic blood pressure ≥ 140 mm Hg	1.35 (1.06-1.73)	1.29 (1.06-1.56)
Total cholesterol level ≥ 240 mg/dL (≥ 6.2 mmol/L)	1.14 (0.89-1.44)	0.90 (0.77-1.06)
Diabetes	3.25 (2.04-5.19)	1.50 (1.07-2.11)
Spells, No.‡	3660	3303
Nursing home admissions, No.	282	900

Abbreviations: BMI, body mass index (calculated as weight in kilograms divided by the square of height in meters); NHEFS, National Health and Nutrition Examination Survey I Epidemiologic Follow-up Study.¹⁰

*Unless otherwise indicated, results are reported as relative risk (95% confidence interval).

†Boldface numbers indicate $P < .05$. Both regressions included age at the beginning of the spell, female sex, black race, underweight, major diagnoses ever given by physician at baseline (heart attack/failure, stroke, cancer, arthritis, chronic lung disease, fracture of the hip, spine, or wrist), and a time trend.

‡See "Methods" section for definition of *spells*.

95% CI, 1.07-1.60, respectively), although the association was not statistically significant among persons aged 45 to 64 years ($P = .09$).

Elevated blood pressure was associated with increased risk of nursing home admission in both age groups (RR, 1.35; 95% CI, 1.06-1.73 and RR, 1.29; 95% CI, 1.06-1.56). Diabetes was associated with a 3.25-fold increased risk among persons aged 45 to 64 years at baseline (95% CI, 2.04-5.19). Among the elderly respondents, the RR for diabetes was 1.50 (95% CI, 1.07-2.11). Elevated total cholesterol level was not associated with nursing home admission in either age group.

We experimented with adding intermediate categories, including prehypertension (systolic blood pressure, 120-139 mm Hg), overweight (BMI, 25-29), and moderately high cholesterol level (200-239 mg/dL [5.2-6.2 mmol/L]). None of these categories was statistically significant in either bivariate or multivariate specifications. Models with continuous measures of blood pressure, BMI, and total cholesterol level produced results consistent with the categorical models: blood pressure and BMI were statistically significantly associated with nursing home admission; cholesterol level was not.

RISK ASSOCIATED WITH PAIRS OF RISK FACTORS

Table 3 lists relative risks associated with selected pairs of risk factors, calculated from the results in Table 2; the calculations are for individuals who have only those risk factors and no others. We included only pairs for which both risk factors were statistically significant for the age group.

Table 3. Multivariable Hazards Analysis of Nursing Home Admission for Selected Pairs of Risk Factors by Age Group at Baseline*

Risk Factor Pair†	Age at Baseline, y	
	45-64	65-74
Diabetic-smoker	5.09 (3.11-8.33)	1.98 (1.55-2.53)
Diabetic-inactive	4.55 (2.89-7.15)	NR
Diabetic-hypertensive	4.40 (2.71-7.17)	1.93 (1.58-2.35)
Diabetic-obese	NR	1.96 (1.58-2.45)
Smoker-inactive	2.19 (1.55-3.08)	NR
Smoker-obese	NR	1.72 (1.26-2.35)
Smoker-hypertensive	2.12 (1.48-3.03)	1.69 (1.29-2.23)
Inactive-obese	NR	NR
Inactive-hypertensive	1.89 (1.27-2.89)	NR
Obese-hypertensive	NR	1.68 (1.28-2.22)

Abbreviation: NR, not reported (because one or both of these risk factors were not statistically significant for the age group in Table 2).

*Unless otherwise indicated, results are reported as relative risk (95% confidence interval), and all relative risks shown combine risk factors that were significant at $P < .05$ in the age group.

†Categories are mutually exclusive: for example, diabetic smokers were not obese, inactive, or hypertensive. People with the risk factors shown plus 1 or more others have a different relative risk based on that combination of risk factors.

Among persons aged 45 to 64 years, 2 risk factors were associated with greatly increased risk of nursing home admission, especially if 1 was diabetes. Diabetic smokers had 5 times the risk of middle-aged persons with no risk factors (95% CI, 3.11-8.33). Diabetes combined with other risk factors was associated with 4-fold higher risk. Smoking and inactivity, the most common pairing in the 1988-1994 NHANES III (7.9% of those aged 45-64 years; authors' calculations from unpublished data), had a RR of 2.19 (95% CI, 1.55-3.08).

Among persons aged 65 to 74 years, the increased risk associated with having 2 risk factors was lower but still substantial in some cases. Diabetic respondents who were also smokers, hypertensive, or obese in this age group had almost double the risk of persons with no risk factors. The RR for obesity and hypertension combined, affecting 8.9% of NHANES III adults aged 65 to 74 years, was 1.68 (95% CI, 1.28-2.22).

FIRST VS ALL ADMISSIONS

In part because of shorter follow-up, previous studies have analyzed first nursing home admission rather than all admissions. When we estimated regressions using only first admission for each individual, the relative risks were similar in magnitude and statistical significance to those for all admissions (data not shown).

SHORT VS LONG STAYS

Reschovsky²² found that elderly persons with nursing home stays longer than 3 months had different economic characteristics and functional and cognitive limitations than those with short stays. To test for differences in the relationship between lifestyle-related risk factors and nursing home admission, we estimated logistic regressions to compare long (≥ 90 days) with short

stays (< 90 days); persons with no nursing home admissions were not included. Among persons aged 45 to 64 years at baseline, diabetes was associated with higher risk of a long stay. No risk factors differentiated short from long stays among elderly persons.

COMMENT

Using 2 decades of data for a nationally representative sample of middle-aged and elderly adults from the NHEFS, we examined associations of 6 major lifestyle-related risk factors with the risk of future nursing home admission; those alive at the end of follow-up (1992) were 65 to 94 years old. The results show that modifiable lifestyle factors were associated with substantially greater risk of nursing home admission, even after adjustment for other health characteristics. The risk associated with each lifestyle-related factor was greater for persons who were middle-aged at baseline than for those who were elderly. These findings suggest that prevention is more effective earlier, not only to reduce differential mortality but also to reduce nursing home admissions for those who survive to old age. At the same time, our results show that prevention is also valuable for the elderly population.

Smoking at baseline had an RR of 1.56 (95% CI, 1.23-1.99) for admission over the next 2 decades in middle-aged persons (aged 45-64 years at baseline) and 1.32 (95% CI, 1.08-1.61) in elderly persons (aged 65-74 years at baseline). The US Preventive Services Task Force (USPSTF),²³ which has promulgated comprehensive evidence-based guidelines for clinicians, gave its highest rating, an "A," to screening adults for tobacco use and providing brief behavioral counseling and tobacco cessation interventions.

The RR for inactivity was 1.40 in middle-aged persons (95% CI, 1.05-1.87), but inactivity was not statistically significant for elderly persons. The USPSTF decided that, despite substantial evidence of physical activity's benefit, there was insufficient evidence that physicians are effective when they counsel patients to increase physical activity.²⁴ Obesity had an RR of 1.31 in elderly respondents (95% CI, 1.07-1.60) but was not statistically significant in middle-aged respondents. This finding speaks to a recent call to estimate obesity's effect net of other risk factors, as done here, and to identify new outcomes to support its role as a health risk.²⁵ In 2003, the USPSTF¹⁶ issued a "B" rating for screening, intensive counseling, and behavioral intervention for obese persons.

Our results confirm the importance of diabetes and hypertension as independent risk factors for nursing home admission. Diabetes was associated with a more than 3-fold greater risk for persons aged 45 to 64 years at baseline (RR, 3.25; 95% CI, 2.04-5.19) and an RR of 1.50 in elderly persons (95% CI, 1.07-2.11), while the RRs for hypertension were 1.35 (95% CI, 1.06-1.73) and 1.29 (95% CI, 1.06-1.56), respectively. Total cholesterol level, the only measure of lipids in NHANES I,¹⁰ was not associated with nursing home admission.

The USPSTF,^{16,23,24,26-28} the Adult Treatment Panel III (ATP III) of the National Cholesterol Education Program,³ and the Joint National Committee on the Preven-

tion, Detection, Evaluation, and Treatment of High Blood Pressure (JNC)⁴ have increasingly emphasized the risks of multiple risk factors and tailored their guidelines to focus attention on these individuals. In 2004, ATP III stressed the importance of addressing lifestyle-related risk factors simultaneously.²⁹ In its obesity guideline, the USPSTF noted that improvements in glucose metabolism, blood pressure, and lipid levels follow weight loss,¹⁶ while JNC 7⁴ stressed the risks of hypertension in combination with diabetes.

Supporting this emphasis, our calculations show that combinations of 2 risk factors were associated with much higher risks of nursing home admission, especially if 1 risk factor was diabetes. Diabetic smokers aged 45 to 64 years had 5 times the risk of middle-aged persons with no risk factors (95% CI, 3.11-8.33), while diabetic smokers aged 65 to 74 years had almost double the risk of their counterparts with no risk factors (95% CI, 1.55-2.53). Persons aged 45 to 64 years who were both smokers and inactive, the most common pair in the 1988-1994 NHANES III, had more than twice the risk of nursing home admission (95% CI, 1.55-3.08). For those aged 65 to 74 years, the most common pair in NHANES III, obesity and hypertension, had an RR of 1.68 (95% CI, 1.28-2.22).

The NHEFS represents a unique opportunity, unmatched in other data sets, to examine risk of nursing home admission. First, it tracked a large representative sample of community-dwelling adults that included middle-aged as well as elderly populations. Second, it tracked their nursing home use for much longer than other studies—almost 20 years. Third, the NHEFS provided comprehensive data, from medical history, physical examination, and laboratory tests, on risk factors assessed by primary care physicians during routine checkups.

Although the NHEFS follow-up ended in 1992, the results remain pertinent today. A review of National Nursing Home Surveys for 1977, 1985, and 1999³⁰ reported that, while discharges of persons staying less than 90 days doubled between 1977 and 1999, the proportion of residents on any given day who had been in the home more than 90 days was stable: 85.6% in 1977 and 82.2% in 1999. The report notes that “the nursing facility was in 1999, as it was in 1977, a place where many of the residents had been in the facility for substantial durations since their admission.”^{30(p3)} Our analysis indicates that, while lifestyle-related factors are associated with greater risk of nursing home admission, they do not, except for diabetes in the middle-aged, distinguish between short and long stays but are correlated with the risk of both.

Except for Zizza et al,³¹ previous studies of nursing home admission analyzed elderly populations and either did not include lifestyle-related factors or did not report results for them. Zizza et al analyzed the association between obesity and nursing home admission in NHEFS adults aged 45 to 74 years. Along with demographic variables, they included, but did not report results for, height, smoking status, and physical activity. They found that obesity was associated with increased risk of admission. They did not analyze middle-aged and elderly persons separately.

Our analysis has several limitations. First, the NHEFS excluded persons aged 75 years or older at baseline. For

identifying longer-term risk factors for admission, omission of this group is not a serious limitation; their advanced age means that all baseline factors are short-term determinants of risk. Second, risk factors were measured only at baseline, so we could not examine how risk changed as risk factors changed. Thus, although the NHEFS is well suited for examining the impact of risk factors over a longer period of time, it is not suitable for investigating the interplay among risk factors and social support nearer the time of admission. Third, nursing home stays may have been undercounted, especially early in the follow-up, due to the 10-year recall period between baseline and first follow-up (1982-1984). However, nursing home admissions are relatively infrequent and thus easier to recall than other types of health care utilization, such as hospital stays.¹⁸ Finally, NHANES I did not measure low-density lipoprotein cholesterol, the current standard for diagnosing and treating hyperlipidemia.

In summary, lifestyle-related factors are important predictors of nursing home admission, especially for middle-aged persons. Evaluation and treatment of these risk factors could reduce the risk of future nursing home admission as well as the risk of death. Clinicians can use these findings to communicate risks of nursing home admission associated with modifiable lifestyle-related factors to their patients.

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