The Prevalence of Seasonal Affective Disorder Is Low Among Descendants of Icelandic Emigrants in Canada

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Objective: To examine whether a genetic selection within the Icelandic population helps it to adapt to the long arctic winter.

Participants and Setting: The target population was a group of adults in the Interlake district of Manitoba, Canada, wholly descended from Icelandic emigrants. The ancestry of every individual in this group can be traced back to 1840.

Design: The Seasonal Pattern Assessment Questionnaire was mailed to a random sample of the study population. The data were compared with results obtained with similar methods in populations in Iceland and on the eastern seaboard of the United States.

Main Outcome Measures: Prevalence rates of seasonal affective disorder and subsyndromal seasonal affective disorder.

Results: The prevelance rates of seasonal affective disorder and subsyndromal seasonal affective disorder were found to be 1.2% and 3.3%, respectively, in this group of Canadians of wholly Icelandic descent. These are significantly lower than those measured with similar methods among people living along the east coast of the United States (χ^2=12.6 and 14.4, respectively, P<.001). Standardized rate ratio for this group compared with the American group was 0.18 for seasonal affective disorder and 0.38 for subsyndromal seasonal affective disorder.

Conclusions: This is the second study to find the prevalence of seasonal affective disorder and subsyndromal seasonal affective disorder to be lower among Icelanders or their descendants than among populations along the east coast of the United States. The results indicate that the relationship between prevalence of these disorders and geographic latitude is more complex than has previously been suggested; genetic adaptation in Icelandic populations may play an important role.

(Arch Gen Psychiatry. 1993;50:947-951)

SEASONAL AFFECTIVE disorder (SAD) is a condition of depression regularly occurring in fall or winter with remission during the following spring or summer.[1] Subsyndromal SAD (S-SAD) is a milder form of SAD.[2] In the United States, a higher prevalence of SAD has been found to correlate with higher geographic latitude.[3] The prevalence of SAD in Iceland was recently measured with the same methods used earlier in the United States.[4] Interestingly, the rate of prevalence was found to be lower in Iceland than in the United States although Iceland lies much farther to the north. It was suggested that there may have been a genetic selection within the Icelandic population that has helped it to adapt to the long arctic winter. If this is correct, one might expect to find relatively low prevalence rates of SAD and S-SAD among people of Icelandic descent living outside Iceland. The present study assesses the prevalence of these disorders in descendants of Icelandic emigrants to Canada.

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SUBJECTS AND METHODS

MEANS OF MEASUREMENT

Prevalence rates of SAD and S-SAD were measured in this study with the Seasonal Pattern Assessment Questionnaire (SPAQ)[5] described before.[4]

STUDY POPULATION

In the period between 1870 and 1914, some 18 000 Icelanders (about 20% of the population of Iceland in that period) emigrated to North America, many of them to the Interlake district of Manitoba, Canada.[6] Today, there are approximately 600 adults between ages 20 and 74 years living in the Interlake district who are wholly descended from the Icelandic emigrants. Their present culture and lifestyle are completely Canadian. The properties of this Interlake group have been reviewed in detail.[7] The review concludes that the members of this group are of wholly Icelandic descent, and that the original emigrants were drawn equally from all socioeconomic classes and all parts of Iceland. They evidently represented a cross section of Icelanders at that time. Furthermore, the review concludes that the time that has passed since the emigration to Canada (approximately three to four generations) is hardly long enough to allow for a major genetic selection among the immigrants in the new country. The emigrants cannot be distinguished anthropometrically from their kinsmen in Iceland.[8]

The population of Iceland is itself remarkably homogeneous and was so in the period of emigration.[7] This is evidently due to the fact that, by the late 19th century, the Icelanders had lived in virtual isolation from the rest of the world for some 1000 years.[9] Because of the outstandingly accurate early record keeping in Iceland, we can trace the ancestry of every individual in the Interlake study population back to 1840.[9,10]

SURVEY METHODS

Three hundred persons were selected at random from the Interlake study population described above and were sent the SPAQ in the mail. Of these, 252 responded, for a response rate of 82%, representing nearly 42% of the entire population of adult residents of wholly Icelandic descent in the Interlake district. A range of zero to seven items on each scale of the questionnaire had missing data.

COMPARISON WITH EARLIER FINDINGS

The results from the Interlake district (latitude, 50.5°N) were subsequently compared with results obtained with the same methods in populations in Iceland (63°N to 67°N)[4] and in three areas on the eastern seaboard of the United States—Nashua, NH (42.5°N); New York, NY (40°N); and Montgomery County, Maryland (39°N).[3] The Icelandic, Canadian, and American studies were all conducted by mail. They all relied on the same questionnaire and used the same criteria for SAD and S-SAD. **Table 1** compares the demographic characteristics of the respondents from the three countries. There were significant differences between the groups in marital status and mean age.

STATISTICAL METHODS

The Mantel-Haenszel χ^2 test was used for assessing significance levels when comparing age-specific prevalence rates among countries. Using the world population[11] as reference standardized rate ratios were obtained between countries. Results from the SPAQ from Iceland and the Interlake district were compared using logistic regression analysis. Logarithmic transformation of the data did not result in improved computations of the seasonality score (SS). Power test was calculated as described by Pocock.[12] Confidence intervals were computed for the 95% level.

RESULTS

SEASONALITY SCORE AND PREVALENCE OF SAD AND S-SAD IN THE INTERLAKE GROUP

The mean (±SD) SS in the Interlake district was 4.9±3.4. The SS decreased with increasing age (regression coefficient, −.051 per year; confidence interval, 0.021 to 0.081). After adjusting for age, no significant difference in SS between men and women was discovered (P=.76).

Individuals with SAD and S-SAD were identified with the SPAQ based on the criteria described before.[4] The prevalence rates of SAD and S-SAD proved to be 1.2% and 3.3%, respectively, in the Interlake district. One case of summer SAD[13] (defined before[4]) was found. (For purposes of our study, when not further specified, SAD refers to winter SAD.)

COMPARATIVE RESULTS

Table 2 presents results of multiple regression analysis of the SS and six variables measured with the SPAQ. Compared with their kinsmen in the Interlake district, Icelanders reported more seasonal variation in body weight and energy level but less in social activity. After adjusting for sex and age, the SS was not significantly different between the two groups. Icelanders reported a significantly shorter sleep duration both in summer and winter, but the difference was more pronounced during the summer. The values of all the dependent variables, except sleep length in summer, decreased with age, and seasonal variations were generally found to be more pronounced in women. Country, age, and sex were the only significant determinants of the dependent variables presented in Table 2; however, seasonal changes in weight were also

Table 1. Demographic Features of Subjects in the American, Canadian, and Icelandic Studies*

Feature	America	Canada	Iceland	Differences
Latitude, °N	39-42	50	64-67	. . .
No. of questionnaires mailed	2400	252	1000	. . .
Response rate, %	51	84	61	. . .
Sex distribution				
M	542	125	289	χ^2=0.423, P>.5
F	590	127	298	
Mean (±SD) age, y				
All subjects	45.8±15	47.1±15	37.8±14	. . .
M	45.0±15	48.0±16	38.2±14	NS†
F	46.3±15	46.2±14	37.5±14	
Marital status				
Single	256 (21%)	26 (11%)	124 (21%)	χ^2=49.1, P<.001
Married	775 (63%)	202 (81%)	410 (70%)	
Separated/divorced	133 (11%)	12 (5%)	27 (5%)	
Widowed	70 (5%)	8 (3%)	26 (4%)	
No. of subjects	1234	252	587	. . .

**American rates are totals from Montgomery County, Maryland; Nashua, NH; and New York, NY.*

†Analysis of variance could not be performed and t *test was applied instead. Mean age differences between the US and Canadian groups were not significantly different (*t*=1.91 and 0.072 for male and female subjects, respectively). The Icelandic respondents, male and female, were significantly younger than those from the United States and Canada;* t *values ranged from 5.88 to 8.6,* P*<.001 always.*

Table 2. Comparison of Results From Iceland and Canada With Multiple Regression Analysis of Variables From the Seasonal Pattern Assessment Questionnaire*

	Independent Variables			
Dependent Variable	Intercept	Country	Age	Sex
Seasonality score	6.35	NS	−0.063 (0.081-0.045)	+0.97 (0.44-1.5)
Seasonal variation in social activity	1.38	+0.68 (0.54-0.83)	−0.013 (0.017-0.009)	NS
Seasonal variation in mood	2.66	NS	−0.015 (0.020-0.010)	NS
Seasonal variation in energy	2.46	−0.26 (0.43-0.09)	−0.009 (0.014-0.004)	+0.26 (0.12-0.40)
Seasonal variation in weight, kg	−0.03	−0.09 (0.17-0.01)	−0.005 (0.002-0.008)	+0.24 (0.17-0.31)
Hours slept during winter	7.36	+0.29 (0.06-0.52)	−0.008 (0.014-0.002)	+0.27 (0.10-0.44)
Hours slept during summer	5.91	+0.70 (0.56-0.84)	NS	+0.22 (0.10-0.34)

**The first three scales, on seasonal variation, range from 0 to 4 (0, no change; 4, extremely marked change). Scores were as follows: Iceland, 1; Canada, 2; male, 1; and female, 2. Values are regression coefficients and those in parentheses are 95% confidence intervals. NS indicates not significant.*

dependent on absolute body weight (regression coefficient, .011 kg/kg; confidence interval, 0.009 to 0.013).

Table 3 shows that the age-adjusted prevalences of SAD and S-SAD were significantly lower in the Interlake district than in the northeastern United States. The standardized rate ratio for the Canadian group compared with the American group was 0.18 for SAD and 0.38 for S-SAD. Among the three northeastern American locations, the mean SS was lowest in Montgomery County (6.7±4.3). The mean SS in the Interlake district (4.9±3.4) was significantly lower than in Montgomery County (z=6.51; P<.001).

Age-adjusted prevalence rates for SAD and S-SAD were lower in the Interlake district than in Iceland (1.3% vs 3.6% and 4.1% vs 6.9% for SAD and S-SAD, respectively).

The age-adjusted prevalence of combined SAD and S-SAD was significantly lower in the Interlake district than in Iceland (χ^2=5.7 using the Mantel-Haenszel test; P<.025; standardized rate ratio, 0.52). However, there were no statistically significant differences between the two groups for SAD and S-SAD separately (χ^2=1.8 and 3.2, respectively, with the Mantel-Haenszel test).

The **Figure** shows prevalence rates for combined SAD and S-SAD in the United States, Iceland, and Canada.

COMMENT

UNITED STATES VS CANADA

It has long been suspected that light deprivation is a major etiologic factor in SAD. Accordingly, higher preva-

Table 3. Age-Standardized Prevalence Rates of Seasonal Affective Disorder (SAD) and Subsyndromal SAD (S-SAD) in Canada and the United States*

Variable	Age Group, y ≤24	25-34	35-44	45-54	≥55	Prevalence Rate, %†	Differences‡
Total United States	97	319	257	180	297	. . .	. . .
Total Canada	17	48	46	47	83	. . .	. . .
SAD							
United States	8	24	19	19	12	7.4	12.6
Canada	0	1	1	1	0	1.3	P<.001
S-SAD							
United States	7	51	27	21	20	10.7	14.4
Canada	2	2	0	3	1	4.1	P<.001

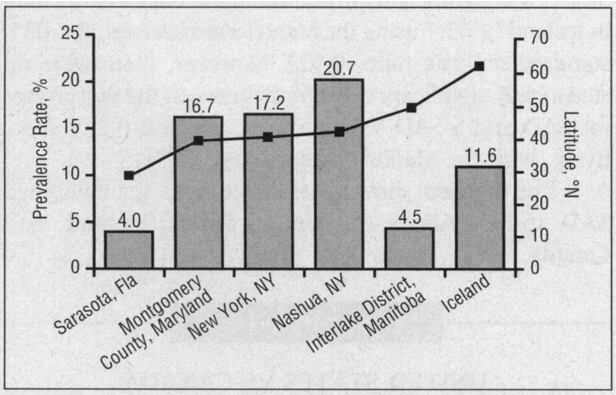
*American rates are the totals from Montgomery County, Maryland (39°N); New York, NY (40°N); and Nashua, NH (42.5°N). Canadian rates are from the Interlake district of Manitoba (50°N).

†The world population[11] was used as the reference population in standardizing the prevalence rates for age with the direct method.

‡In testing for overall differences in prevalence rates the Mantel-Haenszel χ^2 test was applied. Subjects with SAD were excluded from the group "without S-SAD."

lence rates might be expected at higher latitudes. The findings of Rosen et al[3] seemed to provide evidential support for the latitude hypotheses. We, however, previously found that the prevalence rates of SAD and S-SAD were significantly lower in Iceland (63°N to 67°N) than in the three northeastern American locations (39°N to 42.5°N) studied by Rosen et al.[3] This contradicts the latitude hypothesis in any simple form. The Icelandic nation has lived in high latitudes and in virtual isolation from the rest of the world for over 1000 years. Under these conditions, adaptation to high-latitude conditions may have occurred in such a way as to result in relatively low prevalence rates of SAD and S-SAD in the present population of Iceland. This was indeed proposed in our previous article[4] as a possible explanation of the low prevalence rates observed in Iceland. Such an explanation assumes that having SAD or S-SAD is disadvantageous for reproduction, an assumption that has as yet no independent support.

The present study takes advantage of the existence of a population of Canadians wholly descended from Icelandic emigrants. Age-adjusted prevalence rates for SAD and S-SAD and the SS were all significantly lower in this group than in the three American locations mentioned above. Ours is the second study that finds lower prevalence rates for SAD and S-SAD among Icelanders and their descendants than among US citizens, and emphasizes the importance of becoming clearer about the role of factors other than latitude on the prevalence of SAD and S-SAD.



Combined prevalence rates of seasonal affective disorder and subsyndromal seasonal affective disorder at different latitudes (line with squares) in three locations in the United States, Iceland, and among people of wholly Icelandic descent in Canada.

The marital profile of the Interlake group was different from that of the American groups. However, marital status did not influence the SS in either the present or in previous studies.[4,14] The Interlake district is more rural than the locations studied by Rosen et al. The effect of residency (rural vs urban) has been studied in Iceland.

Residency did not influence the SS nor was it a determinant of SAD or S-SAD.[4] Hence, a more rural setting is not likely to explain the relatively low prevalence of SAD and S-SAD among the Interlake group. Similarly, climatic changes across seasons are unlikely to explain the relatively low prevalence rates for SAD and S-SAD found in the Interlake district. Manitoba has a continental climate with extreme temperature differences between winter and summer; common sense suggests that these would tend to exaggerate, rather than suppress, seasonal changes in mood, especially in comparison with such climatic changes as characterize the oceanic environment along the eastern seaboard of the United States.

ICELAND VS CANADA

The properties of the Interlake study population have been reviewed in detail.[7] It seems well established that this population does not differ genetically from the Icelandic population. Seasonal variations in energy level, social activity, and body weight were significantly different between the Interlake and Icelandic groups. The sex- and age-adjusted SS was not significantly different between the two groups. Sleep length, both in summer and winter, was different between the two groups as well. These differences might be due to environmental factors, including latitude. The prevalence rates of SAD and S-SAD were much lower in the Interlake district than in Iceland. The difference between the two groups in combined prevalence rates of SAD and S-SAD was statistically significant. However, there were no statistically significant differences between the two groups for SAD and S-SAD separately. When the prevalence of these disorders becomes as low as among the Interlake group, the power of the test is reduced. For example, if we assume that the true rates are similar to those estimated in this survey, the probability (power) of finding significant differences in prevalence rates for SAD and S-SAD between two groups of sizes such as ours is only 28% and 40%. Thus the lack of significance is not very informative. The finding that the prevalence of combined SAD and S-SAD was significantly lower in the Interlake district than in Iceland lends support to the hypotheses that prevalence rates of SAD and S-SAD are influenced by latitude within genetically similar populations. The findings reported herein need to be corroborated by studies including clinical evaluations of larger samples.

Accepted for publication July 30, 1992.

This study was supported in part by a grant from the Icelandic Scientific Council, Reykjavík.

We thank H. Sigvaldason, PhD, for statistical advice, and G. Pétursdottir, PhD, S. B. Sigurdsson, PhD, M. Karlsson, PhD, and other members of the Icelandic-Canadian research team for valuable assistance.

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REFERENCES

1. American Psychiatric Association, Committee on Nomenclature and Statistics. *Diagnostic and Statistical Manual of Mental Disorders, Revised Third Edition.* Washington, DC: American Psychiatric Association; 1987.
2. Kasper S, Rogers B, Yancey A, Schulz PM, Skwerer RG, Rosenthal NE. Phototherapy in individuals with and without subsyndromal seasonal affective disorder. *Arch Gen Psychiatry.* 1989;46:837-844.
3. Rosen LN, Targum SD, Terman M, Bryant MJ, Hoffman H, Kasper SF, Hamovit JR, Docherty PJ, Welch B, Rosenthal NE. Prevalence of seasonal affective disorder at four latitudes. *Psychiatry Res.* 1990;31:131-144.
4. Magnússon A, Stefánsson JG. Prevalence of seasonal affective disorder in Iceland. *Arch Gen Psychiatry.* 1993;50:941-946.
5. Rosenthal NE, Genhart M, Sack DA, Skwerer RG, Wehr TA. Seasonal affective disorder: relevance for treatment and research of bulimia. In: Hudson JI, Pope HG, eds. *Psychobiology of Bulimia.* Washington, DC: American Psychiatric Press; 1987:205-228.
6. Axelsson J, Palsson JOP, Petursdottir G, Sigfusson N, Way AB. Comparative studies of Icelandic people living in Canada and Iceland. In: Harvald B, Hart Hansen JP, eds. *Circumpolar Health 1981: Proceedings of the 5th International Symposium on Circumpolar Health.* Copenhagen, Denmark: Nordic Council for Arctic Medical Research; 1981:295-299.
7. Axelsson J, Karlsson M, Petursdottir G, Asgeirsdottir AG, Ólafsson Ó, Sigfusson NB, Way AB, Sigvaldason H, Sigurosson SB. Prevalence of cardiovascular risk factors in two separate but genetically comparable populations. In: Postl BD, ed. *Circumpolar Health 1990: Proceedings of the 8th International Congress on Circumpolar Health.* Winnipeg, Manitoba: University of Manitoba Press; 1991:509-511.
8. Palsson JOP. Institute of Anthropology. In: Ragnarsdottir GA, ed. *Icelandic Council of Science and National Research Council Annual Report.* Reykjavík, Iceland: Science Council and National Research Council; 1988:62-64.
9. Petursdottir G. When being small is your strength: a survey of Iceland as a forum for population studies. In: Fortuine R, ed. *Circumpolar Health 1984: Proceedings of the 6th International Symposium on Circumpolar Health.* Seattle, Wash: University of Washington Press; 1985:22-31.
10. Kristinsson JH. *Vesturfaraskrar 1870-1914: A Record of Emigrants From Iceland to America 1870-1914.* Reykjavík, Iceland: Institute of History, University of Iceland; 1983.
11. Doll R, Payne P, Waterhouse J. Comparison between registries. In: Doll R, Payne P, Waterhouse J, eds. *Cancer Incidence in Five Continents.* New York, NY: Springer Verlag NY Inc; 1966:217-218.
12. Pocock SJ. Size of a clinical trial. In: *Clinical Trials.* New York, NY: John Wiley & Sons Inc; 1983:123-141.
13. Wehr TA, Giesen H, Schulz PM, Joseph-Vanderpool JR, Kasper S, Kelly K, Rosenthal NE. Summer depression: description of the syndrome and comparison with winter depression. In: Rosenthal NE, Blehar MC, eds. *Seasonal Affective Disorder and Phototherapy.* New York, NY: Guilford Press; 1989:55-63.
14. Kasper S, Wehr T, Bartako JJ, Gaist PA, Rosenthal NE. Epidemiological findings of seasonal changes in mood and behaviour: a telephone survey of Montgomery County, Maryland. *Arch Gen Psychiatry.* 1989;46:823-833.