A B S T R A C T

Objective: The etiology of multiple sclerosis (MS) remains poorly understood. Socio-demographic characteristics may play important roles in its development.

Methods: In a case-control study of MS, a total of 200 newly diagnosed MS patients and 202 frequency age- and sex-matched controls were studied.

Results: A direct and significant association was observed between cigarette smoking and the risk of MS. Higher education seemed to reduce the risk of MS. Contact with cats was inversely associated with MS, particularly in males, whereas contact with caged birds increased the risk significantly, especially in females. A strong family aggregation of MS was observed among cases. A past history of trauma and eye problems appeared to pose a high risk of MS. Cases had a significant family history of eye problems, mumps, measles, rubella, cancer and auto-immune diseases.

Conclusion: If smoking and history of certain infectious diseases increase the risk of MS significantly, they could be modified and avoided, thereby reducing the likelihood of being afflicted by MS.

A B R É G É

Objectif: L'étiologie de la sclérose en plaques (SEP) est encore mal comprise. Les caractéristiques socio-démographiques peuvent jouer un rôle important dans son développement.

Méthode : Nous avons mené une étude cas-témoins auprès de 200 patients venant de recevoir un diagnostic de SEP et de 202 témoins, jumelés selon l'âge et le sexe.

Résultats : Nous avons observé une association directe et significative entre le tabagisme et le risque de développer la SEP. Un niveau d'instruction élevé semblait réduire le risque de SEP. Le contact avec les chats était associé inversement avec la SEP, particulièrement chez les hommes, tandis que le contact avec les oiseaux en cage augmentait sensiblement le risque, surtout chez les femmes. Une forte aggrégation familiale de SEP a été observée parmi les cas. Des antécédents de traumatismes ou de problèmes oculaires semblent liés à un risque élevé de SEP. Les malades avaient d'importants antécédents familiaux de problèmes oculaires, d'oreillons, de rougeole, de rubéole, de cancer et de maladies auto-immunes.

Conclusion : Si le tabagisme et des antécédents de certaines maladies infectieuses augmentent sensiblement le risque de SEP, ils pourraient être modifiés et évités, réduisant ainsi la probabilité d'être atteint de la maladie.

A Case-Control Study of the Association Between Socio-Demographic, Lifestyle and Medical History Factors and Multiple Sclerosis

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Multiple sclerosis (MS) is a progressive, degenerative disorder that affects the brain, nerves and spinal cord. To date, little is known about its etiology. Women appear to be at higher risk of developing the disease than men (3:2 ratio).¹ MS is rare in oriental populations,¹⁻³ and its rate in whites is higher than in blacks (2:1 ratio). In Canada, the age-adjusted incidence rate of MS is around 100 per 100,000.⁴ Geographical MS clusters have been reported in areas of low iodine concentration,⁵ high exposure to heavy metals,⁶ and high latitude.^{5,7,8} Besides genetics, lifestyle and local environmental factors play important roles in the etiology of the disease.⁹ Increased MS risk has been associated with a history of viral infections,¹⁰ higher socio-economic status¹¹ and dietary habits.¹² To study the possible role of socio-demographic characteristics, as well as lifestyle and medical history in the etiology of MS, we undertook a case-control study in Montreal, Quebec, Canada.

METHODS

Case ascertainment

Incident MS cases, resident in greater Montreal and diagnosed between January

1991 and December 1994, were identified with the collaboration of the Multiple Sclerosis Association of Montreal East, neurologists, and general physician referrals. In addition, announcements were placed regularly in city newspapers to reach other individuals diagnosed with MS during this period. These notices were issued 6 times during the course of the study, and similar announcements were aired on some local radio stations. Eligible incident cases were contacted by phone, and upon informed consent, were visited at home and interviewed.

A total of 353 MS cases were identified during the study period. Of these, 87 (24.6%) were not eligible because of incorrect diagnosis or because they were prevalent cases. The remaining 266 (75.4%) eligible subjects were followed up. Of these, 11 (4.1%) declined to participate, and 52 (19.5%) were not interviewed because of poor health, loss of contact, or refusal of the physician to permit contact with the patient. Finally, 6 cases (2.3%) were excluded after the interview because of incorrect diagnosis. We were therefore able to interview 197 subjects (74.1% of eligible cases).

Control ascertainment

Controls were drawn at random from the general population, and frequency-matched with the cases by age (in 5-year age groups), sex and residential phone number. They were identified by random digit dialling method, using the first 3 digits of the phone number of the cases. They were selected from the telephone directory in which the corresponding cases were listed (all patients studied had a listed tele-

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phone number: only 1% of families in the Montreal region do not have a telephone). A page from the telephone directory was randomly selected from the sampling frame, and the names and addresses of 10 individuals with the same first 3 digit telephone numbers as the cases were selected. A letter was sent to these residences explaining the aims of the study. Approximately one week later, these residences were telephoned to see if there were an individual at each who matched the cases for age and sex and who agreed to be interviewed. If so, an interview was arranged at the control's home. If not, the procedure was repeated. If more than one eligible control was reached at a given number, this information was kept in a databank for further use. Non-residential numbers were discarded, and a "no answer" number was redialled up to 8 times at various points in time, day and night, weekday and weekend, before being rejected. We contacted a total of 236 population-based controls. Of these, 202 (85.6%) eligible controls were interviewed. The remaining 34 (14.4%) were not interviewed for the following reasons: wrong age group or area of residence, poor health, language problems, or refusal to participate (only 5 subjects).

Questionnaire

Trained interviewers administered a modified version of the health and socio-demographic questionnaire developed in our Unit for numerous case-control studies of diet and chronic diseases. The forms have been designed to assess information on such variables as socio-demographics, anthropometrics, occupational and medical history, family history of several chronic diseases, tobacco and alcohol consumption as well as physical activity. Weight and height at diagnosis were self-reported.^{12,13}

Information on socio-demographic characteristics, lifestyle and family history of diseases, etc. obtained in this study related to the 1-year period, before the diagnosis of MS.

Statistical methods

Multiple logistic regression was used to estimate the odds ratios (OR), their corresponding confidence intervals (CI) and

TABLE I Distribution of the Study Subjects by Age and Sex		
	Males Cases/Controls	Females Cases/Controls
Subjects	63/64	137/138
Mean age (years)	42.4/41.2	37.7/38.1
Age groups (years)		
1-29	3/6	33/30
30-39	24/26	44/47
40-49	23/18	47/45
50+	13/14	13/16

TABLE II Risk of Multiple Sclerosis Associated with Sociodemographic Characteristics			
Variable	Cases	Controls	*OR (95% CI)
Marital status			
Never-married	42	42	1.0
Ever-married	158	160	0.9 (0.6-1.6)
Cigarette smoking			
Never-smoked	62	83	1.0
Ever-smoked	138	119	1.6 (1.0-2.4)
0<10/day	15	27	0.7 (0.3-1.5)
10-20/day	34	34	1.4 (0.8-2.4)
20-40/day	71	50	1.9 (1.2-3.2)
40+/day	16	4	5.5 (1.7-17.8)
Physical activities			
Much less active	1	2	0.9 (0.1-8.6)
Less active	44	55	1.2 (0.7-1.9)
As active	64	87	1.0
More active	68	42	2.3 (1.4-3.9)
Much more active	23	16	2.4 (1.1-5.0)
Education			
< 18 years	177	156	1.0
≥ 18 years	23	46	0.4 (0.3-0.8)

*OR = Odds ratio adjusted for age, sex, smoking and education

TABLE III Risk of Multiple Sclerosis Significantly Associated with Domestic Animals		
	Cases/Controls	*OR (95% CI)
Cats	127/156	0.5 (0.3-0.8)
All	36/50	0.3 (0.1-0.8)
Males	91/106	0.6 (0.3-1.0)
Females	32/36	0.6 (0.3-1.1)
For less than 5 years	23/32	0.4 (0.2-0.8)
For 5 to 10 years	64/83	0.4 (0.3-0.7)
For 10 years or more		
Birds	84/54	1.9 (1.0-2.3)
All	18/18	1.1 (0.5-2.4)
Males	66/36	2.5 (1.5-4.2)
Females	41/29	1.8 (1.0-3.0)
For less than 5 years	16/12	1.4 (0.6-3.2)
For 5 to 10 years	20/7	3.6 (1.4-8.9)
For 10 years or more		

* OR = Odds ratio adjusted for age, sex, smoking and education

p values. All models were adjusted for age, sex, education and smoking to allow for possible confounding by these factors. Further adjustment for total energy intake did not modify the results (data not shown). All tests were 2-sided.

It was predicted that a minimum of 200 cases and 200 controls would be needed to obtain meaningful differences between the study groups.

RESULTS

A total of 200 individuals with MS and 202 age- and sex-matched controls were interviewed in this study. The mean age of the male cases was 42.4 years, compared with 41.2 years among controls. The mean age of females was 37.7 years for cases and 38.1 years for the controls, indicating age similarities (Table I). There was no associa-

TABLE IV
Risk of Multiple Sclerosis Significantly Associated with Medical History and Familial History of Diseases and Conditions, Before the First Onset of the First MS Symptoms

Disease	Cases/Controls	*OR (95% CI)	Cases/Controls	*OR (95% CI)
Multiple sclerosis	-	-	15/5	3.4 (1.2-9.7)
Cranial trauma without loss of consciousness	16/5	4.0 (1.4-11.4)	10/13	0.9 (0.4-2.1)
Only events before first MS symptoms	14/5	3.4 (1.2-10.1)		
Eye (vision)	19/4	4.9 (1.6-15.0)	24/12	2.2 (1.1-4.6)
Only events before first MS symptoms	6/4	1.4 (0.4-5.2)		
Mumps	81/70	1.3 (0.9-2.0)	46/30	1.8 (1.1-3.0)
Measles	108/97	1.3 (0.8-1.9)	49/32	1.7 (1.0-2.8)
Rubella	15/15	0.9 (0.4-2.0)	25/11	2.5 (1.2-5.4)
Cancer	8/0	infinity	63/48	1.5 (1.0-2.5)
Only events before first MS symptoms	5/0	infinity		
Auto-immune diseases	6/1	6.5 (0.8-55.1)	21/7	3.4 (1.4-8.3)
Only events before first MS symptoms	4/1	3.8 (0.4-34.4)		

* OR = Odds ratio adjusted for age, sex, smoking and education
 Familial history (father, mother, sons, daughters, brothers and sisters)

tion between marital status and the risk of MS.

We found that cigarette smoking was associated with MS (Table II). Comparing ever-smoked with never-smoked resulted in an OR of 1.6 and 95% CI of 1.0-2.4. For heavy smokers (20-40 cigarettes per day), the risk increased almost 2-fold [OR=1.9; 95% CI (1.2-3.2)]. The cigarette-smoking habits studied here related to the 1-year period before the diagnosis of MS.

Subjects with MS tended to be more physically active than controls before the diagnosis of MS [OR=2.3; 95% CI (1.4-3.9)]. This was based on personal expression of the study subjects, comparing their physical activities with individuals of the same age and sex in the general population. Highly educated individuals seemed to have a lower risk of developing MS [OR=0.4; 95% CI (0.3-0.8)]. Perhaps this factor assisted them in avoiding certain risk factors, such as smoking, etc.

Subjects [OR=0.5; 95% CI (0.3-0.8)], particularly men [OR=0.3; 95% CI (0.1-0.8)], who had contact with cats showed a lower risk of developing MS. For those who had cats (Table III) for 5-10 years, the OR was 0.4, and 95% CI 0.2-0.8. Women but not men who had contact with birds were at higher risk for MS [OR=2.5; 95% CI (1.5-4.2)]. The risk from having birds for 10 years or more was significantly higher [OR=3.6; 95% CI (1.4-8.9)] among cases than controls. It appears the length of exposure confers a strong protective (cats) or risk factor (birds) effect.

In this study, it was found that MS cases had significantly high risks from a familial

history of the disease [OR=3.4; 95% CI (1.2-9.7)] (Table IV). Individuals with a past history of traumas had a significantly higher risk of developing MS [OR=4.0; 95% CI (1.4-11.4)]. A very large proportion of MS cases, compared with the control group, had vision problems [OR=4.9; 95% CI (1.6-15.0)], but most of them (13 out of 19) occurred after the diagnosis of MS. The important point in this regard was the high frequency of family history of vision problems among MS families [OR=2.2; 95% CI (1.1-4.6)].

It was also found that cases had a significantly higher frequency of family history of mumps [OR=1.8; 95% CI (1.1-3.0)] and measles [OR=1.7; 95% CI (1.0-2.8)], rubella [OR=2.5; 95% CI (1.2-5.4)], cancer [OR=1.5; 95% CI (1.0-2.5)], as well as diseases related to the immune system [OR=3.4; 95% CI (1.4-8.3)]. A positive family history of illnesses related to viral infections among MS cases was an interesting outcome, and further studies will clarify the possible role of infectious agents in the occurrence of MS.

DISCUSSION

Cigarette smoking appears to play an important role in the etiology of MS. Subjects who smoked 20-40 cigarettes a day had approximately twice the risk of developing MS, compared with non-smokers. There was clear evidence of a dose-response correlation between the number of cigarettes smoked and the risk of developing MS. Some studies¹⁴⁻¹⁷ into the effects of cigarette smoking on motor

function have shown that nicotine causes a transient worsening of motor functions in patients with MS. It has been suggested¹⁸ that perhaps nicotine might disturb the synaptic transmission of impulses within the central nervous system, but other researchers¹⁹ believe that its vasoconstrictive action accentuates symptoms during acute exacerbation of MS. However, in a case-control study in England²⁰ there was no significant association between cases and controls regarding the number of smokers.

Qualitative questions about the physical activities of the study subjects, before the diagnosis of the disease, revealed that individuals with MS tended to be more active than the controls. It is difficult to interpret this finding, since physical activities always play a preventive role in the etiology of chronic diseases such as cancer, cardiovascular maladies, diabetes, etc.

Contact with cats showed an inverse association with MS, particularly in males. This was more evident and significant in subjects having cats for 5 years and more. Only one case-control study^{20,21} and one correlation survey²² indicated that exposure to some indoor pets such as dogs and cats was significantly higher in MS cases, compared with controls, particularly among those who were exposed to neurologically ill dogs. This suggests that dogs may serve as vectors of MS. However some case-control studies²³⁻²⁷ and correlation analyses¹⁷ established no correlation between having domestic animals, particularly dogs at home, and the risk of MS. Another case-control study suggested that occupational

contact with dogs and cats increased the risk of MS.²⁸ Our investigation indicated an increased risk of MS among female cases having contact with birds. The possible association of exposure to caged birds and MS has been reported,^{24,28,29} suggesting that they are very likely involved as exogenous causative agents of this disease.

With regard to family history of MS, we observed an OR of 3.4, indicating a strong family aggregation of MS among cases. This could not have been due to chance or recall biases, since the clinical characteristics of MS are obvious, and cases and controls would remember them well. In a cohort study in Switzerland,³⁰ it was found that 18.8% of MS cases had a family history of the disease. No information was given on the MS rate in the general population of the study region.

Cases with a history of trauma, particularly without loss of consciousness, had a significantly higher risk of developing MS (OR=4.0). It has been suggested³¹ that alteration of the blood-brain barrier (BBB) is an obligatory step in the pathogenesis of MS. A large body of clinical and neuropathologic, neuropsychologic, radiologic and experimental evidence shows that trauma, particularly mild concussive injury to the head, neck or upper back, may result in increased BBB permeability, leading to the formation of new lesions or the enlargement and activation of old lesions, a necessary step in developing MS. The authors suggest that in such situations, trauma acts as a facilitator to the postulated but still not fully understood pathogenetic mechanism of lesion formation.

A significantly higher number of subjects with MS (OR=4.9) had a family history of eye (vision) problems than the controls. Optic neuritis is a frequent harbinger of MS, and intra-ocular inflammation is one of the frequent accompaniments of MS.³² In our study, not only did a very high proportion of cases, compared with the controls, exhibit eye problems, but the frequency of this particular problem was 2-fold higher among relatives of cases than controls.

In our investigation, patients with MS reported a significantly stronger family history of childhood diseases such as mumps, measles and rubella than the con-

trols. In cohort²³ and case-control studies,³³ MS cases were found to have a history of measles, mumps, rubella and varicella infections at a later age, compared to the general population ($P<0.005$). There was no difference between the frequency of vaccination of MS patients and the controls. Antibody titers for mumps were significantly higher in MS cases than in the controls. MS cases also tended to have higher titers for measles antibodies when compared with the control group, but this difference was not significant. A positive family history of infectious diseases in the past was one of the important findings of our study and may have some obvious associations with the frequency of MS.

In our investigation (although based on small numbers), both the personal and familial history of auto-immune diseases as well as family history of cancer were associated with MS. This supports the suspected auto-immune pathogenesis of MS suggested previously.^{34,35}

Recall bias regarding the family history of childhood diseases and conditions may have occurred, but since these diseases are not known to be related to MS, the bias could be the same between cases and controls.

In general, cigarette smoking appears to be the strongest environmental risk factor for MS. There is also a significant correlation between family history of infectious diseases and MS. This finding supports the possible role of certain viral infections during early life and the development of MS later on. Although contact with cats decreases the risk of MS in both sexes, exposure to birds increases the risk significantly, particularly in women. Finally, trauma without loss of consciousness and auto-immune diseases are associated with the occurrence of MS.

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