

Short Report

Relation of mathematical ability to psychosis in Iceland

Karlsson JL. Relation of mathematical ability to psychosis in Iceland. Clin Genet 1999; 56: 447–449. © Munksgaard, 1999

A study of mathematically gifted Icelanders demonstrates an increased risk of mental illness in their ranks. Psychotic disorders are also frequent among their relatives. Linkage of academic records with previously published data on the family distribution of psychosis reveals a pattern compatible with the hypothesis that high arousal plays a role in reasoning ability.

Jon L Karlsson

Institute of Genetics, Reykjavik, Iceland

Key words: creativity – mathematics – psychosis

Corresponding author: Jon L Karlsson, Institute of Genetics, Hraunteig 16, Reykjavik, Iceland. E-mail: jonlk@l-cafe.net

Received 23 April 1999, revised and accepted for publication 7 September 1999

Conditions are especially favorable in Iceland for family studies of traits associated with psychiatric disorders, because of readily available longitudinal historical, educational, and medical records that can be coupled with extensive genealogical information. Also helpful is the small but adequate size of the nation (275000, doubled since 1940) and its stability, along with a high literacy rate. This paper deals with the occurrence of psychosis in relation to academic status on the island, where it has long been suspected that high performers on scholastic tests may be particularly vulnerable to mental illness (1). For reasons that have been explained by others (2), both delusional and affective psychoses are treated as a unit in the present investigation.

Materials and methods

Demographic data make it possible to identify and follow the approximately 2500 individuals born in Iceland each year and to trace their family trees.

A large investigation of psychotic illness (3) has led previously to characterization of sizable samples of patients' relatives selected from the records of the Kleppur Mental Hospital, which serves the whole country (4). The study embraced the entire population of the island born in the period 1851–1940 and surviving past the age of 15. The material was divided into three generations of 30 years each and the basic rates were established of ever having been admitted to the mental hospital with a psychotic diagnosis up to the year 1968. Various classes of relatives of the 1377 index cases were

identified and their comparative rates of hospital admission were determined in the same manner. For the purposes of the present investigation, the focus is on the generation born between 1911 and 1940, embracing 2137 full siblings of patients, 1146 children of index cases, 4673 nephews and nieces, and 517 grandchildren.

Information about academic performance is accessible in the university library in Reykjavik, listing actual grades in different subjects attained by each student matriculating from the 'gymnasium' type university preparatory schools. These institutions, offering two standard curricula emphasizing either languages and humanities or mathematics and science, were formerly attended by a small fraction of the population selected through rigorous admission tests. For the present study the scores assigned in the final written mathematics examination at the Reykjavik College at the age of 20 have been assembled for scholars born between 1911 and 1940. Until 1936 this was the only school offering a mathematics and science curriculum. The six best mathematics performers each year during the 30-year period form a sample of individuals whose backgrounds have been investigated. These graduates had attended courses in algebra, geometry, analytical geometry, trigonometry, and calculus, and the tests covered all these areas. The 180 scholars included in the main study embrace 0.25% of all persons born between 1911 and 1940 who survived past the age of 15. Thus, they represent the 99.75 percentile segment of the Icelandic population as measured here and constitute the top

20% of the 887 mathematics graduates of that period. If mathematical ability is evenly distributed in randomly selected population segments, the expected number of high achievers in any group can be estimated by multiplying the total number by 0.25%. Icelandic students have in the past generally performed well compared with others in competitive examinations; some members of the present cohort have accepted positions as mathematics professors at major European or American universities.

Once the names and birthdates of the students had been assembled, identification of the parents and full siblings was achieved through use of the genealogy records of the National Archives. Uncles and aunts, as well as grandparents, were also readily discovered. This material has been cross-matched with the data on hospital-treated psychosis from the previous study of mental illness. No information was requested from the mathematicians, all the data being derived from public records. A study similar to the original investigation of psychosis would be more difficult at present because of the development of antipsychotic medications and the fact that patients who are hospitalized are now treated in more than one center. New laws on confidentiality similarly interfere with access to medical data.

Results

Perusal of the assembled information reveals a pattern suggestive of an increase of mental illness in the families of Icelandic mathematicians, not only in the present material, but in data on individuals born in a prior period. The high ranking students show a definite risk, and the same is true of their relatives. The observed kind of distribution is not seen in randomly selected material. The actual rates of psychosis are summarized in Table 1, demonstrating the increased risk among the top mathematicians and their immediate family members. Further analysis of the data is presented in Table 2, showing mathematical achievement in relatives identified in the earlier publication through occurrence of psychotic illness (3).

Table 1. Comparative rates of documented psychosis in Icelandic mathematicians, their full siblings, and the general population, all classes born between 1911 and 1940

Class	N	% Hospitalized	Comparative rate
Mathematicians	180	3.3	4.1
Full siblings	440	2.7	3.4
General population	70 000	0.8	1.0

Table 2. Expected versus observed numbers of mathematicians among mental patients and their relatives born in Iceland in the period 1911–1940

Type of person	N	Mathematicians	
		Expected	Observed
Psychotic probands	544	1.4	6
Full siblings	2137	5.5	12
Children	1146	2.9	4
Grandchildren	517	1.3	5
Nephews–nieces	4673	12.0	22

There is an obvious clustering of mathematical ability in certain families. Several instances are seen where two or more siblings have distinguished themselves as high performers. The usually observed gender difference (5) is also seen. Of the 180 successful index cases, only seven are women, none of them the number one performer in any year. One female was the overall top graduate in her class, although male members scored higher than her in mathematics.

Since by its nature this research deals mostly with males, it is not practical to perform a parallel study of high performing females. However, an investigation of all 105 women who have chosen the mathematics sections of the Icelandic gymnasia provides a group of adequate size, comprising 0.3% of all females born between 1911 and 1940. Table 3 presents the findings derived from this material, the expected numbers again based on the assumption that reasoning ability is evenly distributed in the population, although here the expectation is computed by multiplication of the total by 0.3%. Presence of the psychosis factor in those inclined toward mathematics seems evident. Girls who see themselves as capable in arithmetic and hence choose the mathematics curriculum show a significant increase of mental illness in their families. Previously identified women, who have either been psychotic or are relatives of psychotics, have an elevated likelihood of being graduates of the mathematics sections of the Icelandic schools.

Only hospital-treated mental cases are included in this study, showing rates as of the year 1968. The disease risk is not concentrated in just a few

Table 3. Expected versus observed numbers of female graduates in mathematics and science among psychotic patients and their relatives born in Iceland in the period 1911–1940

Class	N	Expected	Observed
Psychotic women	278	0.8	2
Full sisters	1068	3.2	9
Daughters	573	1.7	3
Nieces	2336	7.0	8

families. Some kinships contain an affected index case while others show documented psychosis only in the relatives. The two major types of psychotic illness occur intermingled in the various families. Of the top mathematicians in the main study, four were diagnosed schizophrenic at the hospital, the other two affective. Full siblings show eight instances of schizophrenia and 11 of affective illness. Other identified relatives were diagnosed 22 schizophrenic and 37 affective. The total is thus 34 instances of schizophrenia and 50 of affective illness.

Discussion

The 3% rate of hospitalization among the top mathematicians and their siblings in Table 1 by the year 1968 must be considered highly significant. A chi-square test of these 620 individuals with 18 instances of psychosis instead of the expectation of 5 demonstrates a probability of less than 1% that this is an accidental occurrence. According to the partly dominant inheritance hypothesis for psychosis (3), a population born with the postulated major gene has a 25% lifetime risk of developing serious mental illness, but just one-third of that number, or 8%, leads to institutional care. Since the individuals studied here were still relatively young in 1968, the figure is likely to rise further. Additional instances of psychosis are in fact known, although not included in the data. It consequently seems probable that at least half of the best mathematicians must harbor a psychosis factor. It has previously been estimated that highly creative world-famous mathematicians may all carry a psychosis gene (6).

Similar conclusions can be arrived at by evaluating the comparative increase in psychosis. Since

the risk of hospitalization by 1968 for the 70000 Icelanders born between 1911 and 1940 and surviving past the age of 15 is 0.8%, the increase among the mathematicians is 4-fold. That is the same figure as the comparative risk in first-degree relatives of mental patients, just over half of whom can be assumed to be born with a psychosis factor.

While a few of the mathematicians in this study developed mental illness, most became productive citizens in the fields of science or technology. Several took positions as college instructors or university professors.

Association of the proposed psychosis gene with creativity is recognized (7), but a connection to academic performance has received less attention. The findings in the present study suggest that further information needs to be gathered on that subject. It can be surmised that high arousal, thought to be connected with excessive cerebral stimulation, is operative in mathematical inclinations, although only a fraction of psychosis gene carriers exhibit such mathematical ability.

References

1. Karlsson JL. *Genetics of Human Mentality*. New York, NY: Praeger, 1991.
2. Crow TJ. The continuum of psychosis and its implication for the structure of the gene. *Br J Psychiatry* 1986; 149: 419–429.
3. Karlsson JL. Partly dominant transmission of schizophrenia in Iceland. *Br J Psychiatry* 1988; 152: 324–329.
4. Helgason T. Epidemiology of mental disorders in Iceland. *Acta Psychiatr Scand* 1964; 173 (Suppl): 1–258.
5. Benbow CP, Stanley J. Sex differences in mathematical reasoning ability: more facts. *Science* 1983; 222: 1029–1031.
6. Karlsson JL. *Inheritance of Creative Intelligence*. Chicago, IL: Nelson-Hall, 1978.
7. Goodwin FK, Jamison KR. *Manic Depressive Illness*. Oxford: Oxford University Press, 1990.