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Predictors of people's perceptions of second hand smoke exposure as a risk factor for multiple sclerosis

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ABSTRACT

Background: There are both environmental and genetic factors which are associated with multiple sclerosis (MS) development. The primary objective of this study was to examine the predictors associated with people's attitudes towards second hand smoke exposure being a risk factor for development of MS.

Methods: The data set was drawn from the Health Canada: Smoking Survey conducted in 2004 and 2005 by Environics Research Group in partnership with Health Canada to survey the public in the province of British Columbia (N = 1468), Newfoundland (N = 1442), Quebec (N = 1404), Ontario (N = 1443) and Saskatchewan (N = 1413). A multilevel mixed effects logistic regression model analysis was carried out in order to determine whether people's perceptions of second hand smoking as a risk factor for MS varied based on the province of residence.

Results: Age, sex, having a household member who smoked inside their home, if respondents were bothered by second hand smoke exposure and smoking status were associated with increased odds of people agreeing to second hand smoke exposure being a risk factor for MS development. The province of residence was also a factor in people's perceptions.

Conclusion: The study results could guide in the development of stop second hand smoking campaigns on social media, TV and bus stop shelters and enforcement of stricter policies on smoking areas. This could help raise awareness about the risk of second hand smoking and its detrimental effect on people living with MS.

1. Introduction

Second hand smoke exposure is detrimental to health since it leads to ischaemic heart disease, lower respiratory infections, asthma and lung cancer (Öberg et al., 2011). There are many environmental factors that are associated with multiple sclerosis (MS) development and exposure to cigarette smoke is one of them (Stroup, 2015). In a study by Sundström et al. (2008), it was found that cotinine a nicotine metabolite in cigarettes were found to increase the risk of MS (Sundström et al., 2008). However people's perceptions about second hand smoke exposure on MS development is an understudied area.

Recent studies have reported the harmful effects of second hand smoke exposure on development of MS among children as well as adults (Sundström et al., 2008; Hedström et al., 2011; Mikaeloff et al., 2007). Children who had parents who smoked were at a greater risk of having a first episode of MS RR = 2.12 (95% CI 1.43–3.15) (Mikaeloff et al., 2007). Hedstrom et al. assessed the effect of passive smoking on the risk of MS and found that individuals who have never smoked were at a 1.3 times greater odds 95% CI (1.1-1.6) of developing MS if they were exposed to passive smoking (Hedström et al., 2011). Passive smoking as a risk factor for MS is a fairly new topic that hasn't received much attention. Therefore not many people are aware of the impact that second smoke exposure has on MS. Many smoking campaigns inform people about smoking and risk of lung cancer and cardiovascular disease but fail to talk about its impact on MS development.

In a meta-analysis study conducted by Zhang et al.2016 on risk of smoking on MS, they found that along with smoking being a risk factor for MS development, passive smoke exposure also increased the risk of developing MS as opposed to individuals who were unexposed (Zhang et al., 2016). Some studies have stated that a person's genetic background also plays a role in whether passive smoke exposure will result in MS development later on in life. Individuals who have a special class II allele HLA-DRB1*15 were 3 times more likely to develop MS as opposed to individuals who didn't have the allele. (Lincoln et al., 2005;

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Brynedal et al., 2007; Sawcer et al., 2012)

Hedström et al. explored the interaction of passive smoking and HLA genotype and found that compared to non-smokers who did not have the two genetic risk factors (HLA-DRB1*15 and HLA-A*02) individuals who had the two risk factors and who were not exposed to passive smoking were OR = 4.5 (95% CI 3.3–6.1) times more likely to develop MS (Hedström et al., 2014). However individuals who had the two genetic risk factors and who were exposed to passive smoking were OR = 7.7 (95% CI 5.5–10.8) times more likely to develop MS (Hedström et al., 2014). Thus indicating that development of MS is associated with genetic factors and could be influenced by exposure to passive smoking (Hedström et al., 2014). Apparent in these studies is that both environment and genetic factors plays a role in MS development.

MS is a rare condition, not many people will be aware of the condition or the risk factors associated with MS such as passive smoking. If people are not aware of the risk factor then prevention is difficult. Several studies have been conducted on demographic factors of people's perception of second hand smoke exposure in relation to lung cancer or chronic obstructive pulmonary disease. However studies on exploring people's perception of second hand smoke exposure on MS is rare. It is important to evaluate population knowledge on MS so as to gain a better understanding on ways to educate people. The objective of this research is to determine the demographic, socioeconomic and personal predictors associated with people's perception on whether they think that second hand smoking is a risk factor for MS. As a secondary objective, whether this perception varies based on the province of residence will also be examined in order to find out if there are macro level effect.

2. Methods

2.1. Data source

The data set was drawn from the Health Canada: Smoking Survey which was conducted in 2004 and 2005 by Environics Research Group in partnership with Health Canada to survey the public in the provinces of British Columbia (N = 1,468), Newfoundland (N = 1,442), Quebec (N = 1,404), Ontario (N = 1,443) and Saskatchewan (N = 1,413) on measuring the impact of smoking bans (EKOS 2005, Health Canada, 2005). This data file is a public use file. Random digit dial sampling process was used to select people in each province. The survey was conducted to measures the knowledge, attitudes and behaviors of the population towards smoking and second hand smoking in public places. Only individuals who were 18 years of age and older were included in the analysis.

2.2. Study sample

There was a total of 7170 respondents in the initial Health Canada Smoking survey. The study sample was restricted to individuals 18 years of age and older since this is the legal age of smoking. After age restriction was applied, there were 7166 people respondents who remained in the sample. The sample was restricted to individuals who answered the question to whether second hand smoke can cause MS (N = 4,815). After missing values were removed, 4229 observations remained for the analysis.

2.3. Variables assessed

Survey respondents were asked whether they agree that second hand smoking was a risk factor for MS. Individuals were asked to rate their agreement and had 4 categories to choose from (strongly agree, somewhat agree, somewhat disagree or strongly disagree). In this analysis individuals who replied strongly agree or somewhat agree were classified as "1 = Yes" and those who replied as somewhat disagree or strongly disagree were categorized "0 = No". This was the dependent variable of interest.

The factors that were included in the analysis were sex, age, marital status, education, number of people living in the household, whether other members of the household smoked in the house, if they were bothered by second hand smoke, if they had children under the age of 18, the frequency of breathing in second hand smoke and smoking restrictions in either workplace, restaurant or shopping malls. The predictors used for the analysis are shown in Table 1.

Table 1
Descriptive statistics and univariate analysis for perception of second hand smoking as a risk factor for MS based on complete case analysis (N = 4,229).

Variables	OR	95% CI	p-value	N
Sex			$p < 0.001$*	
Male	Ref			2074
Female	0.78	0.69–0.88	$p < 0.001$	2155
Age			$p < 0.001$*	
≤24	Ref			496
25–30	0.73	0.56–0.95	0.021	444
31–36	0.84	0.65–1.07	0.164	519
37–42	0.68	0.54–0.87	0.003	571
43–48	0.58	0.45–0.74	$p < 0.001$	576
49–54	0.56	0.43–0.72	$p < 0.001$	544
55–60	0.55	0.42–0.72	$p < 0.001$	469
≥61	0.95	0.75–1.21	0.696	610
Marital status			0.0083*	
Married or living as a couple	Ref			2566
Single	1.03	0.88–1.20	0.69	1028
Widowed	1.2	0.90–1.60	0.213	207
Separated	0.92	0.66–1.30	0.64	153
Divorced	0.63	0.48–0.83	0.001	275
Education			$p < 0.001$*	
Less than high school degree	Ref			727
High school degree	0.63	0.51–0.77	$p < 0.001$	915
More than high school but less than university	0.54	0.45–0.64	$p < 0.001$	1716
University degree or greater	0.45	0.37–0.56	$p < 0.001$	871
Number of people living in household			0.0002*	
Less than 2 people	Ref			2199
Greater than 3 people	1.27	1.12–1.43	$p < 0.001$	2030
Do other members of your household smoke inside your home?			$p < 0.001$*	
Yes	0.67	0.58–0.78	$p < 0.001$	1076
No	Ref			3153
Bothered by second hand smoke $p < 0.001$*				
Very much	Ref			1263
Somewhat	0.56	0.47–0.66	$p < 0.001$	1151
Not very much/not at all	0.31	0.27–0.36	$p < 0.001$	1815
Smoking status			$p < 0.001$*	
Smoker	Ref			2551
Non-smoker	1.95	1.72–2.21	$p < 0.001$	1678
Children in household under age of 18			0.0043*	
Yes	1.21	1.06–1.37	0.004	1552
No	Ref			2677
Frequency of breathing in second hand smoke			$p < 0.001$*	
Everyday	Ref			1849
Once to few times a week	1.43	1.23–1.66	$p < 0.001$	1225
Less than a month to 3 times a month	1.27	1.08–1.49	0.004	979
Never	1.42	1.03–1.95	0.028	176
Smoking restrictions in workplace, restaurant or shopping malls			$p < 0.001$*	
Yes	0.7	0.59–0.82	$p < 0.001$	3497
No	Ref			732

* Significance at $p < 0.20$

2.4. Analysis

A two level multilevel mixed effects logistic regression model analysis was carried out in order to determine whether people's perceptions of second hand smoking as a risk factor for MS varied based on the province of residence. A complete case analysis was conducted in which

only variables with complete values were used in the model and missing values were removed. Unadjusted and adjusted odds ratios with 95% CIs with p-values were computed. Univariate analysis was conducted using a ($p < 0.20$). Manual backward selection was used to build the multivariable model based on ($p < 0.05$). Confounders were tested in the final model and were retained if the addition of that variable changed the coefficients of the other variables by more than 20%. Interactions were assessed and added to the model if they were significant at ($p < 0.05$). Akaike's information criterion (AIC) was used to compare fit of models. The effectiveness of the final model was assessed using receiver-operating characteristics (ROC) and plots of standardized residuals. The analysis was performed using STATA IC 15 (StataCorp 2015).

3. Results

The final sample consisted of 4229 observations. Based on the descriptive statistics, there were 1639 individuals who agreed that second hand smoking causes multiple sclerosis (MS) and 2590 individuals who disagreed to second hand smoking causing MS. Ontario and Saskatchewan had higher levels of responses. In terms of smoking status 60% were smokers and 40% were nonsmokers. When comparing across provinces, Newfoundland had the highest rate of people agreeing (49%) to second hand smoke exposure causing MS, while Quebec had the lowest percentage of people agreeing (33%). Univariate analysis indicated that all predictors were significant with the dependent variable which are shown in Table 1. Based on the multivariate analysis, sex, age, education, if members of household smoked inside their home, if respondent was bothered by second hand smoke exposure, the respondents smoking status and the interaction between sex and smoking status was found to be significant.

In the model building process marriage status, number of people in the household, the frequency of breathing in second hand smoke and smoking restriction in either workplace, restaurant or shopping malls were removed (p-values > 0.05). Variables which were removed previously were added back into the model as confounders. The interaction of sex and smoking status was found to be significant at ($p = 0.01$). Table 2 shows the multivariate analysis. Males (OR = 1.18 95%CI 1.40–2.00) were more likely to agree that second hand smoke could cause MS compared to females.

A gradient effect was seen in age whereby as age increased the less likely people were to agree to second hand smoking causing MS. Individuals between the ages of 37–42 years of age were less likely to agree to second hand smoking causing MS (OR = 0.67 95%CI 0.50–0.89) compared individuals who were less than 24 years of age. Individuals between the ages of 43–48 (OR = 0.59 95%CI 0.44–0.79) were also less likely to agree that second hand smoke could cause MS compared to individuals who were less than 24 years of age. Similar findings were found for individuals who were 49–54 (OR = 0.57 95% CI 0.42–0.77) and 55–60 years of age (OR = 0.55 95%CI 0.44–0.76). Table 3 shows comparison between age categories.

When comparing between ages, individuals who were 61 and over were more likely to agree that second hand smoking causes MS in comparison to those who were 43–48 years of age (OR = 1.46 95% CI 1.10–1.94), 49 to 54 years (OR = 1.52 95%CI 1.16–2.00) and 55–60 years of age (OR = 1.57 95% CI 1.19–2.08). Education was significant in the final model whereby individuals with a high school degree (OR = 0.58 95% CI 0.47–0.72) were less likely to agree that second hand smoking could cause MS. Individuals with greater than high school diplomas but less than a university degree (OR = 0.46 95%CI 0.3–0.57) were less likely to agree to second hand smoke causing MS compared to individuals with less than a high school degree. Similar results were found for individuals with a university degree (OR = 0.31 95%CI 0.25–0.40) or greater. However, the odds ratios remained within the same range across different levels of education levels with only slight differences.

Table 2
Multivariate analysis for perceptions of second hand smoke as a risk factor for MS (N = 4,229).

Variables	OR	95% CI	p-value	N
Sex			$p < 0.001$*	
Male	1.67	1.40–2.00	$p < 0.001$	2074
Female	ref			2155
Age			$p < 0.001$*	
≤24	ref			496
25–30	0.83	0.62–1.10	0.193	444
31–36	0.86	0.65–1.15	0.309	519
37–42	0.67	0.50–0.89	0.006	571
43–48	0.59	0.44–0.79	0.000	576
49–54	0.57	0.42–0.77	0.000	544
55–60	0.55	0.40–0.76	0.000	469
≥61	0.86	0.63–1.19	0.365	610
Marital status			0.54	
Married or living as a couple	ref			2566
Single	0.97	0.80–1.17	0.744	1028
Widowed	1.01	0.72–1.42	0.938	207
Separated	1.01	0.71–1.45	0.948	153
Divorced	0.77	0.57–1.04	0.085	275
Education			$p < 0.001$*	
Less than high school degree	ref			727
High school degree	0.58	0.47–0.72	$p < 0.001$	915
Greater than high school diploma but less than university degree	0.46	0.38–0.57	$p < 0.001$	1716
University degree or greater	0.31	0.25–0.40	$p < 0.001$	871
Number of people living in household including themselves			0.10	
Less than 2 people	ref			2199
Greater than 3 people	1.17	0.97-1.41	0.097	
Do other members of your household smoke inside your home?			0.03*	
Yes	ref			1076
No	1.22	1.02-1.45	0.029	3153
Bothered by second hand smoke			$p < 0.001$*	
Very much	3.27	2.69-3.97	$p < 0.001$	1263
Somewhat	1.80	1.52-2.14	$p < 0.001$	1151
Not very much/not at all	ref			1815
Smoking status			$p < 0.001$*	
Smoker	ref			2551
Non smoker	1.50	1.20-1.87	0.000	1678
Children in household under age of 18			0.45	
Yes	1.08	0.88–1.32	0.450	1552
No				2677
Frequency of breathing in second hand smoke			0.05	
Never	ref			176
Everyday	0.91	0.64–1.30	0.604	1849
Once to few times a week	1.04	0.74–1.48	0.810	1225
Less than a month to 3 times a month	0.88	0.57–1.15	0.228	979
Smoking restriction in workplace or restaurant or shopping malls			0.08	
Yes	0.85	0.71–1.02	0.077	3497
No	ref			732
Interaction of Sex and Smoking status			0.01*	
Male × smoker	1.42	1.09–1.87	0.010	

* Significance at $p < 0.05$

Having household members who smoke inside their home was also associated with whether or not people think that second hand smoking could cause MS. Individuals who had no household members who smoked in their home were more (OR = 1.22 95%CI 1.02–1.45) likely to agree that second hand smoke could cause MS. The level that people felt bothered by second hand smoking was also associated with whether or not they felt that second hand smoking could cause MS. Individuals who were very much bothered by second hand smoking were more (OR = 3.27 95% CI 2.69–3.97) likely to agree that second hand smoking could cause MS compared to those who were not very much or not bothered at all. Similar results were found for individuals who were somewhat bothered by second hand smoking (OR = 1.80 95%CI 1.52–2.14). Smoking status was also found to be significant in the model. Non-smokers were more (OR = 1.50 95%CI 1.20–1.87) likely to

Table 3
Comparison of categorical variables that were significant from multivariate analysis based on $p < 0.05$.

	OR	95% CI	
Age comparison		Lower	Upper
61 and over vs 43–48	1.46	1.10	1.94
55–60 vs 49–54	0.97	0.73	1.28
61 and over vs 49–54	1.52	1.16	2.00
61 and over vs 55–60	1.57	1.19	2.08
Interaction of Sex and Smoking Status			
(Male#non-smoker) vs (Male#smoker)	1.05	0.85	1.31
(Female#smoker) vs (Male#smoker)	0.60	0.50	0.71
(Female#non-smoker) vs (Male#smoker)	0.90	0.72	1.12
(Female#smoker) vs (Male#non-smoker)	0.57	0.45	0.71
(Female#non-smoker) vs (Male#non-smoker)	0.85	0.69	1.05
(Female#non-smoker) vs (Female#smoker)	1.50	1.20	1.87

agree that second hand smoking leads to MS compared to smokers.

The interaction of sex and smoking status was significant in the final model. Male smokers were more (OR = 1.42 95%CI 1.09–1.87) likely to agree that second hand smoking causes MS. When comparing interaction terms, it was found that female non-smokers were more (OR = 1.50 95%CI 1.20–1.87) likely to agree that second hand smoking causes MS compared to female smokers. Significance was also found when comparing female smokers to male smokers (OR = 0.60 95% CI 0.50–0.71) as well as between female smokers and male non-smokers but to a lesser extent (OR = 0.57 95% CI 0.45–0.71).

The interactions in the model are depicted in Fig. 1. Non-smoking females had a higher probability of agreeing to second hand smoke exposure leading to MS development compared to female non-smokers. Male smokers had a higher probability of agreeing that second hand smoke exposure leads to MS development compared to female smokers. Fig. 2 shows that as age increased the probability of agreement to second hand smoke exposure decreased. Fig. 3 shows that those who were very much bothered by second hand smoking had a greater probability of agreement to the question as opposed to those who were not bothered by second hand smoke exposure. The ROC curve suggested that the multilevel mixed effects logistic regression model correctly classified 70% of people on their perceptions of whether second hand smoking causes MS indicating a fair model (95% CI 0.69–0.72). The model without interaction term was compared to the model with an interaction term using Akaike's information criterion (AIC). The results indicated that the model with the interaction term with sex and smoking status had an (AIC = 5,201) compared to the model without the interaction term (AIC = 5,205). Therefore the model with the interaction term was considered better since it has a lower AIC. For the random effects of the model, 1.9% of the total variability in the dependent variable was explained by the province level.

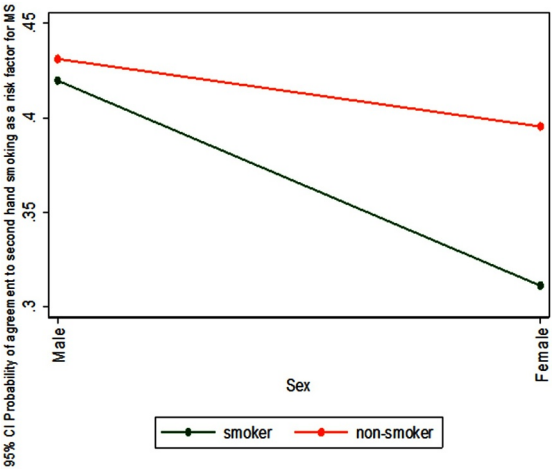

Fig. 1. Predicted probabilities and 95% CI of agreement for second hand smoking as a risk factor for MS by sex and smoking status.

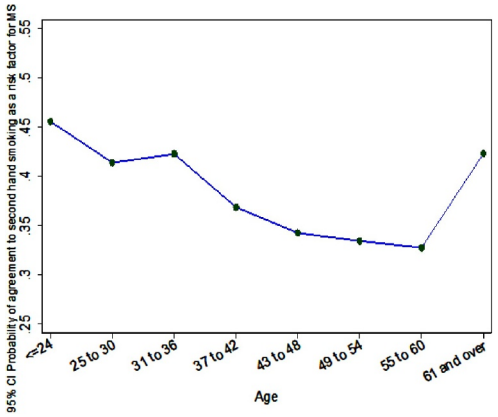

Fig. 2. Predicted probabilities and 95% CI of agreement for second hand smoking as a risk factor for MS by age.

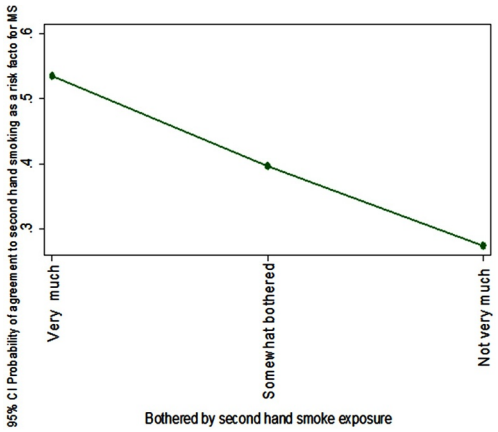

Fig. 3. Predicted probabilities and 95% CI of agreement for second hand smoking as a risk factor for MS by whether respondent was bothered by second hand smoke exposure.

4. Discussion

The main objective of this study was to determine the demographic, socioeconomic and personal predictors associated with people's level of agreement to whether they think that second hand smoking is a risk factor for MS. Based on the results of this research it was evident that demographic factors were associated with people's perceptions of whether second hand smoking is a risk factor for MS. As a secondary objective we explored whether this perception varied based on the province of residence to find out if there is a macro level effect. The complete case analysis indicated that 1.9% of the variability in responses in the dependent variable was explained by province in which the person resided. One of the reasons for this variability could be due to taxes on cigarettes and the tax hike that occurred in certain provinces over the years (Ort and Perry, 2003). Another reason for this variability could be due to effects of stop-smoking campaigns in the provinces and the frequency in which messages about the harms of second hand smoking are shown in advertisements.

In this study, 39% of people agreed that second hand smoking causes MS while 61% of people disagreed to second hand smoking causing MS. The low prevalence of people in Canada who agree to second hand smoke exposure being a risk factor for MS development shows the lack of awareness of MS risk factors. Males were more likely to agree that second hand smoking causes MS in comparison to females.

The prevalence of smoking among males globally is 4.4 times greater in comparison to females (WHO, 2011). However an interaction effect was seen whereby male non-smokers were more likely to agree that passive smoke exposure causes MS as opposed to male smokers. Similar interaction effect was found for female non-smokers compared to female smokers. Therefore smoking status plays a role in people's perceptions since smokers were more likely to disagree to harmful effects of passive smoking as opposed to non-smokers.

Having household members who did not smoke was associated with greater odds of people agreeing that passive smoking is dangerous. This finding was similar to a study conducted in Oregon where banning smoking among households with non-smokers or with at least one smoker was associated with a greater awareness of the harmful effects of smoke exposure (Pizacani et al., 2003). This shows the importance of banning smoking in households and it's impact on people's perceptions.

Age was a contributing factor in opinions for second hand smoke and MS development whereby older individuals were more likely to agree that second hand smoking causes MS as opposed to younger people when looking at comparisons between age categories. A study done on the prevalence of passive smoking found that a higher prevalence of passive smoking was evident in the older population as opposed to the younger population (Yang et al., 2016). This suggests that older individuals may have experience with the harms of second hand smoke exposure as opposed to the younger generation. With age comes more life experiences in terms of having friends or family members who have gone through problems with MS. Therefore older individuals would have a better understanding of risk factors of primary and secondary smoking and its effect on health. In addition to this older individuals may have greater interactions with clinicians and would have received advice to not smoke or quit smoking in order to prevent chronic diseases from occuring or to reduce symptoms of exisiting conditions which could be a possible explanation as to why older people were more inclined to agree to the question asked on second smoke exposure causing MS as opposed to the younger respondents (Shadel et al., 2015).

Individuals who had greater levels of education such as high school degree or greater were less likely to agree to second hand smoke exposure being a risk factor for MS. These findings were consistent with a study that investigated the sociodemographic characteristics and it's association with second hand smoke exposure among women (Baheiraei et al., 2013). In this study it was found that women who had lower levels of education were more likely to be exposed to second hand smoke exposure (Baheiraei et al., 2013). The findings from this study suggest that having higher levels of education doesn't necessarily mean that a person has more awareness about second hand smoke exposure. People's perception of risk factors may be based on life experiences and their social interactions which shape their opinions about certain subjects regardless of their education level.

This study had many strengths. This was the first multilevel study that assessed people's knowledge on whether they think that second hand smoking is a risk factor for MS development. Secondly the model correctly classified 70% of people on their perceptions of whether second hand smoking causes MS indicating a good model fit. The sample used was representative of the Canadian population since the major provinces were surveyed. Some of the limitations of this study was the response bias. Survey respondents may assume that second hand smoke exposure may cause MS because of the way in which the question was asked and might answer in a desirable manner. Since this was a cross sectional study, a cause and effect relationship cannot be assumed. Another limitation was the high number of smokers in the survey which could have biased the results of the study, since smokers are more likely to disagree that smoking is detrimental to health, they would be more inclined to disagree to the question of whether second hand smoke exposure could increase risk of MS. Limitations also exist with regards to the number of survey questions that were asked on the topic of MS. Since there was only one survey question that was asked on MS which didn't include a definition of the illness, the survey participants may have mistaken the condition for another illness. In addition to this, the survey was conducted through telephone interviews which may lead to higher number of non-responses if individuals are not available during the time the call was placed.

5. Conclusion

Public health awareness about the risks of second hand smoke exposure is needed. There have been two studies that have shown the impact of second hand smoke exposure and how it increases the risk of developing MS among children and adults (Hedström et al., 2011; Mikaeloff et al., 2007). In order to reduce the exposure in public places, legislative bans need to be more restrictive in terms of specifying where people can't smoke. Public smoking bans in Canada has been effective in reducing the prevalence of smoking and have been effective in reducing rates of illnesses such as acute myocardial infection in Saskatoon (Government of Ontario 2018; Lemstra et al., 2008; Naiman et al., 2011). However, in terms of MS, not many people are aware that second hand smoke exposure can trigger relapses in MS, therefore patient and public education is important. One way to educate people about second hand smoking and MS is through advertisements on television or on buses. Advertisements about the harms of cigarette smoking and it's effect on lung cancer or advertisements on alcohol use and impaired driving have been effective in raising awareness in these two areas and can also be effective for diseases such as MS (McVey and Stapleton, 2000; Hyland et al., 2006). Creating stop smoking campaigns which includes messages about harmful effects of second hand smoking and it effects on neurological conditions such as MS would also be effective in reducing smoking and second hand smoking.

Since sociodemographic factors were associated with people's perceptions about second hand smoke exposure and MS, educational programs in hospital settings that raise awareness on this topic need to be created. In addition to this, stop smoking campaigns need to incorporate messages about the various health problems that second hand smoke exposure could cause in children as well as in adults. Lung cancer, chronic obstructive pulmonary disease and heart disease are the main problems which are normally advertised as health problems associated with second hand smoking, other illness such as MS are left out and should be incorporated into stop smoking campaign messages.

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Declaration of Competing Interest

None.

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