Exercise and Quality of Life Among People With Multiple Sclerosis: Looking Beyond Physical Functioning to Mental Health and Participation in Life

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Objective: To describe the prevalence of exercise in a national sample of veterans with multiple sclerosis (MS) and the association of exercise with quality of life, including physical health, mental health, and participation restriction.

Design: Cross-sectional cohort study linking computerized medical records to mailed survey data from 1999.

Setting: Veterans Health Administration.

Participants: Veterans with MS (N=2995; 86.5% men) who received services in the Veterans Health Administration and returned survey questionnaires.

Interventions: Not applicable.

Main Outcome Measures: Demographic information, Veteran RAND 36-Item Health Survey (VR-36), self-reported exercise frequency.

Results: Among all survey respondents with MS, only 28.6% (95% confidence interval, 26.9-30.2) endorsed any exercise. In adjusted logistic regression, exercise was associated with younger age, more education, living alone, lower levels of bodily pain, and higher body mass index. After adjusting for demographic variables and medical comorbidities, exercise was associated with better physical and mental health. People who exercised reported they had better social functioning and better role functioning (participation in life despite physical and emotional difficulties).

Conclusions: Exercise in veterans with MS is uncommon. In the context of chronic illness care, the identification of exercise patterns and promotion of physical activity may represent an important opportunity to improve mental health and quality of life among people with MS. Intervention should address factors associated with lower rates of exercise including age, education, and pain.

Key Words: Exercise; Health status; Mental health; Multiple sclerosis; Quality of life; Rehabilitation.

MULTIPLE SCLEROSIS IS a chronic degenerative disorder of the central nervous system affecting as many as 350,000 people in the United States. It is associated with a host of unpredictable and disabling symptoms that include, but are not limited to, sensory and motor loss, fatigue, difficulties with balance, sexual functioning, pain, cognitive impairment, and depression. MS is typically diagnosed between the ages of 20 and 40 years, and because most people have a relatively healthy lifespan, they usually have a prolonged course of illness. Over the past several decades, researchers have made significant progress in identifying the neuropathology of MS using techniques such as magnetic resonance imaging, and in slowing the disease process using disease-modifying therapies. Nonetheless, MS remains a disease without a definitive cure, and as a result, there is a substantial need for individuals with MS to identify ways they can manage the disease and limit its impact on functioning and QOL.

Health-promoting behaviors, such as exercise, represent an important way people with MS may participate in the disease management process. The significant and wide-ranging benefits of exercise for overall health have been extensively documented in many populations and include reduced blood pressure, body fat, and risk of coronary heart disease, as well as improvements in bone density, mental status, and psychologic well being.

In past decades, people with MS were often advised to avoid significant physical activity because of concerns that it might induce fatigue or even facilitate an exacerbation of the disease itself. However, a growing body of evidence linking exercise to improved physical functioning has had an important impact on clinician practice patterns. Current findings suggest that people with MS receive substantial benefit from physical activity. Several clinical trials have examined the benefits of formal exercise programs. Although interventions have varied...
considerably in modality and their relative emphasis on strength and endurance, exercise training has increased walking speed, endurance, strength, balance, and aerobic capacity, and reduced fatigue. In addition, trials of physical therapy and inpatient rehabilitation, which include but are not limited to exercise, have also produced improvements in mobility and global disability, and decreases in MS-related symptoms. Exercise has been shown to be safe and very well tolerated among people with MS.

The relationship between exercise and psychologic well being in MS is less well established, but some studies also suggest that increased physical activity may make important contributions to mental health. Petajan et al found that a structured and professionally guided outpatient exercise program brought significant decreases in depression, anger, and fatigue for participants with MS relative to controls. Wiles et al reported a physical therapy intervention for MS had a positive impact on depression and anxiety. More generally, people with MS who have higher levels of physical activity have been shown to endorse greater satisfaction with life. These results are consistent with an increasing literature beyond MS suggesting that exercise may improve mood states and mental health in the general public, and among other populations with disabilities. Nonetheless, not all studies of exercise in MS have shown positive mental health benefits and questions about the nature and extent of this relationship remain.

In addition to physical and mental health, there is increasing recognition that health professionals should look beyond impairments and deficits and define functioning more broadly to include overall QOL. One well established roadmap for operationalizing this very broad concept is the ICF championed by the World Health Organization. The ICF proposes a taxonomy of functioning that includes impairments (ie, problems in body function or structure), activity limitations (ie, difficulty in executing activities), and participation restrictions (ie, lack of involvement in community, social, occupational, and other meaningful and desirable life pursuits). A person's QOL is determined by a combination of all 3 of these factors, as well the environment in which they occur. Each level of functioning is partially but not entirely determined by the previous level. As previously suggested, it is this final level, participation restriction, that is most often neglected by an overly narrow focus on illness at the expense of recognizing the larger impact of illness on life.

Despite growing interest in research on QOL, data examining the relationship between exercise and participation restriction in MS are sparse and relatively equivocal. Two studies examining structured exercise training programs, one a group-based outpatient intervention, the other an addition to an inpatient rehabilitation program, have reported greater improvements in self-reported social interaction in their exercise treatment conditions. A study by Freeman et al found inpatient rehabilitation had a positive impact on participation, using a measure that included social and occupational functioning, although exercise itself was not quantified and was only 1 component of the overall treatment. Other authors have found no impact of exercise on participation and no association between exercise capacity and leisure physical activity. In a large, prospective evaluation, Stuifbergen et al found a positive association between exercise and a global measure of QOL, but participation was not specifically delineated. Consequently, understanding of the potential impact of exercise on social and community participation is limited.

The current study is intended to serve several purposes. First, it provides an estimate of self-reported exercise in a large, national sample of people with MS. In particular, this sample of predominantly male veterans represents an important opportunity to examine the physical activity of men with MS, a group that is typically underrepresented in MS research. Second, this study examines correlates of exercise in this population. It is hypothesized that barriers to activity, including but not limited to older age, pain, and greater BMI, will be associated with lower levels of exercise. Third, the current study explores the relationship between exercise and both physical and mental functioning (mental health), with the expectation based on existing literature that all 3 will be positively correlated. Mental functioning is of particular interest because it has not received as much attention in existing literature. Finally, the investigation of greatest interest in this study is the relationship between exercise and participation restriction. It is hypothesized that after controlling for physical functioning, mental health, and other covariates, exercise will be positively associated with 3 other subscales of the VR-36 (Role Emotional, Role Physical, Social Functioning) that most closely correspond to the ICF category of participation restrictions.

METHODS

This current study is a cross-sectional, secondary data analysis of a cohort created by the linkage of a VA national administrative database containing medical record information with a mailed national health survey conducted in 1999.

Participants

Potential participants were first drawn from the VA MS National Data Repository, a database containing information on all veterans receiving MS-related health care services within Veterans Health Administration from 1998 to 2004. The repository is updated periodically, but at the time of the data extraction for this study, it contained 32,009 unique cases. To reduce inaccurate ascertainment because of coding errors, people were included in a final target population only if they met 1 or more of the following 4 criteria: (1) they had an inpatient hospitalization for MS (hospitalization was coded with the International Classification of Diseases diagnostic code 340 for MS), (2) they had received a disease-modifying agent (interferon β-1a, interferon β-1b, or glatiramer acetate) used only to treat MS, (3) they were VA service connected for MS (the diagnosis had been confirmed through a medical review process for purposes of VA reimbursement of services), or (4) they had at least 1 outpatient encounter for which the primary ICD diagnosis code was 340 during each year in which they received some VA medical service. The process of identifying a target population within the VA MS National Data Repository by means of a search algorithm has been validated by chart review in previous work and has been shown to be an effective means of eliminating people who do not have MS. A total of 17,470 veterans were included in the target population.

Information on people in the target population was then linked to data from the VA Office of Quality and Performance 1999 LHS. The LHS was conducted to establish the health status and health behavior patterns of a nationally representative sample of veterans receiving care across the VA health care system. The overall LHS was returned by 877,775 of 1.4 million enrollees who were mailed surveys (63.1% response rate). Similarly, among people with MS in the target population, the LHS was returned by 2994 of 4685 enrollees who were mailed surveys (63.9% response rate). All procedures were approved by the local human subjects review committee.
Measures

Demographic information. Sex, race (white vs nonwhite), education level (high school or less vs more than high school), marital status (currently married vs all other), and living alone (yes vs no) were all obtained from the LHS. Age in years at the time of the survey was obtained from the VA MS National Data Repository.

Medical comorbidity. Medical comorbidity was measured using a modified version of the Seattle Index of Comorbidity.47 The Seattle Index of Comorbidity is a weighted composite of self-reported medical conditions (eg, cancer, diabetes) combined with age and current smoking status into a single score reflecting total medical comorbidity. The Seattle Index of Comorbidity score has been shown to predict rates of mortality and hospitalization.47 Self-reported medical conditions were obtained from survey data. For the present study, age was an independent variable of interest, so it was not included in the index.

Body mass index. BMI was calculated from self-reported height and weight variables in the survey according to Centers for Disease Control and Prevention guidelines48 as weight in kilograms divided by height in meters squared. Two aspects of height and weight data are worthy of note. First, response options for weight were categorized into 10-lb increments; consequently, the mean value for each 10-lb weight band was used. Second, height and weight values had defined maximum and minimum values. The lowest weight category was 41kg (90lb) or less, and the highest was 146kg (321lb) or more. Height values ranged from 152cm (60in) or less to 191cm (75in) or more. It is possible that these limited ranges could have introduced ceiling or floor effects into the BMI estimates, although a review of population height and weight data from this period suggests that the response options would truncate values only for people who were extremely tall or heavy, and for far fewer than 5% of total cases. For example, the mean value of the top 5% of weight was 122kg (268lb), far below the available upper limit of 146kg (321lb).49

Physical functioning. Physical functioning was measured using the 10-item Physical Functioning scale of the VR-36, which is adapted from the SF-36.50,51 Participants were asked to rate to what extent their health limits physical activities such as “walking 1 block” and “bathing or dressing yourself” with values ranging from 1 (yes, limited a lot) to 5 (not limited at all). Item responses were summed and then transformed to a standardized score with a range of 0 to 100, with higher scores reflecting better physical functioning. The SF-36 is widely used and has been validated for use with people with MS.52-54 Internal consistency of this scale in the current sample was excellent (α=.95).

Mental health. Mental health was measured using the 5-item Mental Health scale of the VR-36.50,51 Participants were asked to respond to questions about their mental health, such as “Have you felt downhearted and blue?” and “Have you been a nervous person?” in the past 4 weeks with values ranging from 1 (all of the time) to 6 (none of the time). Item responses were summed and in some instances reverse-scored, then transformed to a standardized score ranging from 0 to 100. Higher scores reflected better mental health. Internal consistency of this scale in the current sample was good (α=.86).

Participation restriction. Participation restriction was measured in 3 ways. First, we used the 4-item Role Physical and 3-item Role Emotional scales of the VR-36.50,51 Participants were asked to respond to questions about the impact of physical health and emotional problems on their daily activities, such as, “Have you...cut down on the amount of time you spent on work or other activities?” and “Have you...accomplished less than you would like?” in the past 4 weeks. Values for both scales ranged from 1 (no, none of the time) to 5 (yes, all of the time). All item responses were reverse-scored, summed, and transformed to produce a standardized score ranging from 0 to 100. Higher scores reflected better role functioning (less participation restriction based on physical and mental health). Internal consistency in the current sample was excellent for both the Role Physical (α=.95) and Role Emotional (α=.96) scales.

Pain. Pain was measured using the bodily pain item from the Bodily Pain scale of the VR-36.50,51 Participants were asked to rate how much bodily pain they had experienced during the past 4 weeks ranging from 1 (none) to 6 (very severe).

Exercise. Exercise was measured with a single item. Participants were asked to respond to the question “How often do you engage in regular activities long enough to work up a sweat?” with values ranging from 1 (none) to 5 (5 or more times a week). This single-item indicator of exercise has been widely used in survey research. It has demonstrated construct validity, correlating with laboratory-based measures of physical fitness including maximal oxygen uptake and maximal treadmill performance,55,56 as well as convergent validity, correlating with other longer questionnaire assessments of physical activity.57 Its predictive utility has also been well established. Lower levels of exercise reported on this instrument have been associated with a greater risk over time for the development of cancer,58,59 diabetes,60 and stroke.61 Because of the heavily skewed distribution of this variable (71.4% endorsed no exercise), responses were dichotomized to reflect the presence or absence of exercise. For secondary analyses, responses were dichotomized to reflect the presence or absence of exercise 3 or more times a week.

Data Analysis

We first examined the dataset to determine the extent to which the final study sample was representative of the larger population of veterans with MS using age, sex, and race variables available on all people in the repository. Selection bias (whether a person was or was not sent a survey) and response bias (whether a person did or did not return a survey) were examined for these 3 variables.

Regression analyses were conducted using available data with no imputation for missing values. Sensitivity analyses were conducted without variables that had the most missing data to clarify results.

The prevalence of exercise was estimated using simple proportions and 95% CIs. Logistic regression was used to identify correlates of exercise. First, an initial multiple logistic regression analysis was conducted to examine the unique association between exercise and 6 potential demographic correlates (age, sex, race, education level, marital status, living alone) and 2
health correlates (pain, BMI). Next, all variables significant at a multivariate level were again entered into a final multiple logistic regression. This step was conducted to produce a final regression with the maximum available sample size and reduce loss of data because of missing data in each variable. Both the initial and the final multiple regression analyses produced identical lists of significant correlates.

We used hierarchical multiple regressions to examine the relationship between exercise and health status, controlling for available correlates that included demographic variables and medical comorbidities. Health status was measured with 2 scales of the VR-36 reflecting physical functioning and mental health.

Finally, for our primary analyses we used 3 hierarchical multiple regressions to examine the relationship between exercise and each aspect of participation restriction (VR-36 Role Physical, Role Emotional, Social Functioning scales). Both demographic and health status variables (Physical Functioning, Mental Health) were entered to control for their association. Two a priori interactions were entered in a final step of each equation to test whether (1) the association between Physical Functioning and participation and (2) the association between Mental Health and participation varied depending on exercise status. Continuous variables included in interactions were centered to facilitate their interpretation.62

We also conducted several sensitivity analyses to examine the stability of our findings. First, reduced models without demographics were run to examine the potential influence of missing data on the association between exercise and participation restriction. Full regression analyses were also rerun with the exercise variable recoded to reflect the presence or absence of regular physical activity (≥3 a week) to examine whether there were substantial differences in the relationship between exercise and participation restriction based on the frequency of exercise.

**RESULTS**

**Comparability of the Study Sample**

**Selection bias.** To determine whether people who were mailed the LHS survey were representative of the larger MS target population, the 2 groups were compared on sex, race, and age. There were no sex differences between people who were or were not mailed surveys, but surveys were more likely to be received by nonwhites (39.3% vs 34.3%; $\chi^2_{1,N=10,973}=16.21; P<.001$). People who were mailed surveys were significantly older than those who were not (mean ± SD, 54.19±12.60 vs 52.78±13.05, respectively; $F_{1,16944}=40.06; P<.001$), although the difference of a little over a year was small.

**Response bias.** Similarly, to determine whether people who returned the LHS survey differed from those who did not, these 2 groups were also compared on sex, race, and age. There were no differences in survey response by sex or race, but individuals who returned surveys were on average older than those who did not (mean ± SD, 55.30±12.22 vs 52.18±13.03, respectively; $F_{1,4633}=66.23; P<.001$).

**Prevalence of Exercise**

The vast majority of survey respondents with MS (71.4%) endorsed no regular exercise. A total of 28.6% (95% CI, 26.9–30.2) reported some form of regular exercise, with 10.5% (95% CI, 9.4–11.6) exercising less than 1 time a week, 8.2% (95% CI, 7.2–9.3) exercising 1 to 2 times a week, 6.2% (95% CI, 5.3–7.0) exercising 3 to 4 times a week, and 3.7% (95% CI, 3.0–4.4) exercising 5 times a week (table 1).

| Demographic and Health Status Information of Survey Respondents |
|---|---|---|
| Age (y) | 55.30±12.22 |
| Sex (male) | 86.5 |
| Race (white) | 86.7 |
| Education level (more than high school) | 61.4 |
| Marital status (unmarried) | 37.9 |
| Living alone | 18.7 |
| Health status (VR-36) |
| VR-36 Physical Functioning scale (0–100) | 23.09±28.30 |
| VR-36 Mental Health scale (0–100) | 61.09±22.77 |
| Participation restriction |
| VR-36 Role Physical scale (0–100) | 23.76±27.91 |
| VR-36 Role Emotional scale (0–100) | 39.40±29.78 |
| VR-36 Social Functioning scale (0–100) | 38.97±28.96 |
| Medical comorbidity |
| Sustained Index of Comorbidity | 3.69±2.73 |
| BMI | 26.17±4.82 |
| VR-36 pain intensity item (1–6) | 3.84±1.34 |
| Exercise |
| None | 71.4 |
| Once a week | 10.5 |
| 1 to 2 times a week | 8.2 |
| 3 to 4 times a week | 6.2 |
| 5 times a week | 3.7 |
| Total any exercise | 28.6 |

NOTE. n = 2687–2980. Health status variables from the VR-36. Higher scores on each VR-36 scale indicate better functioning with the exception of the pain intensity item.

**Correlates of Exercise**

Multiple logistic regression identified several variables associated with exercise. In the final multivariate model, age (adjusted OR = 96; 95% CI, 95–97) and higher levels of pain intensity (adjusted OR = 1.56; 95% CI, 1.28–1.91), living alone (adjusted OR = 1.40; 95% CI, 1.11–1.76), and higher BMI (adjusted OR = 1.04; 95% CI, 1.02–1.06) were associated with a higher likelihood of exercise. Sex, race, and medical comorbidity were unrelated to exercise when adjusting for other correlates and consequently were not included in the final model (table 2).

**Exercise and Physical Functioning, and Mental Health**

Hierarchical multiple regression identified several variables associated with the VR-36 Physical Functioning and Mental Health scales in this study. Demographic variables were entered in the first step to control for their influence, accounting for 9% of the unique variation in Physical Functioning ($F_{change}=2135=50.73; P<.001$). Medical comorbidity accounted for 5% of the unique variance in Physical Functioning ($F_{change}=2136=42.65; P<.001$), with higher levels of pain associated with lower levels of functioning ($β = −2.3; P<.001$). Finally, exercise accounted for 16% of the unique variation in Physical Functioning above and beyond all other variables ($F_{change}=2135=491.79; P<.001$), with the presence of any exercise associated with higher levels of functioning ($β = .42; P<.001$; table 3).
Demographic control variables accounted for 1% of the unique variation in Mental Health ($F_{(change)3,2163}=5.11; P<.001$). Medical comorbidity accounted for 17% of the unique variation in Mental Health ($F_{(change)3,2163}=147.76; P<.001$), with medical comorbidity and pain intensity associated with lower levels of Mental Health ($β=-.14, P<.001$; and $β=-.37, P<.001$, respectively). Finally, exercise accounted for 1% of the unique variation in Mental Health above and beyond all other variables ($F_{(change)3,2162}=25.90; P<.001$), with the presence of any exercise associated with higher levels of functioning ($β=-.10; P<.001$).

### Exercise and Role Functioning (Participation in the Face of Physical and Emotional Limitations)

Hierarchical multiple regression also identified several variables associated with participation restriction as measured by the VR-36 Role Physical and Role Emotional scales. Demographic control variables accounted for 6% of the unique variation in Role Physical scores, which measure participation despite limitations because of physical health ($F_{(change)3,1969}=30.75; P<.001$). Medical comorbidity accounted for 11% of the unique variation in Role Physical scores ($F_{(change)3,1969}=92.90; P<.001$), with pain intensity associated with lower levels of activity ($β=-.34; P<.001$). Health status accounted for 24% of the unique variation in Role Physical scores ($F_{(change)2,1969}=408.28; P<.001$). Better physical functioning and better mental health were both associated with higher levels of participation ($β=.17, P<.001$; and $β=.52, P<.001$, respectively). Exercise accounted for 1% of the unique variation in Role Emotional scores ($F_{(change)1,1966}=440.28; P<.001$). Better physical functioning and better mental health were both associated with higher levels of participation ($β=.17, P<.001$; and $β=.52, P<.001$, respectively). Exercise accounted for 1% of the unique variation in Role Emotional scores ($F_{(change)1,1966}=83.72; P<.001$), with the presence of exercise associated with higher levels of participation ($β=.18; P<.001$). Neither hypothesized interaction was significant.

The effect of small amounts of missing data in each variable was compounded in the final multivariate model. For this reason, we reran both analyses without demographic variables to examine the potential impact of selective attrition on our findings. The reduced equations with fewer missing participants ($n=2218$ and $n=2245$) produced essentially identical results (ie, exercise was still positively correlated with both role functioning scales, and pain, for example, was still negatively correlated with both scales).

### Exercise and Social Functioning

Using an identical hierarchical multiple regression, several variables were associated with participation as measured by the VR-36 Social Functioning scale. Demographic control variables accounted for 1% of the total variation in Social Functioning ($F_{(change)3,1970}=5.75; P<.001$). Medical comorbidity accounted for 21% of the unique variation in Social Functioning ($F_{(change)3,1970}=179.37; P<.001$), with higher levels of pain associated with lower functioning ($β=-.46; P<.001$). Health status, including physical functioning and mental health, accounted for 22% of the variance in Social Functioning ($F_{(change)2,1965}=390.87; P<.001$; $β=.31, P<.001$; and $β=.39$, respectively).

### Table 2: Multivariate Logistic Regression Correlating Exercise With Demographic and Pain Variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>OR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>0.96 (0.95–0.97)¹</td>
</tr>
<tr>
<td>Education (more than high school)</td>
<td>1.56 (1.28–1.91)¹</td>
</tr>
<tr>
<td>Living alone (yes)</td>
<td>1.40 (1.11–1.76)¹</td>
</tr>
<tr>
<td>Pain intensity (range, 1–6)</td>
<td>0.77 (0.72–0.83)¹</td>
</tr>
<tr>
<td>BMI</td>
<td>1.04 (1.02–1.06)¹</td>
</tr>
</tbody>
</table>

NOTE. Total $n=2374$. ORs shown are those for the final multivariate model with only variables significant at the multivariate level entered simultaneously. Abbreviation: Pain intensity, VR-36 Bodily Pain item. *$P<.01$; †$P<.001$.

### Table 3: Hierarchical Multiple Regression Correlating Exercise With VR-36 Health Status: Physical Functioning and Mental Health

<table>
<thead>
<tr>
<th>Variable</th>
<th>Physical Functioning</th>
<th>Mental Health</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$β$</td>
<td>$R^2_{change}$</td>
</tr>
<tr>
<td>1. Demographics</td>
<td>.09*</td>
<td>.09*</td>
</tr>
<tr>
<td>2. Medical comorbidity</td>
<td>.05*</td>
<td>.14*</td>
</tr>
<tr>
<td>SIC</td>
<td>.05</td>
<td>–.14*</td>
</tr>
<tr>
<td>Pain intensity</td>
<td>–.23*</td>
<td>.02</td>
</tr>
<tr>
<td>BMI</td>
<td>.04</td>
<td>.16*</td>
</tr>
<tr>
<td>3. Exercise</td>
<td>.42*</td>
<td>–.14</td>
</tr>
</tbody>
</table>

NOTE. $n=2143–2170$. Each group of variables was entered in a separate step in the order specified in the table. Results presented control for demographics entered in step 1 (not shown = age, sex, race, living alone). Abbreviations: $β$, standardized regression weights; pain intensity, VR-36 Bodily Pain item; $R^2_{change}$ $R^2$ value for the individual regression step; $R^2_{total}$ total $R^2$ value for the model at that step; SIC, Seattle Index of Comorbidity without age. *$P<.001$. 

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Exercise accounted for 1% of the unique variation (F_{change1,1964} = 17.84; P < .001), with the presence of any exercise associated with better functioning (β = .08; P < .001; see Table 4). Finally, the interaction between mental health and exercise when regressed on social functioning was significant, such that the relationship between mental health and exercise was stronger for people who exercised (β = .48 vs β = .61). Although the total variation accounted for by this interaction step was significant (F_{change2,1962} = 4.56; P < .01), it was extremely small (total R^2 change < .01). Similar to the role functioning scales, the regression examining social functioning was also rerun without demographic variables (n = 2206). Again, results were essentially identical, with no change in the significance or direction of association between variables.

### Regular Exercise: Correlates and Relationship to Participation

A similar pattern of results was obtained when exercise was redefined to reflect the presence or absence of physical activity 3 or more times a week in accordance with established recommendations. First, correlates were examined using the sequence of logistic regression described. In the final multivariate model, age and higher levels of pain intensity were associated with a lower likelihood of regular exercise. Education and living alone were associated with a higher likelihood of regular exercise, although education only trended toward significance. BMI was not significantly correlated with regular exercise (results not shown).

Identical hierarchical multiple regression analyses were run to establish the relationship between regular exercise and physical functioning and mental health. Similar to previous results, regular exercise accounted for a small but unique proportion of variance in both VR-36 health status variables after controlling for demographics and medical comorbidity (results not shown). A final series of parallel hierarchical multiple regression equations examined the relationship between regular exercise and participation restriction (participation in the face of physical and emotional limitations as well as social functioning). Again, regular exercise accounted for unique variance in all 3 participation variables after controlling for demographics, medical comorbidity, and health status (results not shown).

### DISCUSSION

#### Exercise Rates

Overall, our results suggest that a minority of people with MS engage in regular exercise, with 71.4% endorsing none at all. Despite differences in the definition of physical inactivity, this rate is roughly 3 times what is typically found in general population samples. Overall, people with MS also appear to have lower rates of frequent exercise, with fewer than 10% of participants endorsing physical activity 3 or more times a week, compared with an estimated 26.2% of the U.S. population engaged in a similar (or somewhat more strenuous) level of activity over the same period.

#### Correlates of Exercise

Exercise among people with MS was less common with increasing age. This finding is consistent with literature on exercise in general, because age is associated with a decline in physical functioning, as well as the accumulation of medical comorbidities that may decrease health status. It likely also reflects reductions in physical activity corresponding with the progression of MS-related disability. The relationship between pain and exercise is likely complex. In the present study, greater bodily pain was also associated with a reduced likelihood of exercise. This finding is typical of observational studies where pain may represent a very immediate and compelling barrier to greater activity. At the same time, structured exercise programs have been a cornerstone of effective chronic pain treatment. Greater BMI was also associated with a greater likelihood of physical activity. Although somewhat surprising, other studies have also found a positive relationship between BMI and exercise. One potential explanation for this
result may be that increased BMI serves as an impetus for exercise, and at least 1 study has documented that higher BMI is associated with greater exercise intentions. In any case, further investigation of the relationship between BMI and exercise in MS is warranted.

Exercise and Physical and Mental Functioning

Consistent with a well established body of evidence, the presence of exercise was associated with better physical functioning across multiple life domains such as dressing and walking. For people with MS, exercise may enhance physical functioning by improving speed, endurance, strength, balance, and aerobic capacity. In this cross-sectional and observational study, however, it seems equally likely that reduced functioning may have served as a barrier to exercise.

Of greater interest in this study was the association between exercise and mental functioning as defined by the Mental Health scale of the VR-36. Items on this well established scale largely reflect symptoms of depression and anxiety, and the measure can be readily conceptualized as an indication of overall emotional distress. Consistent with several recent studies, people who endorsed some exercise reported better mental health even after controlling for demographic factors and medical comorbidities. The strength of this association, however, was modest, accounting for only 1% of the unique variance in mental health outcome, although the model proposed in this study provided a very conservative test because of the number of covariates.

There are many possible reasons exercise might be linked to lower levels of emotional distress. In addition to direct physiologic impacts, exercise may reduce barriers and increase access to pleasant events and reinforcing activities. This process, a component of cognitive behavioral therapies often referred to as behavioral activation in the psychotherapy literature, has been shown to have substantial positive impact on depression in and of itself, even without the cognitive components of the intervention. The behavioral activation hypothesis is further bolstered by the findings in this study relating to participation (described in the next paragraph), because exercise is shown to be related to better social functioning and role functioning (the achievement of life goals in the face of limitations). Each of these things may be viewed as access to reinforcers. Nonetheless, despite the theoretical coherence of our present findings, as with physical functioning, the direction of causality in this relationship remains unknown, and it remains plausible that positive mood states simply improve willingness and ability to exercise.

Exercise and Participation Restriction

The primary aim of our study was to examine the relationship between exercise and participation restriction as conceptualized by the ICF and operationalized by 3 scales of the VR-36. These scales measured social functioning as well as 2 separate measurements of role functioning (engagement in life despite physical and emotional limitations). Results uniformly supported our hypothesis that exercise would be associated with greater participation. Exercise concurrently predicted participation even after controlling for demographics, medical comorbidities, and both physical and mental health. Although the magnitude of effect was again modest (accounting for between 1% to 3% of variances), the finding was consistent across all 3 participation measures, and as previously mentioned, the test of association was extremely conservative. Furthermore, in several instances, exercise moderated the relationship between functioning and participation. People with higher levels of physical functioning had fewer participation restrictions related to health, but this relationship was even stronger for people who exercised. Similarly, people reporting better mental health reported better social functioning as well, but again this relationship was stronger for people who exercised. Overall, results provide additional evidence of an important link between exercise and participation in a literature with few and often contradictory findings.

Strengths, Limitations, and Future Directions

Several limitations of the current study are worthy of note. First, study data were obtained from available information created by the linkage of 2 large national VA databases. The survey response rate was 64%, and respondents tended to be older and, to a lesser degree, disproportionately nonwhite. Results also may not generalize to people with MS who are not veterans and do not receive care in the VA health care system. Information on MS-specific measures of disability, such as the Expanded Disability Status Scale, was not available in this dataset, nor were variables measuring environmental contributions to QOL.

As previously noted, data were cross-sectional, and the study design did not provide a mechanism for testing causal relationships among exercise and QOL variables. All information on exercise was obtained from a single question contained in a mailed survey and may be subject to biases associated with self-report. The particular exercise item used in this study, “How often do you engage in regular activities long enough to work up a sweat?” was taken from the landmark Physicians’ Health Study and has generated significant debate about its strengths and weaknesses, the latter including the fact that sweating may be temperature-dependent and therefore season-dependent, and also the recognition that it is possible to engage in sustained and meaningful physical activity that has health benefits without reaching an intensity level producing substantial sweating. Nonetheless, our findings do provide a complement to the existing literature, which has been largely limited to small clinical trials of exercise interventions. Results are based on a large national sample representative of the age, sex, and race of all known people with MS in the VA health care system, and provide the first national snapshot of exercise rates and associations with activity and participation among people with MS. Additionally, because MS is more prevalent among women, most large-scale studies to date have had predominantly female samples. Our study provides data on a very large sample of men with MS.

Future survey studies would benefit from elaboration on exercise practices, including duration, intensity, and type (ie, activity focused on strength, endurance, balance) and better quantification of other strenuous physical activity. We provide an additional plea, articulated by Sutherland and Andersen among many others, that future exercise trials, even when focused primarily on impairment as a primary outcome (eg, leg weakness), include other measures of activity limitation and participation restriction to assess better the impact on QOL.

CONCLUSIONS

Despite well known health benefits, exercise among veterans with MS is uncommon, with less than one third endorsing any regular exercise in the past year. People who exercised reported greater QOL in addition to better physical and mental health. Discussion of physical activity should be integrated into ongoing chronic illness care and programs designed to promote self-management of MS, with specific emphasis on potential barriers to exercise including older age, lower education, and pain.
References


