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Rural residence and risk of dementia

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Introduction: We sought to determine whether residence in a rural region is associated with a higher risk of dementia and a higher risk of developing dementia over a 5-year period than residence in an urban region.
Methods: This was a secondary analysis of a prospective cohort study. In 1991 and 1992, 1751 adults aged 65 years and older and residing in the community were sampled from a representative population-based registry, which included the entire province (time 1). Follow-up occurred 5 years later (time 2). Age, sex and education were self-reported. Rurality was determined by the population of the Census subdivision, with a population greater than 19 999 considered urban. Cognition was assessed using the Modified Mini-Mental State Examination, with those scoring below 78 invited to undergo a clinical examination to determine the presence of dementia. Cross-sectional analyses were conducted for participants with complete data at time 1. Prospective analyses were conducted for participants with normal cognition at time 1, who had complete data and survived until time 2. Logistic regression models were constructed for the outcome of dementia at times 1 and 2.
Results: Residence in a rural region was not associated with dementia in the cross-sectional analyses (adjusted odds ratio [OR] 1.08, 95% confidence interval [CI] 0.61–1.91) and did not predict dementia 5 years later (adjusted OR 1.05, 95% CI 0.66–1.68).
Conclusion: We found no difference in the risk of dementia among older adults living in urban and rural regions of Manitoba.

Introduction : Nous avons voulu déterminer si le fait de vivre en milieu rural est associé à un risque plus élevé de démence et à un risque plus élevé de développer une démence sur une période de 5 ans, comparativement au fait de vivre en milieu urbain.
Méthodes : Il s'agit de l'analyse secondaire d'une étude de cohorte prospective. En 1991 et 1992, 1751 adultes de 65 ans ou plus vivant dans la communauté ont été échantillonnés à partir d'un registre représentatif de la population de toute la province (période 1). Un suivi a été effectué 5 ans plus tard (période 2). L'âge, le sexe et la scolarité étaient autodéclarés, et la ruralité était déterminée à partir des subdivisions utilisées aux fins de recensement : une population de 19 999 personnes ou plus était réputée urbaine. La cognition a été évaluée au moyen d'une version modifiée du mini-examen de l'état mental, et les sujets qui obtenaient un score inférieur à 78 étaient invités à subir un examen clinique pour déterminer la présence de démence. Des analyses transversales ont été réalisées pour les participants au sujet desquels on disposait de données complètes lors de la période 1. Des analyses prospectives ont été réalisées pour les participants dont la cognition était normale à la période 1, au sujet desquels on disposait de données complètes et qui avaient survécu jusqu'à la période 2. Des modèles de régression logistique ont été élaborés pour le paramètre de démence aux périodes 1 et 2.
Résultats : Le fait de vivre en région rurale n'a pas été associé à la démence selon les analyses transversales (rapport des cotes [RC] ajusté 1,08, intervalle de confiance [IC] de 95 % 0,61–1,91) et ne s'est pas révélé prédicteur de la démence 5 ans plus tard (RC ajusté 1,05, IC de 95 % 0,66–1,68).
Conclusion : Nous n'avons observé aucune différence pour ce qui est du risque de démence chez les adultes âgés du Manitoba, qu'ils vivent en milieu rural ou urbain.

INTRODUCTION

Dementia is a common issue facing older adults, their families and society in general. It is associated with functional decline,[1] reduced quality of life,[2] caregiver burden,[3] entry into a nursing home[4] and death.[5] The epidemiology and geographic variation of dementia has recently received increasing attention.[6] A rural residence over the course of one's life could be associated with dementia for several reasons. First, the educational opportunities and quality may differ between rural and urban regions (Fig. 1). This may affect dementia rates given that education is strongly associated with dementia.[7,8] Second, access to activities that enhance cognition (e.g., libraries and social supports and networks) may vary between and within rural and urban regions. Third, disease states and risk-factor prevalence may differ in rural and urban regions, as may access to medical care. Finally, certain environmental and occupational exposures, such as pesticides[9] and defoliants,[10] may be more prevalent in rural regions and may also be associated with dementia.

Some studies have demonstrated an increased prevalence of dementia in rural regions compared with urban regions.[6] One recent meta-analysis noted a 1.5-fold increase in the prevalence of dementia in rural areas.[6] However, few of the studies in the meta-analysis directly compared rural and urban regions, and some of the comparisons were across societies (e.g., a comparison of New York City with rural Nigeria[11]). Many of the other studies included in the meta-analysis used small samples or limited measures of rurality or cognition. The Manitoba Study of Health and Aging (MSHA) provided a province-wide sampling frame in 1991 and 1996, including rural regions, targeted at dementia. This offered us the opportunity to study the effect of rural residence on the risk of dementia. Few epidemiologic studies of aging have sampled rural regions over an entire jurisdiction, and fewer still have both a rural and an urban component.

Fig. 1. Photograph of one of the investigator's (P.D.S.) grandfather's class of a 1-room school (front row, middle boy holding the flag). In addition to lower educational attainment, there may be differences in educational quality. Note the misspelling of "We'll" in the banner.

We sought to determine whether residence in a rural region is associated with a higher prevalence of dementia than residence in an urban area, whether residence in a rural region is associated with a higher risk of developing dementia over a 5-year period among those with normal baseline cognition, and whether any association between a rural residence and dementia is confounded by education or general health status. We also conducted a sensitivity analysis in which we considered cognitive test scores in rural and urban regions.

METHODS

Setting

At the time of the MSHA's initial survey in 1991, 13.4% of Manitoba residents were 65 years of age and older. The major urban centres are Winnipeg (1991 population 616 790; 13.2% aged ≥ 65 yr) and Brandon (1991 population 38 567; 15.5% aged ≥ 65 yr).[12] The northern part of the province is predominantly boreal forest, and the population density is low. The southern portion of the province is largely agricultural, with most residents living on farms or in small towns or villages. On average, 24% of the 1991 population of small towns was aged 65 and older, whereas the corresponding percentage for villages was 27%.[13]

Sample

The data are from the 1991–1992 MSHA, an expansion of the Manitoba component of the Canadian Study of Health and Aging (CSHA).[14] In 1991 and 1992, 1751 individuals aged 65 and older and living in the community were interviewed in person by trained interviewers (time 1). These individuals were randomly selected from a list provided by Manitoba Health, which represents one of the most complete listings of residents. The follow-up survey took place 5 years later. All of Manitoba was sampled. However, the sampling frame excluded many First Nations people for whom health care is provided by the federal government (and they are hence not fully included in the provincial sampling

frame). As well, in the 2 northernmost regions, the sampling frame was limited to the major towns (Flin Flon, Thompson and The Pas) to ensure the feasibility of travel to these sites.

We considered 2 samples: a cross-sectional and a prospective sample. The cross-sectional sample was the entire sample at time 1 for which complete data were available on both rural residence and cognitive status. The prospective sample was for individuals for whom data were available at times 1 and 2 on cognitive status, who survived to time 2 and did not have dementia at time 1. Figure 2 shows the flow of participants.

Measures

The measure of urban versus rural residence was based on Beale codes modified for Canada.[15] Census subdivisions were classified according to their population reported in the 1991 Census of Canada[12] as urban areas (population > 19 999) and rural areas (population < 20 000). Respondents were then assigned into one of these groups based on their place of residence. In the sensitivity analyses, we also compared Winnipeg with non-Winnipeg residence. We further conducted an analysis based on the region of residence. Here, we considered the urban regions Winnipeg North, Winnipeg South and Winnipeg West/Centre, and the rural regions Central Manitoba, Interlake, Westman, Eastman, Parkland and Norman.

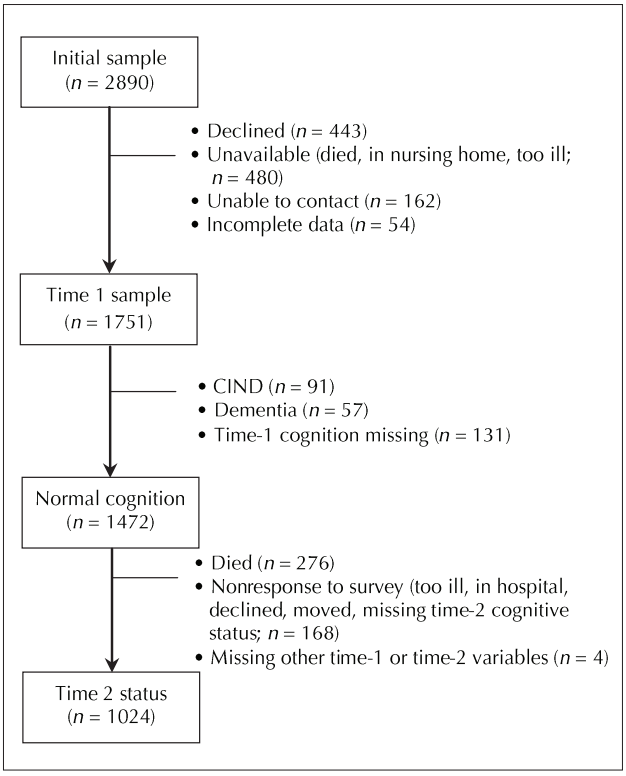

Fig. 2. Flow of participants. CIND = cognitive impairment, no dementia.

Age, sex and level of education (measured by years of schooling) were self-reported. We also included self-rated health, using the item, "How is your health these days?," which we categorized as "good" (which included responses of "good" and "very good") or "not good" (all other responses).

The outcome variable was dementia. This was diagnosed according to the protocol of the CSHA.[14] The Modified Mini-Mental State Examination (3MS)[16] was used as the cognitive measure. This is an expansion and adaptation of the Mini Mental State Examination (MMSE)[17] that includes new items and expanded scoring for some items. It is scored from 0 to 100. Those scoring below 78 on the 3MS were invited to participate in a clinical examination to determine the presence of dementia, which was diagnosed according to criteria of the *Diagnostic and Statistical Manual of Mental Disorders*, 3rd edition. We defined "cognitive impairment, no dementia" (CIND) according to the CSHA protocol. Briefly, these were individuals who scored below 78 on the 3MS but did not meet the criteria for dementia on the clinical examination.

Analyses

We conducted bivariate analyses using χ^2 tests for categorical variables and Student *t* tests (assuming unequal variance) or analysis of variance for continuous variables. In bivariate analyses, we compared rural regions with urban regions. To adjust for potential confounding factors, we constructed logistic regression models. We conducted a cross-sectional analysis and a prospective analysis. For the cross-sectional analyses, the outcome was dementia at time 1. For the prospective analyses, the outcome was dementia at time 2 in a sample of participants who with normal cognition at time 1, survived to time 2 and had no missing data. Logistic regression models were constructed, adjusting for age, sex and level of education.

As a sensitivity analysis, we also considered the 3MS score as a cognitive outcome. Here, we compared the mean 3MS score in rural regions and urban regions. The mean 3MS scores at time 1 and time 2 and the change in mean 3MS scores from time 1 to time 2 were all considered outcomes. Linear regression models were constructed, adjusting for age, sex, education level and self-rated health.

We also considered regional differences. Here, we examined the predictor variable of interest as the region in which the participant resided: Winnipeg

North, Winnipeg South, Winnipeg West/Centre, Central Manitoba, Interlake, Westman, Eastman, Parkland and Norman. These analyses may lack the power to detect differences in dementia rates in multivariable models because the number of individuals with dementia in any particular region was small. However, there is sufficient power to detect differences in the change in 3MS scores.

The study received approval from the Research Ethics Board of the University of Manitoba, and adheres to the Declaration of Helsinki.

RESULTS

Cross-sectional analyses

The baseline characteristics of participants are shown in Table 1. Those who lived in rural areas were more likely to be male and to have a lower level of education. Both rural and urban participants in Manitoba had a lower educational attainment than their counterparts in the CSHA. The 3MS scores were lower in the rural group; although this difference was statistically significant, it was quantitatively small.

At time 1, in the rural group, 574 (81.8%) had normal cognition, 40 (5.7%) were diagnosed with CIND, 28 (4.0%) were diagnosed with dementia and 60 (8.5%) had missing data. In the urban group, 894 (85.3%) had normal cognition, 54 (5.1%) were diagnosed with CIND, 30 (2.9%) were diagnosed with dementia and 71 (6.8%) had missing data. Those with missing clinical data at time 1 had lower education levels, lower 3MS scores and worse self-rated health. We did not note an increased risk of dementia in rural areas in the cross-sectional analyses (Table 2). The effect of a rural residence became even less significant once education level was considered in the logistic regression model. Age and education level had strong effects on the risk for dementia.

When we considered the 3MS score as an outcome (which we treated as a continuous score), the results were similar. For these analyses, we considered the 3MS scores of participants residing in rural regions and urban regions in linear regression models. The 3MS scores were not significantly different in rural regions compared with urban regions after adjustment for age, sex, education and self-rated health.

Table 1: Baseline characteristics of participants

	Cross-sectional sample				Prospective sample			
Characteristic	Rural $n = 642$	Urban $n = 978$	Missing cognitive status $n = 131$	Total $n = 1751$	Rural $n = 407$	Urban $n = 617$	Excluded $n = 448$	Total $n = 1472$
Age, yr, mean ± SD	76.1 ± 6.9	75.8 ± 7.0	79.3 ± 7.9	76.3 ± 7.1	74.8 ± 6.1	74.4 ± 6.2	77.3 ± 7.5	75.4 ± 6.7
Female sex, %	55.9*	61.2*	51.2	58.5	60.2	62.6	56.6	60.1
Years of education, mean ± SD	8.5 ± 3.2*	10.2 ± 3.5*	6.4 ± 3.3	9.3 ± 3.6	8.9 ± 2.9	10.7 ± 3.3	9.5 ± 3.4	9.9 ± 3.3
Self-rated health "poor," %	23.5	24.1	35.4	24.7	17.2	18.0	29.6	21.7
3MS score, time 1, mean ± SD	85.8 ± 9.7*	87.4 ± 9.8*	67.4 ± 10.9	85.3 ± 11.0	89.0 ± 6.7	90.2 ± 6.3	87.0 ± 6.7	88.9 ± 6.6
3MS score, time 2, mean ± SD	83.5 ± 11.1	84.6 ± 13.0	65.2 ± 19.1	83.5 ± 13.0	84.7 ± 10.4	86.3 ± 11.4	77.2 ± 12.7	85.0 ± 11.5
Did not survive to time 2, %	24.3	21.3	40.5	24.2	—	—	—	—

3MS = Modified Mini-Mental State Examination.
*$p < 0.05$.

Table 2: Results of logistic regression models for dementia in the cross-sectional analyses

Variable	OR (95% CI)			
Rurality (ref: urban)	1.44 (0.85–2.43)	1.38 (0.80–2.37)	1.03 (0.59–1.81)	1.08 (0.61–1.91)
Age (per year)		1.15 (1.11–1.20)	1.14 (1.09–1.19)	1.15 (1.10–1.19)
Sex (ref: male)		0.95 (0.55–1.67)	0.89 (0.51–1.57)	0.95 (0.53–1.67)
Education (per year)			0.83 (0.77–0.90)	0.82 (0.76–0.90)
Self-rated health (ref: "good")				1.46 (0.80–2.67)

CI = confidence interval; OR = odds ratio.

Prospective analyses

We considered the sample of individuals who initially had normal cognition, survived to time 2 and had no missing data at time 2 (n = 1024). Here, we also noted no effect of a rural residence on the risk of having dementia at time 2; in the urban group 8.9% of the population had dementia at time 2 compared with 10.1% in the rural group (p = 0.5, χ^2 test). In logistic regression models, there was no effect of a rural residence after adjustment for potential confounding factors. However, age and self-rated health predicted dementia in these models (Table 3). We conducted a sensitivity analysis in which we compared the time-2 score on the 3MS among rural and urban participants. There was also no difference in the 3MS score at time 2 between those residing in rural and urban regions after adjustment for age, sex, education, self-rated health and the baseline 3MS score.

Regional differences

Because neither rural nor urban regions are homogeneous, we also considered the region of residence. We grouped participants into the region of the province in which they resided and used existing administrative boundaries at the time the study was conducted. In these analyses, we did not have enough participants in each region to consider dementia as an outcome. We therefore used the 3MS score at times 1 and 2. Here, we noted differences in the 3MS scores among the regions (Fig. 3). Generally, the regions with high levels of education and income (e.g., Winnipeg South and Westman regions) had higher 3MS scores, regardless of the rurality of the region. However, all regional differences were small, and were not apparent in models adjusting for age, sex and education.

Table 3: Results of logistic regression models for dementia in the prospective analyses

Variable	OR (95% CI)			
Rurality (ref: urban)	1.15 (0.75–1.75)	1.12 (0.72–1.75)	1.03 (0.65–1.63)	1.05 (0.66–1.68)
Age (per year)		1.16 (1.12–1.20)	1.16 (1.12–1.20)	1.16 (1.12–1.21)
Sex (ref: male)		0.85 (0.53–1.35)	0.84 (0.52–1.34)	0.88 (0.55–1.42)
Education (per year)			0.93 (0.82–1.04)	0.93 (0.83–1.05)
Self-rated health (ref: "good")				1.83 (1.10–3.05)

CI = confidence interval; OR = odds ratio.

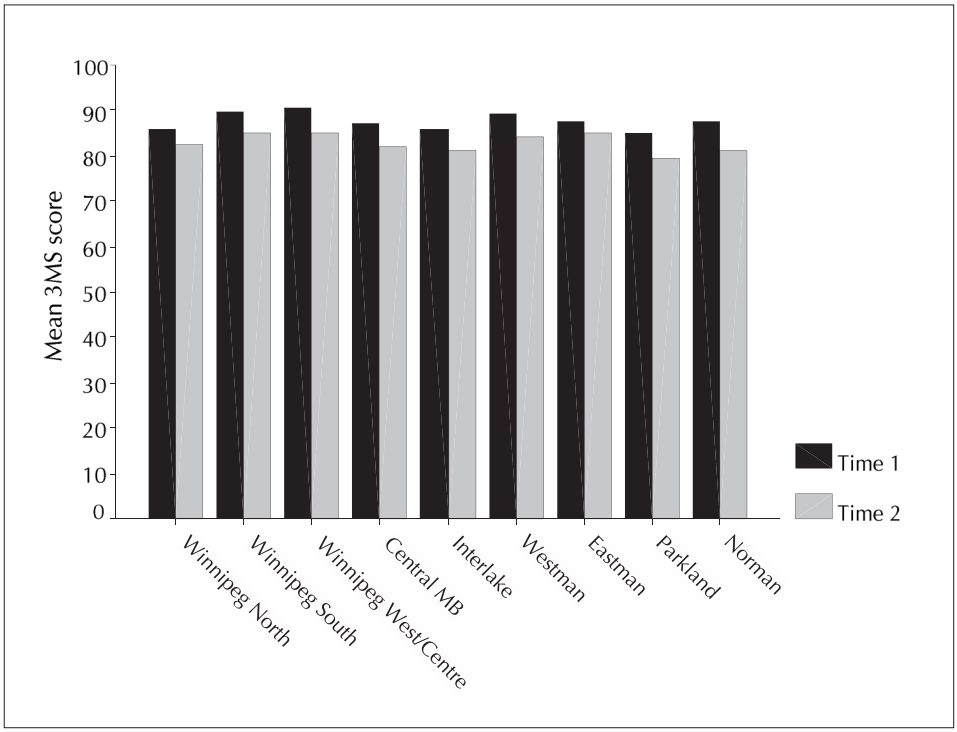

Fig. 3. Cognitive test scores in rural and urban regions of Manitoba. 3MS = Modified Mini-Mental State Examination.

Flin Flon, Thompson and The Pas were mining and service towns at the time of the survey, and the population was younger and more predominantly male, with lower education levels than other regions. We conducted sensitivity analyses in which we excluded the 19 participants from these areas, and the results were not altered.

DISCUSSION

We found no difference in the risk of dementia among older adults living in urban and rural regions of Manitoba. We also did not observe an increase in the risk of developing dementia over a 5-year period. We observed a small difference in the 3MS scores between rural and urban regions. However, this effect was likely due to the considerable difference in education levels in the rural and the urban samples, as it was not apparent in models adjusting for education.

Our results differ from those in previous reports.[6] However, some previous studies did not use standardized measures of dementia,[18] used death certificate data only[19] or compared rural–urban differences across different countries.[20] Our results are somewhat different from the findings of the CSHA. The overall CSHA reported on rural–urban differences in dementia prevalence and found that those living in rural areas had a higher risk for vascular dementia.[21] However, the sampling frame of the CSHA was restricted to within 50 km of a major urban centre. It is therefore difficult to generalize to all rural regions. The MSHA sampled the entire province, including all rural areas except the extremely remote regions, which have very sparse populations. Hébert and colleagues[21] considered vascular dementia, and we did not have the power to study vascular dementia as an end point. Our findings are similar to some others. Lin and colleagues[22] found no rural–urban differences in the risk of dementia in a population-based study in Taiwan. Similarly, no differences were noted in dementia rates or cognitive test scores among the various sites of the Medical Research Council Cognitive Function and Ageing Study in England and Wales.[23]

This study has several strengths. It was a large study involving a large rural population. There are very few studies that have both an urban and a rural population drawn from the same sampling frame. Standardized, reliable measures of cognition were gathered. Also, the geography of Manitoba is such that there is more of a rural–urban dichotomy than in some other regions, which have large suburban and peri-urban areas. This simplifies the definition of rurality, but makes the study of these intermediate regions impossible.

This study also has limitations. First, the data are somewhat old, having been collected in the 1990s. However, it is unlikely that any association between a rural residence and dementia has changed greatly since then. Second, there are no biomedical data available, and we therefore cannot adjust for differences in blood pressure, body mass index or other potential confounding (or mediating) factors. Third, it may be difficult to generalize our findings to other societies where rural and urban regions may be markedly different. Fourth, although we had adequate power to study overall dementia, we lacked the power to study the different types of dementia (e.g., vascular and Alzheimer disease). Finally, we did not consider the residential history of the participants. The effect of a rural residence may be cumulative over the course of a life, and some participants may have moved between rural and urban settings.

The study of any association between rurality and dementia is difficult. Rural regions and urban regions are highly heterogeneous. Even within Manitoba, there is considerable variation in the remoteness, population density, income, industrial base, cultural groups and educational attainment within the rural regions and communities — as there are within Winnipeg. These issues are magnified when comparing across larger geographic areas and across societies. For instance, rural Taiwan and rural England,[22,23] which were the sites of previous research, are quite different from rural Manitoba and from each other. It is difficult to disentangle the factors of rural life that may be relevant for health — remoteness, isolation, educational and career opportunities, access to medical care and unique exposures could all have effects, and it is difficult to understand their individual effects. Future research is needed into which aspects of rurality may affect cognition and at what geographic level they operate (e.g., regional, local and national).

In spite of these problems and limitations, we believe our results have relevance for clinicians, policymakers and older adults themselves. Although we found no increased risk of dementia in rural regions, the well-reported effect of age on dementia prevalence emerged. We could not compare differences in age between rural and urban regions because the MSHA sampling was stratified by age and region. However, most rural areas in Canada have older populations than most urban regions.[24] Thus, there will be large numbers of people with dementia living in rural and remote areas. Provision of care for these people may be complicated by fewer resources and long travel times.[25] Innovative approaches are being studied to address some of these barriers.[26] The strong effect of education merits

attention as well. Education was particularly difficult to deliver to this cohort of older Manitoba residents, especially those living in rural regions. Many of the participants would have been of school age during the Great Depression, when many may have been forced to seek employment or help on farms. Many of the schools were 1-room schools, which may have provided a different experience than their contemporary urban schools. Our results underscore the central importance of education on cognition, and efforts to continue to improve educational opportunities in rural regions will be critical. We also found a significant relation between self-rated health and dementia, consistent with previous research.[27,28] Providing access to high-quality general medical care may be an important component to dementia prevention and care.

There may also be benefits to living in rural areas, with increased support from neighbours, friends and community groups. Learning about these possible factors could help to inform the care of older adults in urban regions. These results may also be important for health care planners. For instance, the need for long-term care may not be driven by differences in dementia rates, but may be highly dependent upon the age structure of the region, and the informal and formal supports in the region.

CONCLUSION

We noted no major differences in the risk of dementia between rural and urban regions of Manitoba. However, more research is needed to address the epidemiology and interventions for older adults with dementia in other rural and urban regions, and consideration of the local context will be important.

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Competing interests: None declared.

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