The association of alcohol consumption and smoking with quality of life, disability and disease activity in an international sample of people with multiple sclerosis

Tracey J. Weiland [a,b,*], Emily J. Hadgkiss [a], George A. Jelinek [a,c], Naresh G. Pereira [d], Claudia H. Marck [a], Dania M. van der Meer [a]

[a] Emergency Practice Innovation Centre, St Vincent's Hospital, Melbourne, Victoria, Australia
[b] Department of Medicine, The University of Melbourne (St Vincent's Hospital), Melbourne, Victoria, Australia
[c] Department of Epidemiology and Preventive Medicine, Monash University, Melbourne, Victoria, Australia
[d] Faculty of Medicine, Notre Dame University, Fremantle, Western Australia, Australia

ARTICLE INFO

ABSTRACT

Background: Modifiable lifestyle factors represent important targets for preventive intervention in multiple sclerosis (MS). We aimed to explore the association of cigarette smoking and alcohol consumption with major MS morbidity outcomes.
Methods: We surveyed a large, international sample of people with MS recruited via Web 2.0 platforms about type of MS, relapse rates, disability, disease activity, health-related quality of life (HRQOL), alcohol use and smoking.
Results: Of 2469 respondents with confirmed MS, 11.7% were current and 40.3% former smokers. Most (61.5%) consumed less than 15 g alcohol weekly; few (0.8%) drank large amounts. Moderate alcohol consumption was associated with increased HRQOL; and after controlling for age and gender, was associated with lower odds of significant disability (41% decrease). After controlling for age, gender and alcohol use, smokers had an increased likelihood of major mobility requirements by 90% compared to never smokers. There was no association between alcohol or smoking and relapse rate or disease activity after controlling for age and gender, however among former smokers, a longer duration of smoking cessation was associated with reduced disease activity. Smokers had significantly lower HRQOL than never smokers and former smokers; heavier smoking was associated with greater decreases in HRQOL.
Conclusion: This cross-sectional study supports previous research showing a link between morbidity indicators in MS and alcohol use and smoking. While people with MS should be advised of the potential risks of smoking, any risks and benefits of alcohol consumption require validation using a prospective cohort of people with MS.

© 2013 Published by Elsevier B.V.

1. Introduction

Multiple sclerosis (MS) is a chronic inflammatory disease of the central nervous system with an incidence of 3.6 cases per 100,000 people in women and 2.0 in men [1], although this varies greatly geographically. The precise aetiology is unknown, but is understood to be influenced by genetic and particularly environmental factors including modifiable lifestyle factors [2].

It appears that people with MS are likely to engage in adverse health behaviours with high smoking rates, obesity, and poor physical activity, similar to the general population of developed countries [3]. However the degree to which such behaviour affects the risk of developing MS,

its course, and associated health outcomes, has only recently received attention.

Lifestyle behaviours such as cigarette smoking and hazardous alcohol use have been linked to an escape–avoidance coping response [4,5]. This coping style has been suggested to be maladaptive to active engagement with one's health and disease management [6], and may, as a result, be associated with poorer disease outcomes or increased co-morbidities [7]. A large body of evidence has been accumulated suggesting a link between smoking and incidence of MS [8,9]. A meta-analysis of six studies revealed increased odds of developing MS of up to 1.51 for those smoking prior to disease onset [10]. Some studies also suggest a role for smoking in disease progression as indicated by standard disability measures and MRI [11–13].

Studies examining the association between alcohol and MS risk or morbidity indicators are fewer in number and less consistent in findings than those for smoking. Studies of drinking habits and the development of MS reveal mixed findings [14–16]. A US survey has shown a dose

response association for alcohol use and lower disability scores in people with relapsing–remitting MS and progressive MS [17]. More recently, alcohol consumption was shown to be inversely associated with increased disease progression among those with relapsing onset MS [18]. The duration of moderate alcohol consumption has been linked to disability and MRI changes (normalized lateral ventricular volume and normalized grey matter volume), with reduced disability among those consuming alcohol for 15 years or less and greater disability among non-drinkers or longer-term drinkers [19]. Interestingly, moderate alcohol consumption has recently been shown in a meta-analysis to be protective against the development of another autoimmune disease, rheumatoid arthritis [20].

With notable exceptions [21,22], health related quality of life (HRQOL) has consistently been measured to be lower among those with MS [23,24]. For people with MS, HRQOL is thought to be affected by a complex interplay between physical, psychological and social factors, rather than by disability alone [25]. Whether alcohol or cigarette use moderates these effects, however is unknown.

We sought to examine the patterns of alcohol use and smoking in a large, international population of people with MS, and to describe the association of these behaviours with a broad range of outcomes including disability, health-related quality of life, and, for people with relapsing–remitting MS, relapse rates and disease activity.

2. Method

2.1. Participants

The study methodology and participant demographics have been detailed previously [26]. To summarise, participants were recruited through Web 2.0 platforms, including social media, through which an online survey was distributed. The web-based tool, SurveyMonkey®, was used to present participants with both a participant information sheet, and for consenting participants, the survey itself. Those eligible for this cross-sectional study included adults diagnosed with MS by a physician. Respondents were excluded if they were under 18 years of age or were unsure of the diagnosis of MS.

2.2. Data collection and tools used

The survey was comprehensive, consisting of 163 questions in total, and took approximately 40 min to complete, with the ability to suspend and re-enter the survey if required. The survey where possible used validated tools that had sound psychometric properties and had been tested in a similar population. The survey collected demographic data and self-reported data for disease profile, medications and supplements, and lifestyle factors. The latter included information on the frequency of alcohol use, and the amount normally consumed on a day when alcohol was consumed (in standard drinks). We advised participants that a standard drink was considered to be one glass of full strength beer (285 ml); two 285 ml glasses of low strength beer; one glass of wine (100 ml); or a 30 ml nip or equivalent of mixed spirits. Each of these is equivalent to 10 g of ethanol. Participants were asked to specify their alcohol intake based on this definition. Data for frequency of alcohol use were collected on an 11-point ordinal scale ('never drink' to 'drink daily'), collapsed to a five point scale (non-drinker, rarely, <1/week, 1 day/week to 3 days/week, 4 days/week to daily). Data for volume of alcohol use were collected on an 11 point scale ('not applicable' to '10 + standard drinks per day'). Data for the frequency and volume (standard drinks) of alcohol consumed were used to derive the variables for alcohol level and binge drinking.

Data were subsequently re-calculated in grammes of ethanol to permit comparison with alternate definitions of a standard drink. Internationally standardised definitions for binge drinking, and guidelines for daily or weekly consumption are lacking. Therefore, we adopted definitions based on median cut-off values for daily alcohol intake specified in guidelines in various countries [27].

A low level of consumption was defined as <15 g/week; participants that specified a frequency of alcohol use of never, rarely or less than once a week were assumed to have a low level of alcohol use. For those not meeting this definition and providing sufficient data on both frequency and volume of consumption, consumption was calculated as either moderate or high. Moderate consumption was considered an average daily intake of 15–210 g/week (or up to 30 g/day) for women and 15–315 g/week (or up to 45 g/day) for men; high was deemed >210 g/week (or >30 g/day) for women and >315 g/week (or >45 g/day) for men [27]. Binge drinking was defined as consuming >75 g/day on any one occasion or a calculated average intake of >75 g/day. Participants who provided data for frequency of alcohol use but failed to specify a volume were excluded from analyses for binge drinking.

Participants were also asked if they were a current smoker, former smoker or never smoker of any tobacco products; the frequency of smoking among former and current smokers (collected on a six-point scale: 'less than one per day' to '>20 per day'); and the time since quitting among former smokers collected on an eight-point ordinal scale ('less than 6 months ago' to '10 years or more ago'). Based on the distribution of responses, these data were collapsed to form a three-point scale (<12 months; 12 months to <10 years; 10 years or more), and amount per day was subsequently combined with data for smoking status and collapsed into three groups (never-smoker; <1–15 per day; 16 + per day).

For all participants, we explored the number of self-reported doctor-diagnosed relapses over the previous 12 months. We then derived the pre-determined variable "disease activity": when specialist-determined relapse rate in the preceding 12 months exceeded the 5 year annualised relapse rate, disease activity was categorised as increasing; when relapse rate for the preceding 12 month was lower than the five year annualised rate, disease activity was categorised as decreasing; and when 12 month relapse rate was the same as the 5 year annualised rate, disease activity was categorised as stable. For this variable, five year annualised relapse rates were calculated by dividing the number of doctor diagnosed relapses over five years by the number of years of disease with an upper limit of five.

Health-related quality of life was assessed using the Multiple Sclerosis Quality Of Life (MSQOL-54), a measure of health related quality of life (HRQOL) developed from the RAND 36-Item Health Survey (SF-36) and supplemented with 18 additional items. It comprises 52 items distributed across 12 scales, giving rise to physical and mental health composites, and two single items and has been extensively validated [28–30].

Level of disability was assessed using the Patient-Determined Disease Steps (PDDS) [31], a self-reported tool which can be used as a surrogate tool for the Expanded Disability Status Scale (EDSS) commonly used to assess gait disability. It is scored on an ordinal scale from 0 (normal) to 8 (bed bound) and correlates strongly with the EDSS (Spearman Rank r = 0.64) and moderately with the Multiple Sclerosis Functional Composite (Spearman Rank r = 0.58), with excellent concordance between raters (kappa 0.8). The PDDS has been used in several studies of people with MS [32–34]. For analyses the PDDS was collapsed from nine to three categories (normal, mild disability, moderate disability = "normal/some disability"; gait disturbance, cane, late cane = "gait/cane disability"; bilateral support, wheelchair, and bedridden = "major mobility support").

Ethics approval was granted by St Vincent's Hospital Melbourne Human Research Ethics Committee (LRR 055/12).

2.3. Data analysis

Data were analysed using IBM SPSS Statistics 20.0 (IBM Corporation). We undertook univariate and multivariate analyses. Continuous data

were summarised using mean (95% CI) and categorical data using number and percentage. Comparisons between two groups on continuous endpoints were undertaken using independent samples t-test, and comparisons involving three or more independent groups were undertaken using analysis of variance (ANOVA) with Least Significant Difference as post-hoc analyses. For categorical data involving two by two contingency tables, data were analysed using Fisher's Exact Test and for categorical data involving more than two groups, Pearson's chi square was used with adjusted standardised residuals used to indicate under- or over-representation of groups.

Given the large number of associations found in univariate analyses, multivariate analyses were undertaken to identify independent predictors of each outcome (disability, HRQOL, relapse rate, disease activity). In all instances, variables included in regression models were age, gender, level of alcohol use (low, moderate, high), and smoking status (never, current, former). When significant associations were found for former or current smokers, further regression models were constructed to assess the predictive effects of number of cigarettes smoked per day (for current smokers) or time since quitting and number previously smoked (for former smokers). The most parsimonious models were selected for reporting.

For disability ('normal/some disability', 'gait/cane disability', 'major mobility support') ordinal logistic regression was undertaken after first checking that the proportional odds assumption was not violated.

Multiple regression (enter method) was used to identify predictors of HRQOL domains of overall HRQOL, physical health composite, mental health composite, pain subdomain, and energy subdomain. Preliminary tests were undertaken to ensure that data satisfied the assumptions of normality, linearity, and homoscedasticity. Variance inflation factor <7 was used as the criterion for absence of multicollinearity. Correlation matrices were also checked for inter-correlated predictors; only correlations of <.70 were accepted. Data were checked for standardised residual values outside the range of −3.3 to 3.3 to ensure no outliers.

Data for 12 month doctor diagnosed relapse rate among those with relapsing–remitting MS were over-dispersed. Consequently negative binomial logistic regression was used in preference to Poisson regression.

For disease activity (decreasing/stable versus increasing), binary logistic regression (enter method) was used to ascertain the odds ratios of the predictors. Preliminary tests of the assumptions of logistic regression were performed, including an examination of multicollinearity to ensure that continuous independent variables were not closely correlated (being a bivariate correlation >0.70).

For all inferential tests, two-tailed tests of significance were used and the criterion for significance was set at .05. All percentages reported were adjusted for missing data on an item by item basis.

3. Results

3.1. Participation, alcohol use and tobacco use

Respondent demographics and clinical characteristics have been described in detail previously [26]. Approximately one third of participants were located in the United States of America (USA), approximately one quarter were located in Australia, and approximately one sixth of participants were based in the United Kingdom. The remaining participants were located in 54 other countries or territories [26].

Of 2469 respondents with a confirmed diagnosis of MS, up to 2286 (92.6%) answered questions regarding alcohol use, and up to 2290 (92.8%) responded to questions about smoking (Table 1). Of the 1493 with relapsing–remitting MS, up to 1398 (93.6%) responded to questions regarding alcohol and up to 1400 (93.8%) responded to questions about smoking.

The majority of respondents who drank alcohol reported consuming alcohol less than once a week, and most were categorised as having low consumption based on our definition (Table 1). Fewer than 1% of all

Table 1
Alcohol use by study participants and the subgroup with relapsing–remitting MS. Data are number (%).

	Whole sample	Relapsing–remitting
Alcohol		
Frequency of alcohol use		
Non-drinker	415/2286 (18.2)	215/1398 (15.4)
Drinks rarely	583/2286 (25.5)	370/1398 (26.5)
Less than once per week	318/2286 (13.9)	208/1398 (14.9)
1 day/week to 3 days/week	566/2286 (24.8)	368/1398 (26.3)
4 days/week to everyday	404/2286 (17.7)	237/1398 (17.0)
Level of alcohol use		
Low (<15 g/week)[b]	1398/2275 (61.5)	838/1391 (60.2)
Moderate (up to 30 g/day for women and up to 45 g/day for men)	858/2275 (37.7)	542/1391 (39.0)
High (>30 g/day for women and >45 g/day for men)	19/2275 (0.8)	11/1391 (0.8)
Binge drinkers[c]		
Binge drinker	20/2264 (0.9)	15/1391 (1.1)
Non-binge drinker	2244/2264 (99.1)	1376/1391 (98.9)
Smoking		
Smoking status		
Never smoked	1099/2290 (48.0)	703/1400 (50.2)
Former smoker	923/2290 (40.3)	551/1400 (39.4)
Current smoker	268/2290 (11.7)	146/1400 (10.4)
Number of cigarettes smoked per day currently		
None	2022/2288 (88.4)	1254/1399 (89.6)
<1 to 15	182/2288 (8.0)	107/1399 (7.6)
16+	84/2288 (3.7)	38/1399 (2.7)
Time since quitting[a]		
<12 months	95/915 (10.4)	59/547 (10.8)
1 year to <10 years	366/915 (40.0)	250/547 (45.7)
10 years+	454/915 (49.6)	238/547 (43.5)
Number of cigarettes previously smoked per day[a]		
<1 to 15	448/652 (68.7)	273/388 (70.4)
16+	204/652 (31.3)	115/388 (29.6)

[a] Former smokers only.
[b] Includes respondents that specified a drinking frequency of <once a week or below and did not provide a quantity.
[c] >75 g/day on any one occasion or a calculated average intake of more than 75 g/day. Calculated only for those that specified a quantity.

participants engaged in binge drinking, and similarly fewer than 1% consumed high levels of alcohol adjusted for gender. Approximately 12% of respondents were current smokers and just over 40% had smoked previously (Table 1).

Among the five modal countries of respondents, there was a trend for smokers to be over-represented among those located in the USA, and under-represented for those in Australia (Table 2). Low alcohol use was common among those in Canada and USA, and less common among those in New Zealand or United Kingdom. Moderate alcohol use tended to be higher among those in New Zealand or United Kingdom, and lower among those in the USA.

3.2. Disability

Level of disability was significantly associated with level of alcohol use; those with moderate alcohol use were more likely to have normal ability or some disability and those with a low level of consumption were more likely to require major mobility support (Table 3). Smoking status, amount smoked and time since quitting were also significantly associated with level of disability. Never-smokers were more likely to have a normal ability or some disability, current smokers were more likely to have gait or cane disability, and the likelihood of this increased with amount smoked per day. Those who had quit 10 or more years ago were more likely to be requiring major mobility support. Our sample of binge drinkers was too small to adequately assess any association with level of disability.

Table 2
Alcohol use and smoking status for respondents from the five modal locations (countries). Data are number (%).

Location (country) of birth	Alcohol use			Smoker (n, %)
	Low	Moderate	High	
United States	531 (69.2)	234 (30.5)	2 (0.3)	109 (14.1)
Australia	345 (58.7)	236 (40.1)	7 (1.2)	48 (8.1)
United Kingdom	208 (51.1)	192 (47.2)	7 (1.7)	50 (12.2)
New Zealand	97 (46.0)	113 (53.6)	1 (0.5)	20 (9.4)
Canada	76 (69.7)	33 (30.3)	0 (0)	12 (11.0)

No inferential analyses performed due to violations of the assumptions of chi square.

After controlling for gender and age which was a significant covariate (OR = 1.085, 95% CI 1.075–1.095, p < .001), being a current smoker increased the odds of requiring major mobility support (bilateral support, wheelchair, or bedridden) almost two fold (OR = 1.903, 95% CI 1.444–2.509, p < .001) compared with never-smokers, while being a former smoker was associated with increased odds of 1.24 (95% CI 1.030–1.494, p = .023) compared to those who had never smoked. Engaging in moderate alcohol consumption compared to low or no alcohol consumption was associated with reduced odds of increased disability (OR = 0.589, 95% CI 0.490–0.708, p < .001). Among former smokers only, neither time since smoking cessation nor amount previously smoked was significantly associated with level of disability. For this group, moderate alcohol use reduced the odds of requiring major mobility support by almost half (OR = 0.595, 95% CI 0.430–0.825, p < .001).

3.3. Quality of life

Quality of life was significantly better, in its various domains (emotional wellbeing and overall quality of life subscale, and physical and mental health composite scores) for those who consumed moderate levels of alcohol compared to those with low consumption (Fig. 1).

Although their numbers were small, participants who engaged in levels of alcohol use considered to be binge drinking had significantly lower levels of mental health-related quality of life (binge drinker: mean: 54.67, 95% CI, 43.9–65.3; non-binge drinker: mean: 66.96, 66.1–67.9, p = .027). Findings for overall quality of life, physical health related quality of life and emotional wellbeing were not significant.

For all domains of quality of life explored, never-smokers had significantly better quality of life compared to former smokers and current smokers, and former smokers had significantly better quality of life when compared against current smokers (Fig. 2).

Compared with those that currently smoked 1–15 or 16 + cigarettes a day, non-smokers (both former and never smokers) had significantly higher levels of quality of life across all components examined (Fig. 3). There was no significant difference in post-hoc tests between those smoking 1–15 or 16 or more cigarettes per day.

While time since smoking cessation had no significant bearing on overall quality of life and the physical health composite, a greater number of years since cessation were significantly associated with quality of life on the mental health composite and emotional wellbeing subscale (Fig. 4).
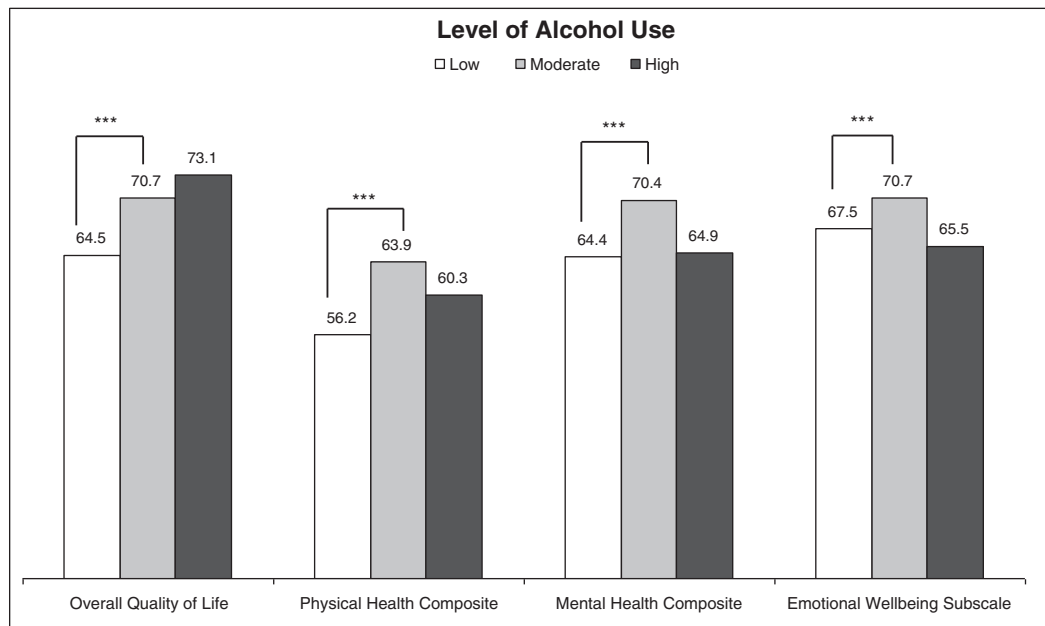
Multiple regression analyses revealed significant models for mental health composite (p < .001), physical health composite (p < .001), emotional wellbeing subscale (p < .001) and overall HRQOL (p < .001). Significant predictors and covariates for each outcome are presented in Table 4. Moderate alcohol use conferred a benefit across all domains explored after accounting for age and gender, while being a former smoker or currently smoking either 1–15 or 16 + cigarettes daily was generally associated with worse HRQOL.

3.4. Relapse rates and disease activity

No significant differences in 12 month self-reported doctor-diagnosed relapse rates or disease activity were found according to, level of alcohol use, smoking status, amount currently smoked, and time since smoking cessation in univariate analyses (data not shown).

Negative binomial regression was used to model predictors of 12 month doctor-diagnosed relapse rate among those with relapsing remitting MS. For each increasing year of age the number of relapses in a 12 month period decreased by 3% (estimate = .973, 95% CI 0.964–0.82, p < .001). Males had a 24% relapse rate reduction (estimate = 0.756, 95% CI 0.587–0.974, p = .031) compared to females. After controlling for age and gender, neither level of alcohol use, smoking status, nor amount smoked were significant predictors of 12 month relapse rate.

For females, the odds of having increasing disease activity increased by nearly 70% (OR 1.692, 95% CI 1.168–2.451, p = .005), but there was no significant effect for age. After controlling for age and gender, there

Table 3
Relationship between alcohol and cigarette use and level of disability among study participants. Data are number (%).

	Normal ability to some disability	Gait/cane disability	Major mobility support	p[a]
Level of alcohol use				p < .001
Low	726 (52.3)[b]	487 (35.1)	**176 (12.7)**[a]	
Moderate	**510 (59.5)**[a]	288 (33.6)	59 (6.9)[b]	
High	13 (68.4)	4 (21.1)	2 (10.5)	
Total	1249 (55.1)	779 (34.4)	237 (10.5)	
Smoking status				p < .001
Current smoker	116 (43.8)[b]	**123 (46.4)**[a]	26 (9.8)	
Former smoker	482 (52.4)[b]	331 (36.0)	106 (11.5)	
Never-smoker	**658 (60.1)**[a]	329 (30.1)[b]	107 (9.8)	
Total	1256 (55.1)	783 (34.4)	239 (10.5)	
Amount smoked currently per day				p < .001
None	**1140 (56.6)**[a]	660 (32.8)[b]	213 (10.6)	
<1–15	86 (47.8)[b]	**80 (44.4)**[a]	14 (7.8)	
16+	28 (33.7)[b]	**43 (51.8)**[a]	12 (14.5)	
Total	1254 (56.1)	744 (33.3)	239 (10.7)	
Time since quitting				p < .001
<12 months	56 (58.9)	33 (34.7)	6 (6.3)	
1 year to <10 years	**217 (59.6)**[a]	117 (32.1)	30 (8.2)[b]	
10 years+	206 (45.6)[b]	177 (39.2)	**69 (15.3)**[a]	
Total	479 (52.6)	327 (35.9)	105 (11.5)	

The bold indicates that the data were over or under-represented according to the adjusted standardised residual when the critical value is set at 2.0. This is the equivalent of saying that there was a difference with p<.05 but no greater precision than that can be determined.

[a] Over-represented according to adjusted standardised residuals.
[b] Under-represented according to adjusted standardised residuals.

Groupwise comparisons: all P<.001
Pairwise comparisons: *** p <.001; All other comparisons NS.

**Fig. 1.** Relationship between level of alcohol use and mean health-related quality of life.

was no significant effect of level of alcohol use, smoking status, nor amount smoked on disease activity.

Among those with relapsing remitting MS who were former smokers (n = 350), age and gender exerted no significant effect on increasing disease activity. The odds of increased disease activity were however substantially reduced for those that had ceased smoking more than 10 years ago (OR 0.465, 95% CI 0.219–0.987, p = .046) and 1–10 years ago (OR 0.490, 95% CI 0.243–0.990, p = .047) compared against those that quit smoking in the previous 12 months.

4. Discussion

4.1. Main findings

Our data, from a large international cross-section of people with MS, provide strong evidence of an association between cigarette smoking and poorer health outcomes in terms of disability and HRQOL. This is consistent with other findings showing deleterious effects of smoking on MS disease risk [8–10] and progression [11–13]. In contrast, our
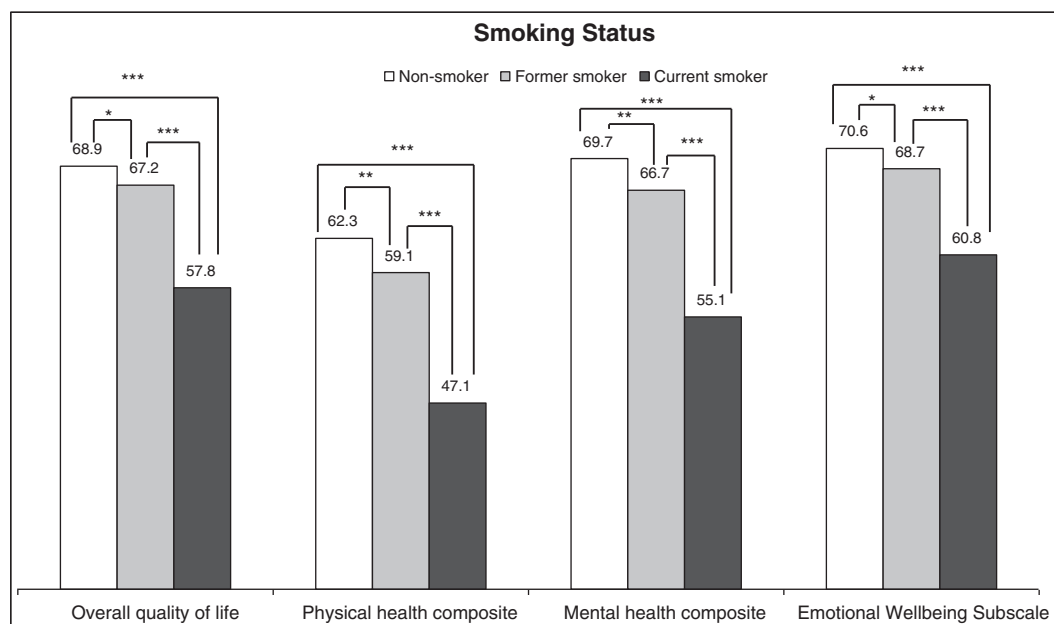
Groupwise comparisons: all P<.001
Pairwise comparisons: *** p <.001; **p<.01; *p=<0.05;

**Fig. 2.** Relationship between smoking status and mean health-related quality of life.
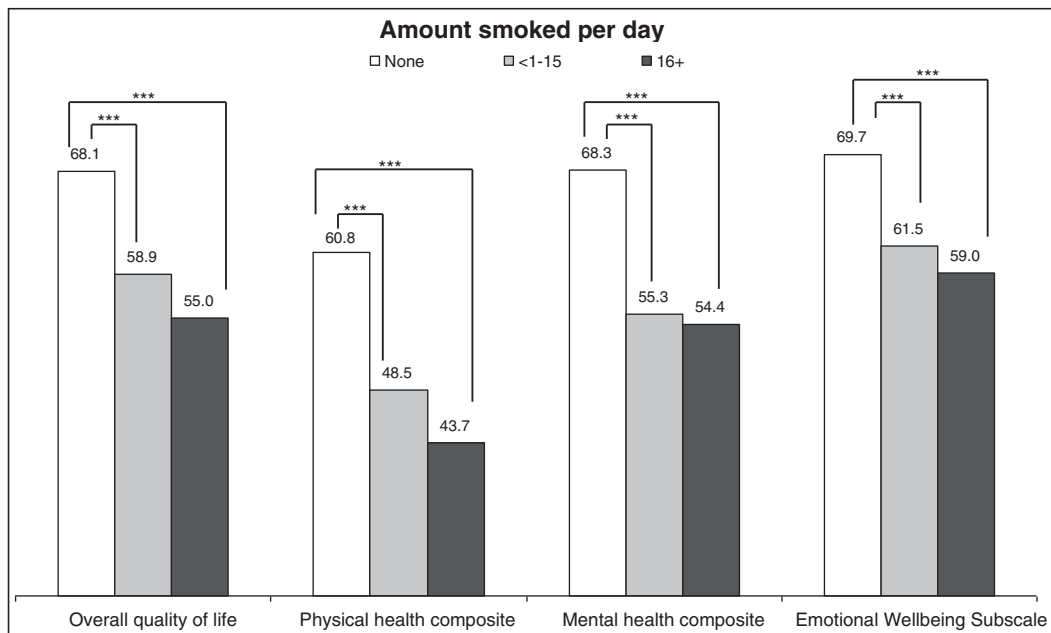
Groupwise comparisons: all P<.001
Pairwise comparisons: *** p <.001; all other comparisons NS.

Fig. 3. Mean health-related quality of life according to amount currently smoked per day.

results showed a marked association between moderate alcohol consumption and positive outcomes in terms of a lower level of disability and better HRQOL (overall quality of life domain, emotional wellbeing domain, and physical and mental health composites) compared to low alcohol intake. This is congruent with the previously reported benefits of moderate alcohol use in other chronic diseases [35–37]. The strong consistency between our data and previously reported associations of smoking and alcohol consumption suggests significant external validity of our data, despite the data all being gathered from self-report.

While most participants in our sample consumed low amounts of alcohol, less than forty percent were moderate drinkers. Similar patterns of alcohol use and smoking were observed for the whole sample and the subgroup of participants with relapsing–remitting MS. Consistent with the findings of others [7], 43% of our sample consumed alcohol at least once a week. Binge drinking, defined in this study as >75 g/day on any one occasion or a calculated average intake of more than 75 g/day, was infrequent, occurring in less than 1% of the total sample and the subgroup of participants with relapsing remitting MS. Similarly, high
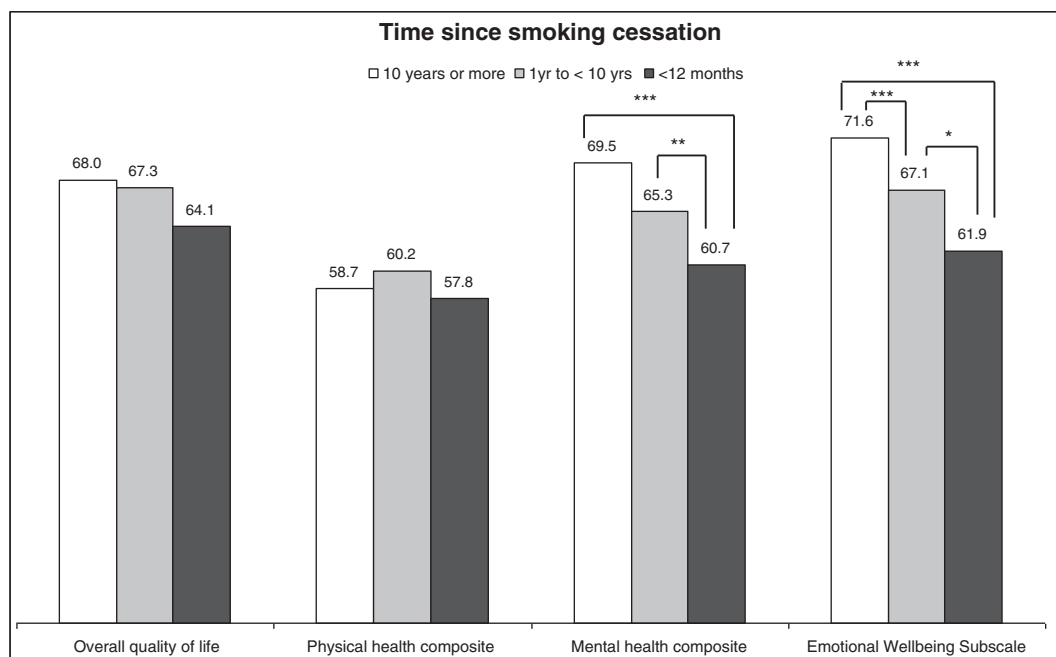
Groupwise comparisons: P<.001; Mental Health Composite and Emotional Wellbeing Scale only.
Pairwise comparisons: *** p≤.001; **p<.01; *p<.05

Fig. 4. Mean quality of life according to time since smoking cessation.

Table 4
Significant predictors and covariates for components of HRQOL.

Outcome	Variable	Adjusted R^2	Beta	SE	p
Mental health composite	Age	.062	.109	.043	.012
	Moderate alcohol consumption		5.823	.945	<.001
	Former smoker		−3.897	.975	<.001
	Currently smoke <1–15 cigarettes/day		−14.086	1.717	<.001
	Currently smoke 16+ cigarettes/day		−15.332	2.453	<.001
Physical health composite	Age	.128	−0.457	.046	<.001
	Moderate alcohol consumption		8.175	.970	<.001
	Former smoker		−3.621	1.008	<.001
	Currently smoke <1–15 cigarettes/day		−15.281	1.749	<.001
	Currently smoke 16+ cigarettes/day		−18.230	2.607	<.001
Emotional wellbeing	Age	.052	.255	.037	<.001
	Moderate alcohol consumption		2.782	.814	.001
	Former smoker		−3.015	.839	<.001
	Currently smoke <1–15 cigarettes/day		−8.554	1.494	<.001
	Currently smoke 16+ cigarettes/day		−12.216	2.104	<.001
Overall HRQOL	Age	.071	−.196	.038	<.001
	Gender, male		−2.751	1.062	.010
	High alcohol consumption		11.874	4.394	.007
	Moderate alcohol consumption		6.546	.832	<.001
	Former smoker		−2.292	.858	.008
	Currently smoke <1–15 cigarettes/day		−10.402	1.521	<.001
	Currently smoke 16+ cigarettes/day		−13.475	2.166	<.001

alcohol use occurred in less than 1% of participants. These findings are in stark contrast to the up to 14% abusing alcohol in a North American sample of people with MS [38], and may reflect the more educated, health-seeking characteristics of our cohort [26]. While more than half of our sample were former or current smokers, remarkably approximately 10% indicated having quit in the preceding 12 months. Close to 12% of our sample were current smokers; this is considerably less than around 20% found by others [7], again probably reflecting our more educated, pro-active sample.

Compared to those with low alcohol consumption, participants reporting a moderate level of consumption had better HRQOL in all domains explored (overall quality of life domain, emotional wellbeing, physical and mental health composites). While moderate alcohol consumption was typically associated with better outcomes in terms of HRQOL, low alcohol use was associated with a need for major mobility support. By contrast moderate alcohol use was associated with a lower level of disability both on univariate and on multivariate analyses. The apparent benefits of moderate alcohol use did not, however, extend to relapse rate and disease activity. It has previously been suggested that moderate alcohol use may have a neuro-protective effect against MS [17,39]. In contrast to the findings for moderate alcohol use, the small number of binge drinkers had worse outcomes than others on the mental health composite. Reduced HRQOL, including mental health, for high intensity binge drinkers has also been documented for those without MS [40]. The small number of binge drinkers in our sample did not enable us to explore associations with outcomes to a satisfactory level of power and precision. A more comprehensive analysis of the association between binge drinking and health outcomes in people with MS, however, is warranted using a larger sample.

A "U-shaped" pattern of association between alcohol use and health outcomes has been observed previously for disability and duration of alcohol use among patients with MS [19]. This is in parallel to the pattern observed for alcohol use and its dose–response association with mortality [41], stroke risk and cardiovascular disease [35–37]. Indeed a moderate level of drinking of 15–45 g per day is thought to be protective against high cholesterol [42] and risk of neurodegenerative disease [41]. It has also been suggested to be protective against coronary heart disease [35,37], however this has been strongly debated and alcohol consumption is not, to our knowledge, endorsed as a healthy lifestyle behaviour by reputable health organisations. The mechanism by which moderate alcohol consumption could be protective for chronic diseases generally, and MS specifically is unclear. A reduction in

systemic inflammation has been observed with moderate use of alcohol [43], suggesting a positive impact on immune function [18,43].

Never smokers had higher levels of HRQOL (overall, physical health, mental health composite and emotional wellbeing) than former smokers or current smokers, while former smokers had greater levels of HRQOL than current smokers. This is not dissimilar from findings for the general population; in a large Finnish study (n = 8028), daily smokers had significantly lower HRQOL than those who had never smoked [44], and the HRQOL of former smokers approached that of never smokers. While significant differences between former and never smokers were observed in our study, the magnitude of difference was small and the pattern toward improved HRQOL was consistent with that observed for the general population [44] and in people with MS that have recently quit smoking [45].

Smoking was associated with markedly increased morbidity in MS, with a higher likelihood of gait or cane disability (on univariate analyses). While smoking status did not affect relapse rate or disease activity, among former smokers a greater time since cessation was associated with a lower level of disease activity. Experimental data point to possible neurotoxic or immuno-modulatory effects of smoking [46,47]. Further investigations of the underlying effects of smoking and smoking cessation in people with MS are required to better understand this association.

4.2. Study strengths and limitations

Our sample comprised a large, geographically diverse population predominantly of Western, English-speaking countries. This together with the fact that our sample included people with all types of MS, suggests that our data may be generalised to people with MS internationally. Data collected for this study were self-reported, hence there may have been inaccuracies due to recall difficulties in less frequent events such as relapse rates, or difficulties estimating the volume and frequency of alcohol intake, although as discussed, the congruence of our results with those of others investigating the area suggests the data collected were robust. There may be an increased likelihood of negative recall bias among those with poorer health status and we cannot exclude the possibility that this biased the results of our study. While the association of smoking and disease outcomes was analysed in this study, we did not seek data on time since smoking commencement or duration of average alcohol consumption, only frequency.

We cannot exclude the possibility of reverse causality, as people with MS who do not deteriorate may be more likely to persist with behaviour such as moderate alcohol use. Similarly, those whose mobility is preserved may be more likely to socialise and drink alcohol moderately. The progression toward disability may itself have an impact on lifestyle.

Given that survey completion was not anonymous it is possible that our sample was affected by participation bias; people that consume high levels of alcohol and heavy smokers may have been less likely to respond to the survey if they have a belief that these behaviours may be deleterious to health or socially undesirable.

4.3. Future research

Exploration of the possible mechanisms by which alcohol exerts its effects on morbidity indicators for MS is required. Given the potential effects of alcohol on immune function, consideration should be given to an observational study that explores immune parameters such as cytokines and eicosanoids among patients with MS with varying levels of alcohol consumption. Exploration of the effects of high alcohol use with a larger sample may be of value. Understanding the mechanisms by which smoking affects disability is also necessary, although the congruence of our data with other research suggests that there is sufficient research to make recommendations about smoking cessation for people with MS.

4.4. Conclusions

This study lends further support to a secondary and tertiary preventive approach to MS management; our data, in line with other research, suggest that disability level may be lower, and quality of life higher among non-smokers. Advising people with MS about the harmful effects of smoking is warranted as is further exploration of the effects of smoking cessation on MS morbidity indicators. Our preliminary findings for alcohol consumption provide no evidence of harm from moderate consumption. However, the potential risks and benefits associated with alcohol use at its various levels require careful prospective validation with a broader range of clinical endpoints before reliable clinical recommendations can be made.

Conflict of interest

We have no conflicts of interest to declare.

Acknowledgements

References

[1] Alonso A, Hernan MA. Temporal trends in the incidence of multiple sclerosis: a systematic review. Neurology Jul 8 2008;71(2):129–35 [Review].

[2] Ramagopalan SV, Dobson R, Meier UC, Giovannoni G. Multiple sclerosis: risk factors, prodromes, and potential causal pathways. Lancet Neurol Jul 2010;9(7):727–39. http://dx.doi.org/10.1016/S1474-4422(10)70094-6.

[3] Marrie R, Horwitz R, Cutter G, Tyry T, Campagnolo D, Vollmer T. High frequency of adverse health behaviors in multiple sclerosis. Mult Scler Jan 2009;15(1):105–13 [Research Support, N.I.H., Extramural].

[4] Bricker JB, Schiff L, Comstock BA. Does avoidant coping influence young adults' smoking?: a ten-year longitudinal study. Nicotine Tob Res Oct 2011;13(10):998–1002 [Research Support, N.I.H., Extramural].

[5] Cooper ML, Russell M, Skinner JB, Frone MR, Mudar P. Stress and alcohol use: moderating effects of gender, coping, and alcohol expectancies. J Abnorm Psychol Feb 1992;101(1):139–52 [Research Support, U.S. Gov't, P.H.S.].

[6] Folkman S, Moskowitz JT. Coping: pitfalls and promise. Annu Rev Psychol 2004;55:745–74 [Review].

[7] Brown RF, Valpiani EM, Tennant CC, Dunn SM, Sharrock M, Hodgkinson S, et al. Longitudinal assessment of anxiety, depression, and fatigue in people with multiple sclerosis. Psychol Psychother Mar 2009;82(Pt 1):41–56 [Research Support, Non-U.S. Gov't].

[8] Riise T, Nortvedt MW, Ascherio A. Smoking is a risk factor for multiple sclerosis. Neurology Oct 28 2003;61(8):1122–4.

[9] Hernan MA, Olek MJ, Ascherio A. Cigarette smoking and incidence of multiple sclerosis. Am J Epidemiol Jul 1 2001;154(1):69–74 [Research Support, U.S. Gov't, P.H.S.].

[10] Hawkes CH. Smoking is a risk factor for multiple sclerosis: a meta-analysis. Mult Scler Jun 2007;13(5):610–5 [Meta-Analysis].

[11] Healy BC, Ali EN, Guttmann CR, Chitnis T, Glanz BI, Buckle G, et al. Smoking and disease progression in multiple sclerosis. Arch Neurol Jul 2009;66(7):858–64 [Research Support, N.I.H., Extramural Research Support, Non-U.S. Gov't].

[12] Pittas F, Ponsonby AL, van der Mei IA, Taylor BV, Blizzard L, Groom P, et al. Smoking is associated with progressive disease course and increased progression in clinical disability in a prospective cohort of people with multiple sclerosis. J Neurol Apr 2009;256(4):577–85 [Research Support, Non-U.S. Gov't].

[13] Sundstrom P, Nystrom L. Smoking worsens the prognosis in multiple sclerosis. Mult Scler Sep 2008;14(8):1031–5 [Research Support, Non-U.S. Gov't].

[14] Nortvedt MW, Riise T, Maeland JG. Multiple sclerosis and lifestyle factors: the Hordaland Health Study. Neurol Sci Dec 2005;26(5):334–9 [Comparative Study].

[15] Ghadirian P, Jain M, Ducic S, Shatenstein B, Morisset R. Nutritional factors in the aetiology of multiple sclerosis: a case–control study in Montreal, Canada. Int J Epidemiol Oct 1998;27(5):845–52 [Research Support, Non-U.S. Gov't].

[16] Hawkes CH. Are multiple sclerosis patients risk-takers? QJM Dec 2005;98(12):895–911 [Review].

[17] Goodin DS. Survey of multiple sclerosis in northern California. Northern California MS Study Group. Mult Scler Apr 1999;5(2):78–88.

[18] D'Hooghe MB, Haentjens P, Nagels G, De Keyser J. Alcohol, coffee, fish, smoking and disease progression in multiple sclerosis. Eur J Neurol Apr 2012;19(4):616–24.

[19] Foster M, Zivadinov R, Weinstock-Guttman B, Tamano-Blanco M, Badgett D, Carl E, et al. Associations of moderate alcohol consumption with clinical and MRI measures in multiple sclerosis. J Neuroimmunol Feb 29 2012;243(1-2):61–8 [Research Support, N.I.H., Extramural Research Support, U.S. Gov't, Non-P.H.S.].

[20] Scott IC, Tan R, Stahl D, Steer S, Lewis CM, Cope AP. The protective effect of alcohol on developing rheumatoid arthritis: a systematic review and meta-analysis. Rheumatology (Oxford) May 2013;52(5):856–67.

[21] Hadgkiss EJ, Jelinek GA, Weiland TJ, Rumbold G, Mackinlay CA, Gutbrod S, et al. Health-related quality of life outcomes at 1 and 5 years after a residential retreat promoting lifestyle modification for people with multiple sclerosis. Neurol Sci Feb 2013;34(2):187–95 [Research Support, Non-U.S. Gov't].

[22] Li MP, Jelinek GA, Weiland TJ, Mackinlay CA, Dye S, Gawler I. Effect of a residential retreat promoting lifestyle modifications on health-related quality of life in people with multiple sclerosis. Qual Prim Care 2010;18(6):379–89 [Clinical Trial].

[23] Olascoaga J. Quality of life and multiple sclerosis. Rev Neurol Sep 1 2010;51(5):279–88 [Review].

[24] Schipper S, Wiesmeth S, Wirtz M, Twork S, Kugler J. Coping strategies and health-related quality of life in multiple sclerosis patients. Psychother Psychosom Med Psychol Aug 2011;61(8):347–55.

[25] Tadic D, Dajic V. Quality of life in patients with multiple sclerosis in Republic of Srpska. Med Glas Ljek komore Zenicko-doboj kantona Feb 2013;10(1):113–9.

[26] Hadgkiss EJ, Jelinek GA, Weiland TJ, Pereira NG, Marck CH, van der Meer DM. Methodology of an international study of people with multiple sclerosis recruited through Web 2.0 platforms: demographics, lifestyle, and disease characteristics. Neurol Res Int 2013;2013:12.

[27] Liang Y, Mente A, Yusuf S, Gao P, Sleight P, Zhu J, et al. Alcohol consumption and the risk of incident atrial fibrillation among people with cardiovascular disease. CMAJ Nov 6 2012;184(16):E857–66 [Comparative Study Research Support, Non-U.S. Gov't].

[28] Acquadro C, Lafortune L, Mear I. Quality of life in multiple sclerosis: translation in French Canadian of the MSQoL-54. Health Qual Life Outcomes 2003;1:70 [Research Support, Non-U.S. Gov't Validation Studies].

[29] Solari A, Filippini G, Mendozzi L, Ghezzi A, Cifani S, Barbieri E, et al. Validation of Italian multiple sclerosis quality of life 54 questionnaire. J Neurol Neurosurg Psychiatry Aug 1999;67(2):158–62 [Comparative Study Research Support, Non-U.S. Gov't].

[30] Yamamoto T, Ogata K, Katagishi M, Shimizu H, Ogawa M, Yamamura T, et al. Validation of the Japanese-translated version Multiple Sclerosis Quality of Life-54 instrument. Rinsho Shinkeigaku Jul 2004;44(7):417–21 [Research Support, Non-U.S. Gov't Validation Studies].

[31] Hohol MJ, Orav EJ, Weiner HL. Disease steps in multiple sclerosis: a simple approach to evaluate disease progression. Neurology Feb 1995;45(2):251–5.

[32] Marrie RA, Cutter G, Tyry T, Hadjimichael O, Campagnolo D, Vollmer T. Changes in the ascertainment of multiple sclerosis. Neurology Oct 11 2005;65(7):1066–70 [Research Support, Non-U.S. Gov't].

[33] Marrie RA, Cutter G, Tyry T, Vollmer T, Campagnolo D. Does multiple sclerosis-associated disability differ between races? Neurology Apr 25 2006;66(8):1235–40 [Comparative Study Research Support, N.I.H., Extramural Research Support, Non-U.S. Gov't].

[34] Hadjimichael O, Vollmer T, Oleen-Burkey M. Fatigue characteristics in multiple sclerosis: the North American Research Committee on Multiple Sclerosis (NARCOMS) survey. Health Qual Life Outcomes 2008;6:100 [Research Support, Non-U.S. Gov't].

[35] Arriola L, Martinez-Camblor P, Larranaga N, Basterretxea M, Amiano P, Moreno-Iribas C, et al. Alcohol intake and the risk of coronary heart disease in the Spanish EPIC cohort study. Heart Jan 2010;96(2):124–30 [Multicenter Study Research Support, Non-U.S. Gov't].

[36] Emberson JR, Bennett DA. Effect of alcohol on risk of coronary heart disease and stroke: causality, bias, or a bit of both? Vasc Health Risk Manag 2006;2(3):239–49 [Review].

[37] Vliegenthart R, Oei HH, van den Elzen AP, van Rooij FJ, Hofman A, Oudkerk M, et al. Alcohol consumption and coronary calcification in a general population. Arch Intern Med Nov 22 2004;164(21):2355–60 [Research Support, Non-U.S. Gov't].

[38] Bombardier CH, Blake KD, Ehde DM, Gibbons LE, Moore D, Kraft GH. Alcohol and drug abuse among persons with multiple sclerosis. Mult Scler Feb 2004;10(1):35–40 [Research Support, U.S. Gov't, Non-P.H.S.].

[39] D'Hooghe MB, Nagels G, Bissay V, De Keyser J. Modifiable factors influencing relapses and disability in multiple sclerosis. Mult Scler Jul 2010;16(7):773–85 [Research Support, Non-U.S. Gov't Review].

[40] Wen XJ, Kanny D, Thompson WW, Okoro CA, Town M, Balluz LS. Binge drinking intensity and health-related quality of life among US adult binge drinkers. Prev Chronic Dis 2012;9:E86.

[41] D'Hooghe MB, De Keyser J. Associations of alcohol consumption with clinical and MRI measures in multiple sclerosis. Expert Rev Neurother Jun 2012;12(6):657–60 [Comment].

[42] Sillanaukee P, Massot N, Jousilahti P, Vartiainen E, Sundvall J, Olsson U, et al. Dose response of laboratory markers to alcohol consumption in a general population. Am J Epidemiol Oct 15 2000;152(8):747–51.

[43] Imhof A, Woodward M, Doering A, Helbecque N, Loewel H, Amouyel P, et al. Overall alcohol intake, beer, wine, and systemic markers of inflammation in western Europe: results from three MONICA samples (Augsburg, Glasgow, Lille). Eur Heart J Dec 2004;25(23):2092–100 [Multicenter Study].

[44] Heikkinen H, Jallinoja P, Saarni SI, Patja K. The impact of smoking on health-related and overall quality of life: a general population survey in Finland. Nicotine Tob Res Jul 2008;10(7):1199–207 [Research Support, Non-U.S. Gov't].

[45] Hays JT, Croghan IT, Baker CL, Cappelleri JC, Bushmakin AG. Changes in health-related quality of life with smoking cessation treatment. Eur J Public Health Apr 2012;22(2):224–9 [Randomized Controlled Trial Research Support, Non-U.S. Gov't].

[46] Kalra R, Singh SP, Savage SM, Finch GL, Sopori ML. Effects of cigarette smoke on immune response: chronic exposure to cigarette smoke impairs antigen-mediated signaling in T cells and depletes IP3-sensitive Ca^{2+} stores. J Pharmacol Exp Ther Apr 2000;293(1):166–71 [Research Support, U.S. Gov't, Non-P.H.S. Research Support, U.S. Gov't, P.H.S.].

[47] Freeman AG. Optic neuropathy and chronic cyanide intoxication: a review. J R Soc Med Feb 1988;81(2):103–6 [Review].