Smoking Status over Two Years in Patients with Multiple Sclerosis

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Abstract

Background: Smoking increases the risk of multiple sclerosis (MS) and possibly disease progression. The reliability of self-reported smoking status is unknown in MS. We assessed the reliability of self-reported smoking status among participants in the North American Research Committee on Multiple Sclerosis (NARCOMS) Registry. **Methods:** In 2004 and 2006, NARCOMS participants reported smoking status using Behavioral Risk Factor Surveillance Survey questions. We compared responses from 5,458 participants answering both questionnaires. We measured agreement regarding smoking status (ever/current) using a κ coefficient, and agreement for ages of starting and quitting smoking, and number of cigarettes smoked using an intraclass correlation coefficient (ICC). **Results:** In 2004, 2,885 (53.4%) participants reported ever smoking. The κ coefficient for ever smoking was 0.90 (95% confidence interval, CI: 0.89–0.92) and for current smoking 0.92 (95% CI: 0.90–0.94). The ICC for age at starting smoking was 0.73 (95% CI: 0.71–0.75) and for age at quitting smoking 0.90 (95% CI: 0.89–0.91). African-Americans, younger participants and those of lower socioeconomic status were less reliable. Depressed participants reported current smoking status less consistently (odds ratio: 0.51; 95% CI: 0.39–0.67). **Conclusions:** NARCOMS participants reliably report smoking status. The impact of depression on reliability of self-reported smoking status needs re-evaluation.

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Introduction

In epidemiologic research, smoking is a frequently studied health behavior because of well-recognized associations with chronic diseases and mortality [1, 2]. In chronic neurologic diseases, including multiple sclerosis (MS), Alzheimer's disease and Parkinson's disease, smoking is increasingly studied as an etiologic and prognostic factor [3–6].

Smoking status is often evaluated by self-report [6], and the reliability of smoking questions from the Behavioral Risk Factor Surveillance Survey (BRFSS) is established in the general population [7, 8]. The reliability of self-reported questionnaires may be affected by participant characteristics. Among healthy adults, sex, ethnicity, and education level influence consistency of reporting of smoking status [9]. Furthermore, depression, physical disability, and cognitive impairment affect validity or re-

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liability of self-reported health data [10, 11]; these issues are common in MS [12]. Given these observations and the increasing study of smoking in MS, it is relevant to establish the reliability of self-reported smoking status in MS.

The North American Research Committee on Multiple Sclerosis (NARCOMS) Registry repeatedly assesses participants with MS over time. Among NARCOMS participants, we aimed to determine the reliability of smoking status as assessed using BRFSS questions, and to determine if reliability was influenced by participant characteristics.

Patients and Methods

NARCOMS Registry

The NARCOMS Registry is a self-report registry for patients with MS. It is approved by the Institutional Review Board at St. Joseph's Hospital and Medical Center [13]. Diagnoses of MS were validated in randomly selected participants [14]. Individuals with MS voluntarily enroll through direct mailings, MS support groups and the Consortium of Multiple Sclerosis Centers/NARCOMS Registry web page [13]. Enrollment involves completing a questionnaire and submitting it to the Registry by mail or online. Participants provide demographic and clinical information regarding their MS at enrollment and semi-annually thereafter by mail or online according to their preference.

Smoking Status

In the Fall 2004 and Fall 2006 Update Questionnaires we assessed smoking status using questions from the CDC BRFSS [15]. The BRFSS includes seven questions capturing current and past smoking behaviors, is typically administered by telephone interview, and has been used widely in other surveys. We included them as self-administered questions. A person who had smoked at least 100 cigarettes in his or her lifetime was defined as a smoker [15]. We classified individuals who were still smoking as current smokers, and those who had quit as past smokers regardless of how recently they had quit. Past smokers reported average daily cigarette consumption during the years they smoked, while current smokers reported current average daily cigarette consumption.

Inclusion Criteria

We limited eligibility to participants who responded to both the Fall 2004 and Fall 2006 questionnaires, with an age at symptom onset ≥16 years and <60 years. Persons with a younger or older age at symptom onset may differ from the rest of the MS population, and we had too few such participants to characterize them adequately (<2% of enrolled NARCOMS participants) [16]. We restricted participants in this analysis to those living in the United States (US) because the BRFSS questions were developed for use within the US. We also required complete information for date of birth, age at symptom onset, and age at diagnosis.

Participant Characteristics

Demographic information provided includes date of birth, sex, race, education, annual household income, health insurance

Table 1. Sources of clinical and demographic data for NARCOMS participants

Data	Data source – questionnaire		
	enrollment	Fall 2004	Fall 2006
Demographics			
Date of birth	+		
Sex	+		
Race	+		
Education	+		
Income			+
Insurance status			+
Marital status			+
Region of residence			+
Clinical characteristics			
Age at symptom onset	+		
Age at diagnosis	+		
Disease duration			+
PDDS			+
CESD			+
Smoking status		+	+

status, region of residence, and marital status. Clinical information includes age at initial symptom onset, age at diagnosis, treatment, and disability status measured using Patient-Determined Disease Steps (PDDS) [17]. PDDS is a self-report measure of disability which correlates highly with a physician-scored Expanded Disability Status Scale (EDSS) score [17]. In 2006, we assessed depressive symptoms using the Center for Epidemiologic Studies Depression Scale (CESD) survey instrument. The CESD consists of 20 items, scored on a Likert scale from 0 (rarely or none of the time) to 3 (most or all of the time) and then summed to provide an overall assessment of clinical depression [18, 19]. The data sources (enrollment questionnaire, Fall 2004 questionnaire, Fall 2006 questionnaire) for participant characteristics are shown in table 1.

Reliability

To assess test-retest reliability of smoking status, we compared responses provided by participants who answered both the Fall 2004 and Fall 2006 questionnaires. We measured agreement regarding smoking status (ever, current) using a κ coefficient. To assess agreement for the ages when smokers started and quit smoking, we used Spearman rank correlations and an intraclass correlation coefficient (ICC).

To determine what characteristics affected agreement for ever smoking we used stratified analyses and multivariable logistic regression, where the dependent variable modeled was concordant responses on both questionnaires. Demographic characteristics considered were age; sex; race; socioeconomic status as measured by education, income, and health insurance status; region of residence; marital status; and whether the questionnaire was completed on paper or online. Race was included as a categorical variable for White (reference group), African-American, and other.

Education was included as categorical variables for <12 years, high school diploma, or associate's/technical, bachelor's, or post-graduate degree (reference group). Annual household income was included as categorical variable as USD <15,000, 15,000–30,000, 30,000–50,000, 50,000–100,000, or >100,000 (reference group). Insurance status was included as private, public (reference group), or none. Region of residence was included as West (reference group), Midwest, South, or East as defined by the US Census Bureau. Marital status was dichotomized as married/co-habiting versus single/divorced/widowed/living alone (reference group). Because of a non-linear relationship found on examining age and outcome, current age was categorized into quintiles with the highest quintile as the reference group.

Clinical characteristics considered were age at symptom onset, disease duration, disability status, and depressed mood. Age at symptom onset, and disease duration were categorized into quintiles, with the lowest quintile as the reference group. Using the PDDS, we classified participants as having mild (EDSS score ≤3.5, no gait impairment), moderate (EDSS score 4–5.5, early gait impairment), or severe (EDSS score ≥6, assistive device for ambulation or non-ambulatory) disability. Disability was included in the model as a categorical variable with mild disability as the reference group. Participants were classified as depressed with a CESD score ≥21 [18, 20].

We used a similar approach to determining what characteristics influenced agreement regarding current smoking status. Statistical assumptions of the models were tested using standard methods [21]. Model fit was assessed using the Hosmer-Lemeshow Goodness-of-Fit test, and discriminating ability was assessed using the c-index.

Results

Agreement

After application of the study inclusion criteria, 5,458 participants had completed both questionnaires. Their characteristics were similar to those reported for the general MS population (table 2) [22, 23]. Of the 5,458 participants, 2,885 (53.4%) participants reported ever smoking in the 2004 questionnaire. Of these, 2,775 (96.2%) reported ever smoking in the 2006 questionnaire. In the 2006 questionnaire, 2,361 (94.3%) of those who reported never smoking in 2004 (n = 2,503) gave the same response in 2006. Only one person reported a year of starting smoking between 2004 and 2006, suggesting that 'new' smokers did not account for inconsistency of reporting. Kappa for agreement was 0.90 (95% confidence interval, CI: 0.89–0.92).

In 2004, 913 participants reported that they currently smoked. Of these, 760 (83.2%) reported currently smoking in 2006. Of the 153 participants who reported currently smoking in 2004 but not in 2006, 100 (65.4%) reported they quit in 2004 or later. Of 4,436 participants who reported not smoking in 2004, 4,373 (98.6%) report-

ed not smoking in the present questionnaire. Thus, 116 (2.1%) participants provided inconsistent responses. Kappa for agreement was 0.85 (95% CI: 0.83–0.87). After excluding those participants who reported quitting between 2004 and 2006, kappa was 0.92 (95% CI: 0.90–0.94).

Table 2. Demographic and clinical characteristics of the study participants in Fall 2006 (n = 5,458)

Characteristic	Value
Sex, n (%)	
Female	4,078 (74.7)
Male	1,380 (25.3)
Race, n (%)	
White	5,148 (94.3)
African-American	134 (2.5)
Other	175 (3.2)
Education, n (%)	
<12 years	112 (2.1)
High school diploma	1,855 (34.2)
Associate's or technical degree	890 (16.4)
Bachelor's degree	1,445 (26.6)
Post-graduate degree	1,125 (20.7)
Marital status, n (%)	
Married/co-habiting	3,684 (67.7)
Never married/divorced/widowed	1,759 (32.3)
Annual income, n (%)	
USD <15,000	541 (12.1)
USD 15,000–30,000	801 (17.9)
USD 30,000–50,000	953 (21.2)
USD 50,000–100,000	1,427 (31.8)
USD >100,000	766 (17.1)
Health insurance, n (%)	
Private	3,993 (74.7)
Public	1,284 (24.0)
None	67 (1.3)
Region, n (%)	
West	1,278 (23.4)
Midwest	1,436 (26.3)
South	1,328 (24.3)
East	1,416 (25.9)
Mean age, years (SD)	
Current age	54.1 (10.2)
Age at symptom onset	31.2 (9.0)
Age at diagnosis	38.2 (9.4)
Mean disease duration, years (SD)	22.9 (11.1)
CESD	
Depressive symptoms (CESD ≥21)	1,616 (29.6)
No depressive symptoms (CESD <21)	3,842 (70.4)
Clinical course, n (%)	
Relapsing	4,691 (89.1)
Progressive	574 (10.9)
PDDS, n (%)	
Mild	1,758 (32.2)
Moderate	617 (11.3)
Severe	3,083 (56.5)

Table 3. Kappa or ICC and 95% CI for test-retest reliability of smoking status reported by NARCOMS participants in 2004 and 2006 according to demographic and clinical characteristics (n = 5,458)

Characteristic	Ever smoked		Currently smoking[1]		Age started smoking		Age quit smoking	
	Kappa	95% CI	Kappa	95% CI	ICC	95% CI	ICC	95% CI
Demographic								
Sex								
Female	0.91	0.90, 0.92	0.92	0.90, 0.94	0.75	0.73, 0.77	0.92	0.91, 0.93
Male	0.88	0.86, 0.91	0.90	0.87, 0.93	0.68	0.64, 0.71	0.88	0.86, 0.90
Race								
White	0.91	0.90, 0.92	0.92	0.90, 0.93	0.73	0.71, 0.75	0.91	0.90, 0.92
African-American	0.83	0.73, 0.93	0.91	0.81, 1.0	0.72	0.62, 0.80	0.85	0.74, 0.92
Other	0.90	0.83, 0.96	0.87	0.76, 0.98	0.71	0.59, 0.80	0.88	0.81, 0.92
Age								
≤44 years	0.93	0.90, 0.95	0.91	0.87, 0.94	0.83	0.80, 0.86	0.86	0.83, 0.89
>44 to ≤50 years	0.90	0.87, 0.93	0.90	0.86, 0.94	0.77	0.73, 0.81	0.88	0.85, 0.90
>50 to ≤55 years	0.94	0.91, 0.96	0.90	0.87, 0.94	0.69	0.64, 0.73	0.93	0.91, 0.94
>55 to ≤60 years	0.91	0.89, 0.94	0.94	0.91, 0.97	0.66	0.61, 0.70	0.90	0.89, 0.92
>60 years	0.86	0.84, 0.89	0.93	0.89, 0.96	0.74	0.71, 0.77	0.88	0.86, 0.90
Education								
<12 years	0.79	0.66, 0.92	0.96	0.90, 1.0	0.77	0.66, 0.85	0.89	0.81, 0.94
High school diploma	0.88	0.86, 0.91	0.85	0.82, 0.88	0.69	0.66, 0.72	0.84	0.82, 0.86
Associate's/technical degree	0.92	0.89, 0.95	0.85	0.81, 0.90	0.73	0.69, 0.77	0.91	0.90, 0.93
Bachelor's degree	0.91	0.89, 0.93	0.83	0.78, 0.87	0.74	0.71, 0.76	0.92	0.90, 0.93
Post-graduate degree	0.91	0.89, 0.94	0.90	0.85, 0.95	0.79	0.75, 0.82	0.90	0.88, 0.92
Marital status								
Married/co-habiting	0.91	0.90, 0.92	0.92	0.90, 0.93	0.75	0.73, 0.77	0.90	0.89, 0.91
Single/divorced/widowed	0.90	0.88, 0.92	0.91	0.89, 0.94	0.71	0.68, 0.74	0.90	0.89, 0.92
Annual income								
USD <15,000	0.84	0.80, 0.89	0.95	0.92, 0.98	0.56	0.48, 0.63	0.89	0.86, 0.92
USD 15,000–30,000	0.88	0.84, 0.91	0.90	0.86, 0.94	0.76	0.72, 0.80	0.92	0.90, 0.94
USD 30,000–50,000	0.92	0.89, 0.94	0.91	0.87, 0.94	0.69	0.65, 0.74	0.93	0.92, 0.94
USD 50,000–100,000	0.92	0.90, 0.94	0.93	0.90, 0.96	0.85	0.83, 0.87	0.94	0.93, 0.95
USD >100,000	0.94	0.92, 0.97	0.87	0.82, 0.93	0.73	0.68, 0.78	0.92	0.90, 0.93
Health insurance								
Private	0.92	0.91, 0.93	0.90	0.88, 0.92	0.74	0.72, 0.76	0.91	0.90, 0.92
Public	0.87	0.84, 0.89	0.94	0.91, 0.96	0.72	0.69, 0.76	0.88	0.86, 0.90
None	0.81	0.67, 0.95	0.87	0.73, 1.0	0.44	0.24, 0.61	0.98	0.95, 0.99
Region								
West	0.90	0.88, 0.93	0.93	0.90, 0.97	0.84	0.81, 0.86	0.92	0.91, 0.93
Midwest	0.90	0.88, 0.93	0.92	0.90, 0.95	0.77	0.74, 0.80	0.91	0.89, 0.92
South	0.92	0.89, 0.94	0.92	0.89, 0.95	0.68	0.63, 0.72	0.91	0.90, 0.93
East	0.90	0.88, 0.92	0.89	0.85, 0.92	0.65	0.61, 0.69	0.88	0.86, 0.90
Method of completing survey								
Paper	0.88	0.86, 0.90	0.92	0.90, 0.94	0.76	0.73, 0.78	0.89	0.87, 0.90
Online	0.93	0.91, 0.94	0.91	0.89, 0.93	0.76	0.74, 0.78	0.92	0.91, 0.93

For both questionnaires, the mean age at starting smoking was 17.9 (4.4) years. The mean age at quitting smoking was 35.0 (11.0) in 2004, and 36.0 (11.3) in 2006. For age at starting smoking, the Spearman correlation between the two questionnaires was 0.83 (95% CI: 0.82–0.84); the ICC for the age at starting smoking was 0.73 (95% CI: 0.71–0.75). For age at quitting smoking, the Spearman correlation between the two questionnaires was 0.90 (95% CI: 0.89–0.91); the ICC for age at quitting smoking was 0.90 (95% CI: 0.89–0.91).

Agreement was lowest for the cigarettes per day variables. The mean number of cigarettes smoked daily by current smokers was higher in 2006 [16.9 (9.8)] than in 2004 [14.9 (9.4)]. The Spearman correlation was 0.74 (95%

Table 3 (continued)

Characteristic	Ever smoked		Currently smoking[1]		Age started smoking		Age quit smoking	
	Kappa	95% CI	Kappa	95% CI	ICC	95% CI	ICC	95% CI
Clinical								
Clinical course								
Relapsing	0.90	0.89, 0.91	0.92	0.90, 0.93	0.72	0.71, 0.75	0.91	0.90, 0.92
Progressive	0.94	0.92, 0.97	0.91	0.90, 0.96	0.77	0.72, 0.82	0.90	0.87, 0.92
Degree of disability (PDDS)								
Mild	0.94	0.92, 0.95	0.89	0.86, 0.92	0.73	0.69, 0.76	0.92	0.90, 0.93
Moderate	0.90	0.86, 0.93	0.94	0.91, 0.98	0.86	0.84, 0.88	0.92	0.90, 0.94
Severe	0.89	0.87, 0.91	0.92	0.90, 0.94	0.70	0.67, 0.72	0.90	0.88, 0.91
Age at symptom onset								
≤22 years	0.93	0.90, 0.95	0.91	0.87, 0.95	0.80	0.77, 0.83	0.86	0.83, 0.88
>23 to ≤27 years	0.90	0.87, 0.93	0.90	0.86, 0.94	0.61	0.55, 0.66	0.94	0.93, 0.95
>28 to ≤32 years	0.94	0.91, 0.96	0.92	0.89, 0.95	0.72	0.68, 0.76	0.88	0.86, 0.90
>33 to ≤39 years	0.91	0.89, 0.94	0.94	0.92, 0.97	0.83	0.81, 0.86	0.92	0.90, 0.93
>40 years	0.86	0.84, 0.89	0.90	0.86, 0.94	0.66	0.61, 0.71	0.90	0.89, 0.92
Disease duration								
≤12.7 years	0.93	0.91, 0.95	0.91	0.88, 0.94	0.80	0.76, 0.83	0.92	0.90, 0.93
>12.7 to ≤18.5 years	0.90	0.88, 0.93	0.91	0.88, 0.95	0.74	0.70, 0.78	0.92	0.90, 0.93
>18.5 to ≤24.6 years	0.92	0.89, 0.94	0.91	0.88, 0.95	0.74	0.70, 0.78	0.90	0.88, 0.91
>24.6 to ≤32.5 years	0.91	0.88, 0.93	0.92	0.89, 0.95	0.66	0.61, 0.70	0.89	0.87, 0.91
>32.5 years	0.87	0.84, 0.90	0.93	0.89, 0.97	0.73	0.69, 0.76	0.90	0.88, 0.92
Depression								
Depressive symptoms	0.90	0.88, 0.92	0.91	0.89, 0.94	0.68	0.64, 0.71	0.90	0.89, 0.92
No depressive symptoms	0.91	0.90, 0.92	0.91	0.89, 0.93	0.76	0.74, 0.78	0.91	0.90, 0.92

[1] Excludes participants who reported that they quit smoking between surveys.

CI: 0.70–0.77), and the ICC was 0.78 (95% CI: 0.74–0.81). The mean number of cigarettes smoked daily by ex-smokers was the same in 2006 [17.7 (11.1)] as 2004 (17.6 (11.6)]. The Spearman correlation was 0.71 (95% CI: 0.68–0.74), and the ICC was 0.68 (95% CI: 0.65–0.71).

Factors Influencing Agreement

For ever and current smoking status, we stratified the population by demographic and clinical characteristics and re-estimated the kappas. We used a similar approach to determining the ICC for the ages of starting and quitting smoking within subgroups (table 3). Due to small sample sizes and missing data, we did not do these analyses for the daily number of cigarettes smoked.

Ever Smoking

As demonstrated by the non-overlapping confidence intervals, agreement with respect to ever smoking was lower in participants >60 years as compared to persons ≤44 years; in participants with annual incomes of USD <15,000 as compared to those with incomes >100,000; in

participants with public as compared to private health insurance; in participants responding online versus paper; in participants with severe as compared to mild disability, and in participants with a relapsing as compared to a progressive clinical course at disease onset (table 3).

On multivariable logistic regression analysis, demographic factors influenced consistency of responses with respect to ever smoking (table 4). Compared to Whites, African-Americans had decreased odds of agreement. Compared to participants aged ≥60 years, younger participants had increased odds of agreement. Participants with higher levels of income and education were also more likely to provide reliable responses. Clinical characteristics were not associated with agreement.

Current Smoking

Participants who reported being current smokers in 2004 and being ex-smokers in 2006, and who indicated quitting smoking between 2004 and 2006, were classified as consistent for purposes of assessing agreement prediction. After accounting for participants who indicated

Table 4. Adjusted OR and 95% CI from multivariable logistic regression analysis for agreement regarding ever smoking status reported by NARCOMS participants in 2004 and 2006 (n = 4,464)

Characteristic	OR	95% CI
Race		
White	1.0	
African-American	0.44	0.24, 0.81
Other race	0.86	0.43, 1.73
Age		
≤44 years	1.69	1.11, 2.59
>44 to ≤50 years	1.18	0.82, 1.71
>50 to ≤55 years	1.82	1.22, 2.73
>55 to ≤60 years	1.50	1.03, 2.19
>60 years	1.0	
Education		
<High school	1.0	
High school diploma	1.86	1.00, 3.45
Associate's or technical degree	2.64	1.33, 5.23
Bachelor's degree	1.94	1.01, 3.72
Post-graduate degree	2.04	1.04, 3.99
Annual income		
USD <15,000	1.0	
USD 15,000–30,000	1.07	0.72, 1.59
USD 30,000–50,000	1.78	1.16, 2.74
USD 50,000–100,000	1.60	1.07, 2.40
USD >100,000	1.97	1.18, 3.31

that they had quit smoking between 2004 and 2006, demographic and clinical characteristics were not associated with differences in the level of agreement. On multivariable logistic regression analysis, demographic and clinical factors influenced reliability of responses with respect to current smoking. Women were more likely to be reliable (OR: 1.35; 95% CI: 1.00–1.81) than men. Participants with major depressive symptoms were 50% less likely to be reliable (OR: 0.51; 95% CI: 0.39–0.67). No interaction existed between gender and depressive symptoms.

We further evaluated the relationship of depression and depressive symptoms to consistency of responses. In 2006, participants reported lifetime diagnoses of depression. We considered participants with CESD scores ≥21 to be currently depressed. Participants with a lifetime diagnosis of depression and a CESD score <21 were considered past depressed. Participants without a lifetime diagnosis of depression and a CESD score <21 were considered non-depressed. As compared to non-depressed participants, past depressed participants did not have decreased odds of consistent responses (OR: 0.96; 95% CI: 0.64–1.44). Compared to non-depressed participants,

currently depressed participants had decreased odds of consistent responses (OR: 0.48; 95% CI: 0.35–0.66).

Age at Starting and Quitting Smoking

Results of univariate analyses for consistency of reported ages at starting smoking are shown in table 3. After multivariable adjustment, women and younger participants were more consistent reporters than men and older participants (data not shown). Participants with a high school diploma had lower levels of agreement than those with higher levels of education. The adjusted ICC was 0.72 (95% CI: 0.70–0.74).

Results of univariate analyses for consistency of reported age at quitting smoking are shown in table 3. After multivariable adjustment, sex and education were not associated with agreement. Participants who were younger or responded online had higher levels of agreement. The adjusted ICC was 0.89 (95% CI: 0.88–0.90).

Discussion

We investigated the reliability of self-reported smoking status in a large cohort of MS patients. MS is a chronic disease of the central nervous system. Patients with MS experience progressively increasing disability over the course of their disease, raising the possibility that reliability of self-reported health data could be inadequate as we begin to assess characteristics of treatment responders and non-responders, and the impact of comorbidity on outcomes [10, 11]. As smoking becomes an etiologic and prognostic factor of greater importance in MS, it is important to show the reliability of self-reported smoking status in this population.

In 2004, more than 50% of cohort participants reported ever smoking, while nearly 17% reported current smoking. After age adjustment (16.6; 15.0–18.1) this is slightly lower than the general US population smoking frequency of 20.9% (20.3–21.5) [24]. Twenty-eight percent of Veterans with MS currently smoke [25]. Studies in Europe suggest that patients with MS currently smoke more than the general population [26].

Several studies suggest that smoking is a risk factor for MS [3, 27]. A recent study suggested smoking is a risk factor for early conversion to MS after a first clinical event suggestive of MS [28]. We found that after accounting for the delay between symptom onset and diagnosis, smoking was not associated with the degree of disability at diagnosis [29]. Reports conflict regarding the effect of smoking on disability progression [4, 30]. Smoking also

appears to influence the phenotype of other chronic neurologic diseases, such as Parkinson's disease and Alzheimer's disease [5, 31].

We found that patients with MS consistently report smoking status (ever smoker, current smoker) using questions from the BRFSS, with kappas similar to those reported in women of varied ethnicity, and the general population [7, 32]. Agreement was not as good for the number of cigarettes smoked per day, or for the age at starting smoking. Other investigators also reported lower reliability for number of cigarettes smoked as compared to ever smoking status [7, 8, 33].

Smoking status was reported less consistently by men, African-Americans, older participants, and participants of lower socioeconomic status. A study of military recruits found that ethnicity and educational background influenced the reliability of self-reported smoking status [9]. Similarly, older age and less education adversely affect validity and reliability of reporting of chronic diseases [34, 35]. Despite the observed differences in reliability between subgroups, however, reliability was still acceptable for research purposes in all demographic groups.

For current smoking status, depressed participants appeared to be less reliable, although the differences in agreement between depressed and non-depressed participants were small. Depression did not affect reliability of other study variables. In adolescents, depression was associated with inconsistent responses regarding smoking status [36]. Given the 2-year interval between surveys, it is also possible that smoking behavior changed; although we could identify persons who reported quitting between 2004 and 2006, we could not identify persons who restarted smoking after previously quitting. We only measured depression in 2006, but depression could potentially influence smoking behavior. Depressed persons smoke more and have a higher risk of relapse following smoking cessation [37, 38]. Nevertheless, the data show face validity in the very infrequent initiation of smoking as would be expected within a diseased cohort.

This study has limitations. The NARCOMS Registry is a volunteer registry, and does not explicitly represent all MS patients in the US. The population is large, however, and has similar characteristics to those reported for MS patients from the National Health Interview Survey [22]. The NARCOMS population is well characterized, sociodemographically diverse, and captures patients followed at community as well as academic centers. The interval between surveys was long for assessing the test-retest reliability of current smoking status, and the average number of cigarettes currently smoked. We did not validate our findings against an objective biochemical test, but this does not affect our findings regarding reliability. Further, we previously demonstrated the validity of self-reported diagnoses of MS and other clinical data in this population [14, 39].

Similar to the general population, patients with MS reliably self-report smoking history using questions from the BRFSS. Reliability of reporting is influenced by demographic characteristics. The impact of depression on reliability of self-reported smoking status in MS should be re-evaluated in another population.

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