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Birthrates of Schizophrenics Following Relatively Warm versus Relatively Cool Summers*

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SUMMARY. Schizophrenics have consistently been found to be born with unusually high frequency in the early months of the calendar year. A previous study found significantly more schizophrenics to be born following warmer as contrasted with cooler summers, thus suggesting that summer temperature or a correlate of summer temperature may be an effective factor in the season of birth schizophrenia relationship. The current study re-tested the warmer vs. cooler summer finding, using both a local sample (N = 301) and a nationwide sample of Swedish schizophrenics (N = 13,440), each sample showing increased frequency of births in the early months of the year. In order to localize the possible effects of temperature to a more specific gestational period, the schizophrenics in each sample were further divided into sub-groups based upon which trimester of gestation likely occurred during the summer prior to the birth. The 71 years (1876-1946) during which the patients were born were rank-ordered by mean summer temperature at representative geographical locations, and the rank-orders of years were divided into temperature quartiles. The rates of births for the total patient groups and the trimester sub-groups among both samples showed no positive linear or systematic relationship to temperature during the previous summer. Even the warmest among the 71 years were not followed by increased rates of births of schizophrenics. The results of the study did not corroborate the earlier finding.

KEY WORDS: Seasonality - Temperature - Schizophrenia.

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INTRODUCTION

Independent studies in different countries, including Scandinavia, have shown that schizophrenics are born with unusual frequency in the early months of the calendar year (Dalén, 1968, 1975; Videbech, Weeke, Dupont, 1974; Ødegård, 1974). A number of explanations have been offered for the observed relationship between schizophrenia and birth season, perhaps the most widely accepted explanation being that season-related factors have a deleterious effect on fetal or early postnatal development, thus increasing the risk for schizophrenia (among other disorders). That the increase in births of schizophrenics occurs in the early months of the year (January-April) suggests that the relevant gestational sequence consists of the first trimester of gestation primarily during the preceding summer, the second trimester primarily during the preceding fall, and the third trimester primarily during late fall or winter.

Pasamanick, Dinitz, and Knobloch (1961) suggested that the part of this gestational sequence relevant to schizophrenia is summer (largely first trimester) and that the relevant variable is environmental temperature or correlates of temperature: They found that significantly more schizophrenics were born following warm, as compared with cool, summers. This is the only report of such a finding in the literature, and the schizophrenic sample which yielded this finding was somewhat atypical in not showing the usual increased relative frequency of births in the early months of the year.

The current study was an attempt to re-test the hypothesis that more persons among schizophrenics are born following relatively warm vs. relatively cool summers. The study used Swedish schizophrenic samples which showed the increased frequency of births in January-April.

The present study also provided the opportunity for further specification of the hypothesized relationship by studying sub-samples of schizophrenics who most likely had a given trimester of gestation during the summer. The hypothesis tested does not specify a given trimester of gestation as most sensitive to the effects of differential summer temperature, but schizophrenics who had gestational trimester I during the summer may be of primary interest, given the observed seasonality of births for schizophrenics.

The study used two psychiatric samples independently collected by McNeil, Dzierzykray-Rogalska, and Kaij, and by Dalén. The first sample is a smaller sample of male schizophrenic and paranoid patients and has the advantage of being relatively specific in terms of summer temperature relevant to the birth location of the majority of patients. The second sample is a nationwide sample of Swedish schizophrenics which is necessarily less specific regarding local summer temperature during gestation, but which has the advantage of increased sample size. For standardization purposes, the two samples were limited to the same range of temperature-years, and analyses were based on a common temperature variable.

METHODS AND RESULTS

Grouping of patients and gestational periods was done according to the following principles: The summer was defined as June 1-August 31. Total patient groups: Patients born in any month of the year are assumed to be relevant to the hypothesis, since almost all pregnancies occur at least partially during the summer. Births during January through June were counted as relevant to the previous summer's temperature; births during July through December were counted as relevant to the same year's summer temperature. For example, those patients who are relevant to the summer temperature in 1940 were born July-December, 1940, and January-June, 1941.

Trimester sub-grouping: The length of gestation was assumed to be 38 weeks (from the beginning of the third week until the end of the fortieth week, per the 40-week pregnancy calendar of S. von Wachenfeldt); the first two weeks from the beginning of last menstruation until fertilization were not counted as included in the gestation. Within the 38-week period, trimesters were defined in the following manner: First trimester from the beginning of the third week until the middle of the fifteenth week; second trimester from the middle of the fifteenth week until the end of the twenty-seventh week; third trimester from the beginning of the twenty-eighth week until the end of the fortieth week.

In order to obtain relatively pure patient sub-groups with a given trimester occurring during the summer, the requirement was made that at least eight weeks of this trimester (as defined above) must have occurred during the summer. Given a gestation of 38 weeks, those having at least 8 weeks of the first trimester during the summer would be born January 20-March 27 of the following year. Accordingly, the second trimester corresponds to birth dates October 28-December 29, and the third trimester to birth dates July 28-October 5. Since population birth figures are available only for whole calendar months, the above trimester groups were rounded off to whole birth months in the following manner: First Trimester Group - born February and March next year; Second Trimester Group - born November and December same year; Third Trimester Group - born August and September same year. (The First Trimester Group was counted as relevant to the summer temperature of the preceding year, while the Second and Third Trimester Groups were counted as relevant to the summer temperature of the same year.) The relationship between temperature and patient birthrates was calculated for both the total patient groups and the different trimester groups.

I. Malmö Psychiatric Sample Analyses

Sample. The sample selected was all men[1] admitted to Östra Psychiatric Hospital, Malmö, Sweden, during 1955-1964, who had received a primary hospital diagnosis of schizophrenia or paranoia by the time of sample selec-

[1] Dalén (1975) found only trivial differences between male vs. female schizophrenics in season of birth patterns.

tion in summer, 1973. Among the total 1,898 male admissions, 285 were classified as schizophrenic and 36 were classified as paranoid. Since schizophrenics and paranoids both show an increased frequency of births during the early part of the year (Dalén, 1975), these two diagnostic groups were combined and analyzed together in the Malmö sample. The 19 (5.9%) patients not born in Sweden were excluded from the sample, as was one patient born in 1874, a year for which no summer temperature data were available. The remaining 301 patients constituted the final sample used for analysis.

As shown in Table 1, the final Malmö sample closely corresponds to the final entire Swedish sample in terms of percentage of births in January-April. The Malmö sample thus conformed to the requirement that the current hypothesis be tested on patient groups showing the expected increase of births in the early months of the year.

Trimester Groups. Within the final sample, 56 patients belonged to the First Trimester Group (born February-March), 48 to the Second Trimester Group (born November-December), and 52 to the Third Trimester Group (born August-September). These three trimester groups constituted 51.8% (156/301) of the total final sample.

Place and Year of Birth. A total of 85.7% (258/301) of the patients were born in the contiguous regions of Skåne and Blekinge in southern Sweden. Temperatures for the city of Lund, in Skåne, were assumed to be generally representative for the birth area of the sample. The birth years ranged from 1877 to 1947, with the relevant summers from 1876 to 1946, a total of 71 years.

Rank-Order of Years by Summer Temperature. The monthly means of the daily temperature at 14:00 (2 p.m.) in Lund (Hamberg, 1887-1918; KSVA, 1876-1948; SMHA, 1919-1949) were used to calculate the mean temperature of June-August. Based on this mean temperature, the years 1876-

Table 1. Season of birth among Malmö and total Swedish schizophrenic samples

	Number (%) born January-April vs. other months	
Patient sample	January-April	May-December
Malmö schizophrenics & paranoids (N = 301)	114 (37.9%)	187 (62.1%)
Total Swedish schizophrenics (N = 13,440)	4911 (36.5%)	8529 (63.5%)

1946 inclusive were rank-ordered from coldest to warmest, and the rank-order was divided into approximate quartiles[2] (Coldest, Next Coldest, Next Warmest, Warmest).

Quartile Patient and Population Birthrates. The number of patients born in the periods relevant to the years of each quartile was divided by the number of live births occurring in Malmöhus County during the same time periods and expressed as number of patient births per 100, 000 live births. For each of the trimester sub-groups, the population figures were comprised of the number of live births in M-County in the two relevant months. Population statistics were obtained in part from publications (BSOS, 1878-1910) and in part from the Swedish Central Bureau of Statistics, Örebro.

Results. As shown in Table 2, no positive linear relationship was found between temperature quartile and patient birthrates. The Warmest quartile did not have the highest patient birthrate in any of the comparisons. Inspection of the rank-order of years by temperature showed that not even the very warmest among the 71 years were followed by increased patient births.

Chi-square analysis of the patient birth frequencies per temperature quartile showed a significant deviation from the expected frequencies, based on population birthrates ($X^2 = 11.94$, 3 df, $p < .02$). This deviation was largely due to an unexpectedly high rate of patient births among the Coldest temperature quartile years. The patient birth frequency for the Warmest temperature quartile showed almost no deviation from the expected number.

Sub-Sample Born 1900-1935. The annual birth frequencies of the Malmö sample showed an inverted-U form over the 71-year period, with relatively few births before 1900 and after 1935. This of course reflects the age distribution of male schizophrenics and paranoids admitted for hospitalization 1955-1964. In order to reduce any bias due to this age distribution, the relationship between temperature quartile and patient birthrates was also calculated (in the same manner) for the years 1900-1935 using the 246 patients born during that period. As shown in Table 2, the Coldest temperature quartile again was associated with the highest patient birthrate. The quartile distribution of patient births for this sub-sample did not significantly deviate from the distribution expected from population birthrates ($X^2 = 4.43$, 3 df, n. s.).

The data from the Malmö sample thus did not support the hypothesis of a positive relationship between summer temperature and subsequent patient birthrates.

[2] All years with the same mean temperature were placed in the same quartile even though this resulted in quartiles of different sizes. Quartile size differences were allowed for by calculating patient births per population births during the same period.

Table 2. Summer temperature quartiles and subsequent birthrates of Malmö psychiatric sample

Patient group born following the summer	Temperature quartile per mean °C. June-August: Coldest (17 years) [17.1-18.3°]	Next Coldest (17 years) [18.5-19.3°]	Next Warmest (18 years) [19.4-20.1°]	Warmest (19 years) [20.2-21.6°]
Entire Malmö sample (N = 301)				
No. born/100,000 in population[a]	56.6	35.8	35.5	45.2
First-Trimester Group (born February-March) N = 56				
No. born/100,000 in population[a]	47.0	45.0	48.0	47.2
Second-Trimester Group (born November-December) N = 48				
No. born/100,000 in population[a]	64.3	22.2	51.8	47.5
Third-Trimester Group (born August-September) N = 52				
No. born/100,000 in population[a]	66.6	43.1	26.2	31.5
Malmö psychiatric sub-sample born 1900-1935 (N = 246)[b]				
No. born/100,000 in population[a]	80.1	75.1	56.8	75.4

[a] Population figures are all live births in Malmöhus County during the months and years covered by the patient groups. Population figures for the entire Malmö sample and the 1900-1935 sub-sample cover 12-month periods, while population figures for the trimester groups cover two-month periods each.

[b] Quartile temperature ranges for the 1900-1935 sub-sample were almost identical to those for the entire sample. The quartiles, in order from Coldest to Warmest, consisted of 8, 9, 10, and 9 years, respectively.

II. Total Swedish Schizophrenic Sample Analyses

Sample. The base sample consisted of 13, 545 male and female patients (a) born in Sweden, and (b) discharged 1962-1964 from all Swedish mental hospitals and psychiatric departments of general hospitals, (c) with a primary hospital diagnosis of schizophrenia (I. C. D. 300). Birth years in this sample ranged from 1871-1951. To make the Malmö and total Swedish samples comparable summer-wise, the current sample was limited to patients born from July, 1876 through June, 1947, with the relevant summers 1876-1946. The 105 (0. 8%) patients born outside these time limits (56 before July, 1876, and 49 after June, 1947) were excluded from the sample. The final sample consisted of 13, 440 schizophrenic patients.

The base sample has been found to have a highly significant excess of births in January-April (Dalén, 1968, 1975).

Trimester Groups. Within the final sample 2, 485 patients belonged to the First Trimester Group, 2, 003 patients to the Second Trimester Group, and 2, 094 patients to the Third Trimester Group. The three trimester subgroups constituted 49. 0% (6582/13440) of the total final sample.

Birth Location and Rank-Order of Years by Summer Temperature. For the present sample, no information was analyzed regarding the geographical distribution of patient births within Sweden. Temperature data from Stockholm were taken as generally representative for the birth area of the total Swedish sample. Data from Liljequist (1950) provided the mean temperature for June-August in Stockholm. The summers of the years 1876-1946 inclusive were rank-ordered from coldest to warmest, and the rank-order was divided into approximate quartiles. The rank-orders of years by Lund vs. Stockholm temperatures were not identical, but bore considerable similarity to one another quartile-wise.

Quartile Patient and Population Birthrates. Population control figures used for the national schizophrenic sample were all live births in the entire country during the relevant months and years. Patient birthrates were expressed per 10, 000 live births in the population, as described above for the Malmö sample.

Results. As shown in Table 3, no positive linear relationship was found between temperature quartile and patient birthrates. For the entire sample, birthrates were very comparable across all quartiles, with the exception of the Next Warmest quartile which showed a considerably lower birthrate. Chi-square analysis of the actual frequencies per quartile showed a highly significant deviation from expected frequencies, mostly reflecting the low rate of the Next Warmest quartile ($X^2 = 172.33$, 3 df, $p < .001$). Among the three trimester sub-groups, two showed the highest patient birthrate for the Coldest quartile, while one showed the highest patient birthrate for the Warmest quartile. In total, the results did not support the hypothesis.

Sub-Sample Born 1890-1944. As was true for the Malmö sample, the birth frequencies in the final Swedish sample showed an inverted-U form over the

Table 3. Summer temperature quartiles and subsequent birthrates of total Swedish schizophrenic sample

Patient group born following the summer	Temperature quartile per mean °C. June-August: Coldest (19 years) [13.0-14.8°]	Next Coldest (16 years) [14.9-15.6°]	Next Warmest (18 years) [15.6-16.4°]	Warmest (18 years) [16.5-18.3°]
Entire Swedish schizophrenic sample (N = 13,440) No. born/10,000 in population[a]	16.7	16.1	12.4	16.5
First-Trimester Group (N = 2485 born February-March) No. born/10,000 in population[a]	18.9	18.1	12.5	17.4
Second-Trimester Group (N = 2003 born November-December) No. born/10,000 in population[a]	15.2	15.0	11.0	16.3
Third-Trimester Group (N = 2094 born August-September) No. born/10,000 in population[a]	16.2	13.9	12.2	15.1
Schizophrenic sub-sample born 1890-1944 (N = 12,554)[b] No. born/10,000 in population[a]	21.6	18.0	18.1	19.0

[a] Population figures are all live births in Sweden during the same months and years covered by the patient groups. Population figures for the entire Swedish sample and the 1890-1944 sub-sample cover 12-month periods, while population figures for the trimester groups cover two-month periods each.

[b] Quartile temperature ranges for the 1890-1944 sub-sample were almost identical to those for the entire sample. Coldest, Next Coldest, and Warmest quartiles consisted of 14 years each, while Next Warmest had 13 years.

71-year period, with fewer patient births before 1890 and after 1944. To determine whether inclusion of the birth years at the beginning and end of the period affected the results, the relationship between summer temperature and patient birthrates was calculated (in the same manner) for the subgroup of 12,554 patients born 1890-1944.

As shown in Table 3, the patient birthrate for the Next Warmest quartile became more comparable to the rates of the other quartiles than was the case for the total 71-year period; inclusion of the early and late birth years thus appeared to have had a differential biasing effect on the rate for the Next Warmest quartile.

Chi-square analysis of the patient birth frequencies for the 1890-1944 sub-sample showed a highly significant deviation from expected frequencies based on population rates ($X^2 = 74.31$, 3 df, $p < .001$). The largest deviation from expectation was the high patient birth frequency for the Coldest quartile; the patient birth frequency in the Warmest quartile was almost exactly that expected from population rates.

False Temperature - Birth Sequence for 1890-1944 Sub-Sample. To investigate whether this highly significant negative relationship between temperature and patient birth frequency could have represented some systematic factor not specifically having to do with the hypothesized relationship but rather with the variables involved (e. g., population and/or schizophrenic birthrates, temperature year distribution, etc.), the relationship between summer temperature and birth frequency was re-calculated for the 1890-1944 sub-sample with the schizophrenics' birth frequency related to summer temperature 1-2 years after the births (e. g., births July, 1928-June, 1929 related to summer temperature 1930).

The resulting temperature quartile birthrates (from Coldest to Warmest: 20.9, 17.7, 19.9, 18.3) were very similar to those found for the real temperature - birth sequence. Analysis of the quartile birth frequencies again showed a highly significant deviation from expectation ($X^2 = 57.60$, 3 df, $p < .001$), with the largest deviation being the unexpectedly large number of schizophrenics born 1-2 years before the Coldest summers. The similarity of results in the real and false sequences was not a result of the same birth years entering the same temperature quartiles in the two sequences.

DISCUSSION

The results for both the Malmö and the national samples did not corroborate Pasamanick et al.'s (1961) finding of an increased frequency of births of schizophrenics following relatively warm summers. The national 1890-1944 sub-sample showed a highly significant relationship between low summer temperature and high schizophrenic birth frequencies the following year. The fact that the false time sequence for summer temperature - birth frequencies showed approximately the same, highly significant relationship would suggest caution in interpreting the results of the true sequence as evidence for more schizophrenics being born following colder summers. Perhaps the safest conclusion is that nothing in the current study confirmed

Pasamanick et al.'s finding.

As suggested by Pasamanick (pers. communication), one interpretation of the discrepancy in results between the two studies is that the summer temperatures in Sweden are considerably lower than those in the original study (Ohio, USA), and thus not sufficiently high to result, however indirectly, in increased births of schizophrenics following even the warmest of Swedish summers. This implies that an absolute minimum temperature level must be reached for the hypothesized relationship to emerge and that relative temperature differences among different years are not sufficient to produce the relationship. Further re-tests of the Pasamanick et al. finding (1961) might best be done in climates similar to that of the original study.

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