ORIGINAL ARTICLE

Parkinson's Disease, Multiple Sclerosis and Changes of Residence in Alberta

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ABSTRACT: ***Background:*** Our objective is to examine how persons diagnosed with Multiple Sclerosis (MS) and Parkinson's disease (PD) change residence following disease onset. We hypothesize that persons choose to change residence (locally or regionally) in different ways depending on whether or not they have been diagnosed with MS/PD. We also estimate the effects of residence change on measures of disease prevalence made at several different levels of geography. ***Methods:*** Using fee-for service and hospitalization data, we identify cases of MS and PD between 1994 and 2004. Both of these case groups are matched to controls based on age, sex, socioeconomic status and municipality of residence. We tabulate and compare the changes of residence among persons in the case and control groups. We also use these data to estimate the effects that changes in residence have on disease prevalence at three different levels of geography. ***Results:*** Both MS and PD patients were more likely to change residence following disease onset compared to groups of matched controls ($p<=0.001$). Most changes of residence occur within the same municipality. The total magnitude of these changes is small, however, and is unlikely to affect estimates of disease prevalence; over our study period, the largest change in geographical prevalence estimates due to individual changes in residence was about 1%. ***Conclusions:*** Persons diagnosed with MS and PD both have mobility characteristics that differ from those of their respective control groups, and in general, are more likely to move to or between Edmonton and Calgary, and less likely to move out of province. However, the balance of mobility characteristics of persons with PD and MS appear unlikely to greatly affect the patterns observed on maps of disease prevalence.

RÉSUMÉ: Maladie de Parkinson, sclérose en plaques et changements de résidence en Alberta. ***Contexte :*** L'objectif de cette étude était d'examiner comment les individus chez qui on a posé un diagnostic de sclérose en plaques (SEP) et de maladie de Parkinson (MP) changent de lieu de résidence après le début de la maladie. Notre hypothèse était que les individus choisissent de changer de lieu de résidence (localement ou régionalement) de différentes façons selon qu'ils sont atteints de la SEP ou de la MP. Nous estimons également les effets du changement de lieu de résidence sur la prévalence à différents niveaux géographiques. ***Méthodes :*** Nous avons identifié les cas de SEP et de MP entre 1994 et 2004 au moyen des données de paiement à l'acte et d'hospitalisation. Ces deux groupes de patients ont été appariés à des témoins selon l'âge, le sexe, le statut socioéconomique et la municipalité de résidence. Nous avons classifié et comparé les changements de lieu de résidence des individus atteints et des témoins. Nous avons également utilisé ces données pour estimer les effets que les changements de lieu de résidence ont sur la prévalence de la maladie à trois niveaux géographiques différents. ***Résultats :*** Les patients atteints de SEP et de MP étaient plus susceptibles de changer de lieu de résidence après le début de la maladie par rapport aux témoins ($p \leq 0{,}001$). La plupart changeaient de résidence à l'intérieur de la même municipalité. Cependant, ces changements sont peu nombreux et sont peu susceptibles de modifier les estimés de prévalence de la maladie. Pendant notre étude, le changement le plus considérable dans les estimés de prévalence géographique dû aux changements individuels de lieu de résidence était d'environ 1%. ***Conclusion :*** Les individus chez qui on pose un diagnostic de SEP ou de MP ont des caractéristiques de mobilité qui diffèrent de celles de leur groupe témoin respectif et, en général, sont plus susceptibles de déménager à ou entre Edmonton et Calgary et moins susceptibles de déménager hors de la province. Cependant, il semble peu probable que la balance des caractéristiques de mobilité des individus atteints de MP ou de SEP influence de façon importante la cartographie de la prévalence de ces maladies.

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The prevalence of many chronic diseases varies geographically, but estimating regional prevalence rates is usually complicated by a variety of methodological problems, including small numbers, variations in physician practice style and variations in health service utilization. Some also speculate that geographic patterns of prevalent disease rates can be further complicated by the tendency of the ill to disproportionately change residence following the onset of disease.[1] Accordingly, estimates of prevalence may be higher or lower in some regions,

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but not strictly due to variations of in situ risk, and instead, are at least partly the result of systematic changes of residence following the onset of symptoms. If true, this not only impacts how we understand geographic patterns of chronic disease, but could influence public health policy, for example, suggesting that prevention strategies based on measures of disease prevalence are unsuitable. These patterns could also indicate that some places are perceived as 'better' or 'worse' at serving the chronically ill, which has implications on resource planning, and measurements of health equity.

There are several possible explanations for patterns of mobility related to morbidity, including accessibility issues, hazard avoidance and changes in residential need.[2] The most recent evidence of these relationships has been found in studies of mental illness.[3-5] Although such research offers evidence of an association between mobility and morbidity, most are unable to separate mobility behaviour related to mental illness—such as a change in mental capacity and judgement—from systematic choices (on the part of the ill or their caregivers) to move for the purpose of better access to services and support. Other studies examine ecological measures of mobility and disease,[6] but little work has been done at the individual-level, and much of this research concentrates on how migration affects measuring exposure to environmental hazards.[7]

Our objective is to examine changes in residence following an incident diagnosis of multiple sclerosis (MS) and Parkinson's disease (PD). We hypothesize that persons choose to change residence (locally or regionally) in different ways depending on whether or not they have been diagnosed with MS/PD, and in particular, that persons with MS and PD change residence either more or less frequently than the general population. We also estimate the effects of residence change on measures of disease prevalence made at several different levels of geography. The results of this study should reveal the similarities (and differences) in patterns of residential mobility, and estimate the degree to which regional prevalence rates might be affected by changes in residence made by the chronically ill.

Methods

We use fee-for-service (FFS) records between 1983 and 2005 and hospitalization Canadian Institute for Health Information (CIHI) records between 1994 and 2005 to obtain information about disease status. We use these data to identify cases of MS (ICD9 340, ICD10 G35) and Parkinson's (ICD9 332, ICD10 G20) in the province of Alberta between 1994 and 2004. We define persons as cases using the same general algorithm for both diseases. A person is a case if they received two or more FFS diagnoses of MS/PD or one or more CIHI diagnoses of MS/PD or one or more FFS diagnoses of MS/ PD from a physician with the neurology specialty. We use historic data from the FFS system to help exclude cases with a history of MS/PD prior to the start date of the study (that is, between 1983 and 1993). Since the remaining cases did not have physician diagnoses of disease in the ten years prior to their diagnoses in the study period, we treat them as 'period incident'. We use the term 'period incident' rather than 'incident' since some of the cases are likely to have been diagnosed prior to 1983, and could not be excluded as existing cases. A person is considered a period incident case in the year they meet the qualifying definition as a case; that is, the date of the second FFS diagnosis used to identify a person as a case, or the date of first diagnosis associated with a hospitalization. A person is considered prevalent from the year they are period incident, and are included in the study until out-migration, death, or the end of the study period.

For comparison purposes, we match a control to each of the MS and PD cases. Matches are on sex, age (+/- 5 years), socioeconomic status (derived from the health insurance premium subsidy level) and the municipality of residence. Since our analysis is longitudinal, and most matching criteria change with time, matches are based on the year of a case's period incident diagnosis. For example, a period incident case with MS that is 45 years-of-age in 2001 is matched to a control that is also 45 (+/- 5) years-of-age in 2001. For the cases and controls, this matching year is referred to as the 'index year'. We observe changes in residential status based on the residential postal code contained in the provincial health care registry system. Though some changes of residence occur within the same postal code (particularly in rural areas) it is impractical to use specific address information as an indicator of change in residential status. The implications of this will be discussed below. All cases and controls are monitored for residential mobility following the index year.

The first part of our analysis consists of a descriptive tabulation of changes of residence among cases and controls. We perform two-tailed tests of differences of proportions, and report *p*-values when an explicit comparison is made between the case and control groups.

Since one of the goals of this study is to determine the effect that changes of residence have on maps of chronic disease prevalence, we also estimate how changes in residence are likely to affect maps of prevalence. We assume that if a disproportionately large number of chronically ill migrate out of a particular region (and there is not a balancing in-migration of the chronically ill) then all else being equal, the prevalence rates in that region have been decreased by out-migration. Conversely, if a large proportion of changes in residence among the chronically ill involve migration into a region (and there is not an offsetting out-migration) then all else being equal, the prevalence rates in that region have been increased by in-migration. We estimate these effects by tabulating the changes of residence between the year of period incident diagnosis and a reference year (2004). The difference between the proportion of cases moving into a region as of 2004 and the proportion of cases moving out of a region as of 2004 is our estimate of the effect of residential mobility on prevalence rates for that area. For completeness, we do this for three different regionalizations of the province of Alberta (Figure 1): the regional health authority (N=9), the 2001 census division (N=19) and the sub-regional health authority (N=68).[8]

Results

Of the 7,602 persons that met the definition of period incident MS between 1994 and 2004, 100% were successfully matched to a control. Of the 6,579 persons that met the definition of period incident PD between 1994 and 2004, 6,534 (99.3%) were successfully matched to a control. Unmatched cases are dropped from our analysis. Among those with MS, 45.9% of the cases and 43.6% of the controls changed residence at least once between

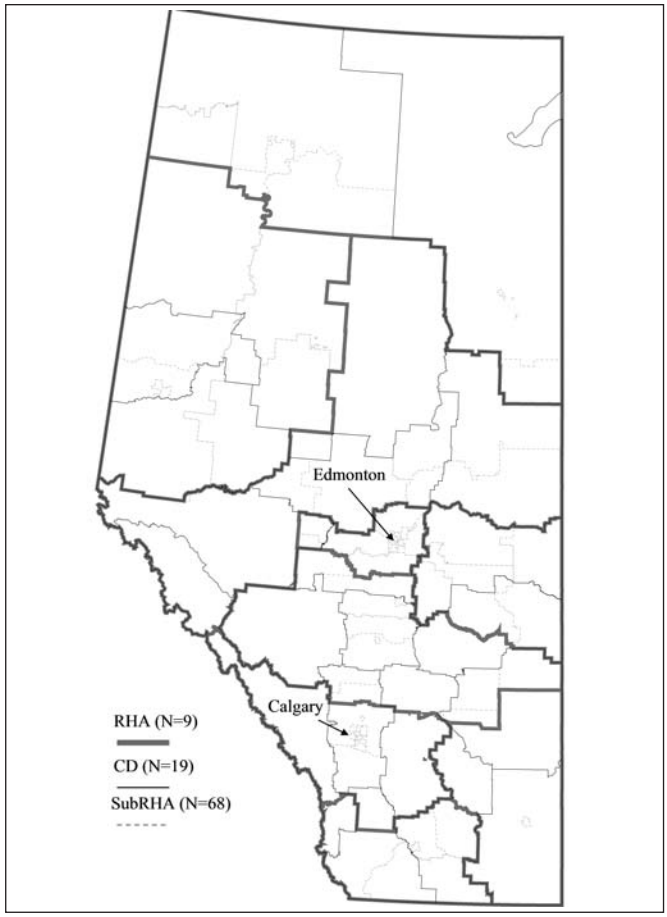

Figure 1: *Regional health authorities (RHA), census divisions (SD) and sub-Regional health authorities (SubRHA).*

the index year and the end of follow-up (p=0.002). Among those with PD, 35.7% of the cases and 26.2% of the controls changed residence at least once between the index year and the end of follow-up (p<0.001). Census-based estimates suggest that Alberta receives up to a third of all inter-provincial migrants in Canada, with a net inter provincial migration of nearly 60,000 annually in recent years.[9] Parkinson's disease cases (10.5%) and controls (17.1%) exhibit considerably different tendencies to migrate out of Alberta over the study period (p<=0.001). A similar pattern emerges for MS cases (14.9%) and controls (17.2%) (p=0.041).

Figure 2 shows the frequency of multiple changes of residence for PD and MS cases and their respective control groups. Multiple changes of residence appear more common for the MS groups than for the PD groups. For the MS group, cases are more likely to make at least one change in residence, but controls appear more likely to be highly mobile, and more likely to move four or more times.

The 2001 population of Alberta was roughly three million persons, with approximately one million people in each of Edmonton and Calgary.[10] Most of the cases and controls that changed residence could be referenced to a municipality of origin and destination based on their residential postal codes, though coding errors left roughly 10% of the cases and controls out of the remaining analysis. Our remaining analysis is also restricted to the first change of residence following the index year, ignoring any sort of secondary or tertiary residential mobility effects. For cases and controls, most moves involved one of the two major cities in the province: Edmonton or Calgary. For persons in the MS group that moved at least once, 49.4% of cases and 48.0% of controls moved to a residence in either Edmonton or Calgary, including changes of residence between these two cities (p=0.116). For the PD group, cases (49.4%) and controls (43.9%) exhibit a statistically significant difference in the tendency to move to new residences in either Edmonton or Calgary, including changes of residence between these two cities (p<0.001). Among the PD group, controls were more likely to move from Edmonton or Calgary to other municipalities inside or outside the province (14.7%) than cases (10.2%) (p=0.004). For both the PD and MS groups, roughly 80% of the changes in residence occurred in the same municipality, and there were no significant differences between the cases or controls in this regard.

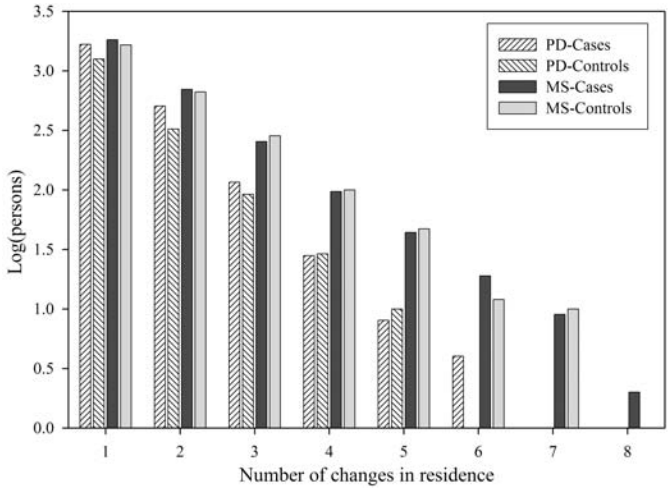

Figure 2: *Frequency of cases by the number of changes in residence.*

There is little systematic change in the regional proportions of MS and PD as a result of in or out-migration. Table 1 shows the variations in the percentage of cases for Regional health authorities (RHAs). Region 23 (which encloses the city of Calgary) shows a small percentage out-migration of both MS and PD cases from the health region between disease onset and 2004. Region 26 (which encloses the city of Edmonton) shows a small percentage in-migration of MS and PD cases. Nonetheless,

Table 1: Percent changes of residence of cases by regional health authority

RHA	*MS*	*PD*
21	0.118	0.211
22	-0.045	0.116
23	-0.936	-0.426
24	-0.215	-0.008
25	-0.312	-0.464
26	0.782	0.513
27	0.186	-0.058
28	0.442	0.024
29	-0.020	0.092

for all regions, the changes were quite small, with the largest change near 1%. The changes in the geographic distribution of cases as a result of residential mobility were even smaller for census divisions (Table 2).

We map out the changes in the geographic distribution of cases for the subRHA boundaries for MS (Figure 3) and PD (Figure 4). As with the other regional units, the largest percentage change is small, at slightly more than 1%. The distribution of in-migration and out-migration of cases is not random, however; the largest percentage changes occur in or around the cities of Edmonton and Calgary.

Discussion

Our results are consistent with the hypothesis that persons with MS or PD are more likely to move in general or move towards specific regions of the province (or out of the province) following the period incident date than the general population. However, most changes in residence did not result in a move out of the municipality of origin. Though moves from smaller communities to Edmonton and Calgary are common, there is little evidence that these moves are more common among those who have MS or PD than other residents of the province. The biggest differences between the case and control groups that changed residence at least once following the index date seemed to have involved out-of province moves; for MS and PD, the control groups were considerably more likely to move out of Alberta than the case groups.

Table 2: Percent changes of residence of cases by census division

CD	*MS*	*PD*
01	-0.024	0.122
02	-0.023	-0.152
03	-0.060	-0.016
04	-0.032	0.133
05	-0.041	0.056
06	0.273	0.924
07	-0.266	-0.499
08	0.107	-0.153
09	-0.077	-0.023
10	-0.265	-0.309
11	0.281	0.389
12	-0.023	-0.192
13	-0.145	-0.003
14	-0.009	0.022
15	-0.105	-0.278
16	0.092	0.025
17	-0.041	-0.025
18	-0.044	-0.030
19	0.205	0.009

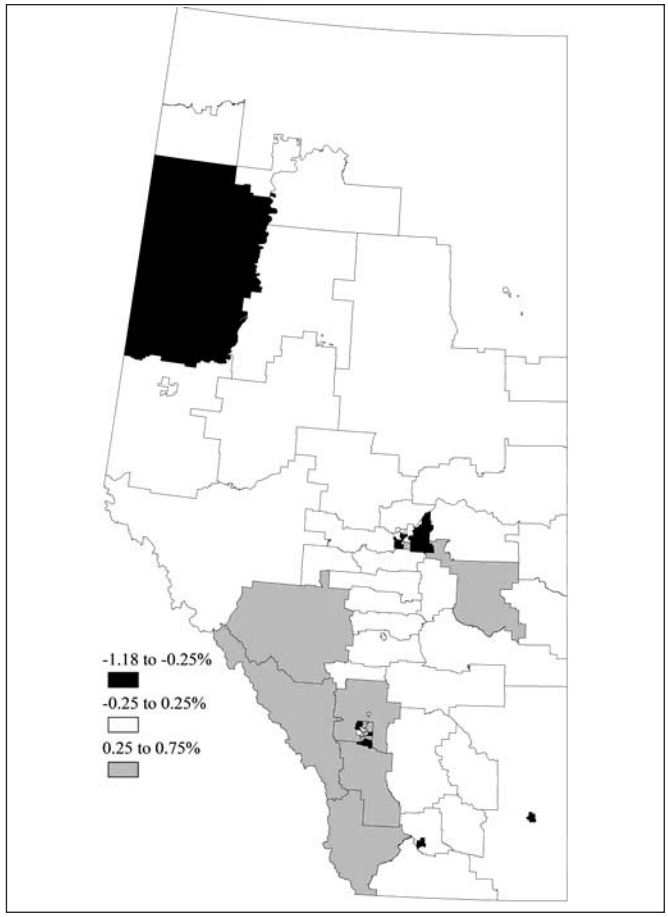

Figure 3: *Percentage change in distribution of MS cases between index date and 2004.*

Our results do not rule out the possibility of a mobility effect over a longer time period. Based on our results, within the first five to ten years following a diagnosis, we speculate that such an effect is probably minor, and over the longer term, the

cumulative effect is unlikely to be large enough to have a drastic affect on prevalence estimates. This is important since it increases the information that regional or geographic analyses of MS and PD prevalence provide. Considerable Canadian research has observed regional variation in MS and PD prevalence.[11-15] Underlying much of this research is a concern that some of these variations could be an artefact of preferential changes of residence following disease onset. Our results do not support this hypothesis, and instead, suggest that most of the geographic variation of MS and PD in Alberta is probably unaffected by preferential mobility patterns.

Most medical specialists that MS patients are likely to consult reside in the Edmonton and Calgary regions, yet cases show no tendency to relocate to these places when compared to matched controls. This could suggest that although the geographic distance between the major service provision centres and some rural communities is great, it may not be prohibitive, or that the benefits of moving closer to the service centres may not warrant the expense and inconvenience of a residence change. Again, over longer time frames, a greater demand for service may be required, and persons may preferentially move if/when the burden of illness increases. Persons with PD exhibited lower levels of mobility than persons with MS, but the PD cases were more likely to make a change of residence that involved either Edmonton or Calgary than the PD control group. Whether this is due service-accessibility issues, lifestyle choices, or other factors is uncertain, but given our study design, this observation seems likely to be related to health status, since the control group was matched on geography, demographics and even socioeconomic status.

Though our findings suggest that persons with PD, and perhaps MS, are more likely to change residence at least once following disease onset, based on our geographic comparisons of the change in the distribution of cases between the index year and 2004, we believe that the effect on prevalence estimates is small. At most, we observed a roughly 1% change in the distribution of cases over the follow up period examined here. Over longer time frames, this may increase, but it is difficult to imagine that even a 5% systematic out or in-migration of cases in an area would have an appreciable effect on estimates of prevalence. It is possible that these effects would be larger at high-resolution scales (such as at the neighbourhood level). However, in most instances, prevalence maps at these scales have high variability (due to small numbers) and require statistical or topological smoothing in order to portray spatial patterns free of underlying statistical noise. Such smoothing is likely to indirectly manage some of the effect associated with systematic changes of residence.

There are several noteworthy limitations in this study, many of which are related to the nature of administrative health data. First, we do not know the true date of disease onset, and merely estimate it based on contacts with health care system. It is possible that long suffering undiagnosed MS/PD cases are more or less inclined to change residence, particularly to aid in the correct diagnosis of disease. If true, we may be underestimating some changes in residence following the true date of disease onset or diagnosis. Second, defining incident cases of chronic disease is generally difficult with administrative data, particularly for diseases in which diagnoses occur early in life and survival times are long. For MS in particular, our case group likely includes a number of persons that were diagnosed well before the study period, and merely had a new MS-related service within the study period. Similarly, persons with existing MS/PD that migrate into Alberta are likely to have been identified as period incident in our study, though ideally, those with a diagnosis prior to 1994 should have been excluded. These limitations probably result in an over-estimate of the true number of incident cases (particularly for MS), and we therefore caution against using our data to make inferences about the annual incidence of MS or PD.

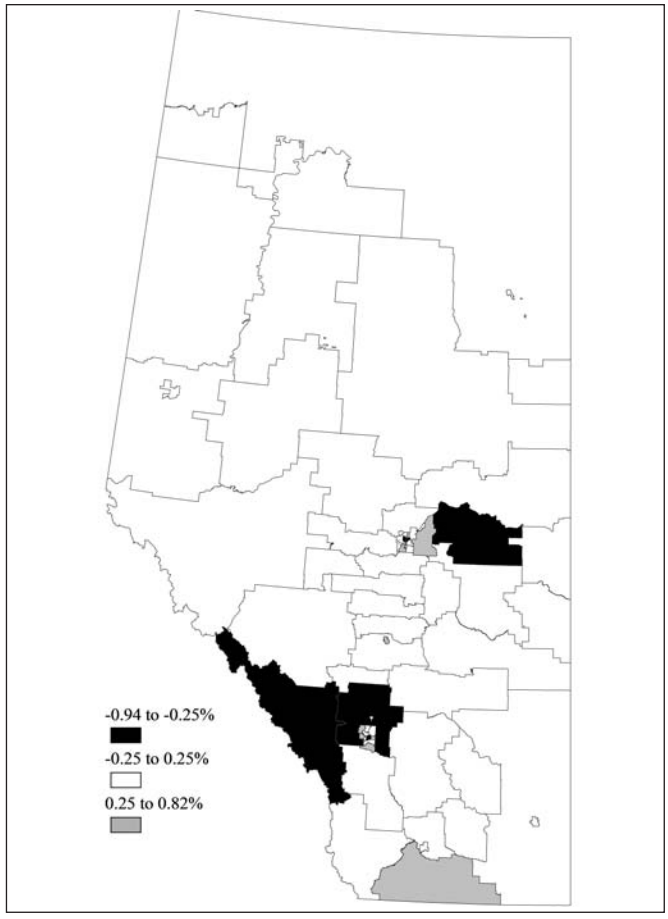

Figure 4: *Percentage change in distribution of PD cases between index date and 2004.*

A third limitation is that we ignore all changes of residence following the first change of residence after the index year. It is possible that the trends we observe would be affected by secondary and tertiary moves, though their infrequency (less than 1% of PD and MS cases moved more than three times) makes this unlikely. Future analyses in which changes of residence are monitored both spatially and temporally may be warranted. Fourth, our geo-referencing procedure was based on

residential postal codes, which are not equally precise over the province. In very rural areas, postal codes can be a poor approximation of the geographic location of a residence. However, for the purpose of identifying changes in residence, we would not expect this error to affect our findings, since we made municipal-level comparisons, and more than three quarters of the changes in residence occurred within the same municipality.

Based on our findings, we make two general conclusions (subject to the limitations discussed above). First, recently diagnosed PD patients, and to a lesser extent, MS patients, have different mobility characteristics following disease onset than a population of controls matched on demographic and socio-economic attributes. Although most moves were within the municipality of origin, PD cases appeared more likely to move to or between Edmonton or Calgary than the PD control group. Furthermore, MS and PD case groups left the province less frequently than their respective control groups. Since our study design involved a comparison of cases to a matched control group, these observations are largely independent of age, region of origin, sex and income. Second, over short time frames this residential mobility is not large enough to greatly affect prevalence estimates in moderately sized geographic regions. Although the effect might be larger for smaller geographies, statistical/topological corrections required in the mapping of prevalence at these scales would likely smooth out such effects.

One of the primary strengths of this study is our ability to compare the mobility patterns of a large number of chronically ill persons to controls selected from the general population. In recent years, an economic boom has activated considerable mobility in the population of Alberta, and to Alberta from other parts of Canada. This has resulted in large shifts in the distribution of the population. Based on our results, MS and PD cases have different residential mobility characteristics than the control groups to which they were matched. Individual decisions to change residence are undoubtedly complicated by a mixture of factors: such as financial concerns, desires for improved service, desires for greater social support and desires to move away from places considered hazardous to one's health.[16] Our results indicate that the sum of these choices, though perhaps of considerable sociological, clinical or health policy importance, do not appear to have a large effect on geographical estimates of MS or PD prevalence.

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