Gunnar Morken

SEASONAL VARIATION OF HUMAN MOOD AND BEHAVIOUR

Gunnar Morken

SEASONAL VARIATION OF HUMAN MOOD AND BEHAVIOUR

Contents

Acknowledgements

The present work was conducted at the Department of Psychiatry and Behavioural Medicine, Faculty of Medicine, Norwegian University of Science and Technology, Trondheim.

First and foremost I want to thank associate professor Olav M Linaker, MD, my supervisor and co-author on all papers, for his enthusiasm and his help based on his scientific skills, for his encouragements and his critical comments.

I am also grateful to professor K Gunnar Gøtestam, MD, PhD, Head of the University Department of Psychiatry and Behavioural Medicine, for his support, his advice and his problem solving skills. His never failing enthusiasm and generosity have been of great importance.

I also wish to thank my co-authors:
Cand scient Solfrid Lilleeng for valuable contributions to the fifth paper.
My wife Anne Mari Sund, MD, for introducing me to Child and Adolescent Psychiatry and for all her enthusiasm regarding my work.

I wish to thank the medical director of Østmarka Psychiatric Hospital, Arne Einar Vaaler, MD, for his support that made it possible for me to find time to write this thesis.

I am very thankful to Kirsten Rasmussen, PhD, associate professor Are Holen, MD, PhD and my brother Magne for their linguistic advice so that my lack of skils in English has been somewhat compensated for.

My many good colleagues and friends at Sør Trøndelag Psychiatric Hospital deserve many thanks.

Finally, very special thanks to my wife Anne Mari and to our daughters Ida, Mari and Tora for their interest and support.

List of papers

1. Seasonal variation of children calls to a help-line. Anne Mari Sund, Gunnar Morken, Olav M. Linaker. Accepted in Journal of Affective Disorders.
2. A help-line for children and adolescents. Seasonal variations in issues. Gunnar Morken, Anne Mari Sund, Olav M. Linaker. Submitted.
3. Seasonal variation of violence in Norway. Gunnar Morken, Olav M. Linaker. American Journal of Psychiatry. 2000 Oct;**157**(10):1674-8
4. Seasonal variation of violence in psychiatric patients and the general population. Gunnar Morken, Olav M. Linaker. European Journal of Psychiatry. 2000 Jul-Sep; **14**(3):153-9.
5. Seasonal variation in suicides and in admissions to hospital for mania and depression. Gunnar Morken, Solfrid Lilleeng, Olav M. Linaker. Accepted in Journal of Affective Disorders.

Introduction

Seasonal variations of mood, behavior and physiology have been of interest since ancient times [1]. In the two last decades descriptions of Seasonal Affective Disorder (SAD) defined as recurrence of an affective episode, often atypical and mild, at the same time of the year have increased interest in annual variations of psychiatric illness both in academic psychiatry and in the general public [2]. Traditionally the main focuses in studies of annual variations of mood and behavior in psychiatry have been on the spring and fall increase in frequency of suicides, of admissions to hospital for mood disorders and for start of an episode of mood disorders [3] while in descriptions of SAD the differences in mood and behavior between summer and winter are the most common phenomena. Posidonus in the fourth century A.D., noted that "melancholy occurs in autumn whereas mania in summer" [4].

Not only psychiatric symptoms and illnesses in patients have been studied for seasonal variations, also variations of behavior and mood in the general population have been examined [5-8]. Most of the reports of seasonal changes in the general population have focused on a summer/winter difference in mood, length of sleep, weight etc. The frequency of depressed mood in the general population seems to be higher in winter. The mean duration of sleep is longer in winter than in summer [9], the body weight among adults increases during winter [10], together with blood pressure [11] and cholesterol [12]. Birth frequencies, as a reflection of sexual activity, are described to have peaks in spring in northern parts of Europe; a seasonal pattern that could reflect increased sexual activity during summer [13]. Authors conclude that the winter depression seen in SAD seems to be an extreme variant of an annual variation affecting greater parts of the population [14, 15].

A second and apparently different seasonal pattern is seen in studies of variations in frequencies of suicides [16-19], onset of affective episodes [20], first visit to a physician for treatment of depression [21], first prescription of antidepressiva medication [21-23] and of admittances to hospital for affective disorders [24, 25], where many studies describe an increased activity in spring and in some studies a smaller peak of activity in late fall.

There are few reports of seasonal variations of phenomena in the general population that resembles the spring and fall increase in suicides and in admissions to hospital for mood disorders.

At least two different patterns of seasonal variation of psychiatric symptoms thus seem to have been described in epidemiological surveys and in clinical samples; a summer/winter difference in mood and a spring/fall increase of activity. In searching for a possible etiology for these seasonal changes, the main focus has been on variations in length of day.

Norway, situated between latitude 58˚ and 72˚ N, has considerable seasonal variations of light and provides good opportunity for studies of variations in human behavior related to changes in length of day.

Some phenomena with seasonal variation

Children and adolescents

Some authors have examined seasonal variations of behavior, mood and physiology in children. In a nation-wide mailed study, American parents of 892 girls and 788 boys with a mean age of 10.5 years, reported an increased rate of behavioral and mood symptoms among their children during winter. The symptoms were: eating more, increased sleep, increased irritability, sadness, withdrawal and tiredness. Larger seasonal variations of symptoms were reported from central and northern parts of the USA than from southern parts [26]. In a study from Finland, Sourander et al. [27] reported more symptoms related to pediatric seasonal affective disorder with increasing latitude. Children and adolescents also report higher rates of depressive symptoms in the winter months in epidemiological studies [28]. In 1986 Rosenthal et al. [29] presented seven children with depressive symptoms during winter which responded well to light treatment. Several authors [30-32] have described Seasonal Affective Disorder (SAD) among children since then. Boehm et al. [33] reported a seasonal variation of calls to a help-line for children with increased frequency of calls concerning suicide in winter. Except for Neinstein [34] reporting increased frequency

of suicides in spring and fall among adolescents, I have found no reports of psychiatric symptoms or behavior with a spring/fall pattern of increased frequency among children and adolescents.

Physiological variables such as growth rate also seem to vary through the year; Height proceeds faster in spring than in other seasons and weight gain is fastest in fall [35-38].

Violence among adults

The existence and possible explanation of seasonal variations in frequency of violence have been a question of some controversy. Some authors describe seasonal variation for homicide with increased frequency in summer [39], while others find no such variation [40]. A few reports of seasonal variation in mild and moderate violence outside institutions exist. Michael and Zumpe described a peak in frequency of violence in the months with highest temperature on several locations in the USA [41, 42]. Feldman and Jarmon reported variation of violence with changes in air pollution in Newark [43]. Frequencies of aggression and violence in psychiatric hospitals have shown seasonal variations both with one [44] and two [45] yearly peaks. In reports correlating seasonal variation in violence in psychiatric hospitals with the diagnoses of the patients, people with mood disorders seem to have more dramatic seasonal variations in frequency of violence than other patients [45, 46].

Affective disorders and suicides

Seasonal Affective Disorder (SAD) has attracted much focus the last two decades [2, 47, 48]. The most common expression of SAD is winter depressions, but summer depressions and some cases of seasonally recurring manias have also been described to start at the same time of the year. Depressed mood is described to affect greater parts of the general population during winter than in the rest of the year [5-7, 14]. The decrease in mood during winter seems to start in fall, in some studies as early as in October [49]. The depressed mood during winter is accompanied by increased weight and length of sleep among affected individuals. Most authors believe that the winter depression of SAD is an extreme variant of a summer/winter difference afflicting the general population [14].

In studies of seasonal variations of affective illnesses in the last century, the most focused phenomena are hospital admission rates for mania and depressions, which both have been shown to have annual rhythms. Persons with mania tend to be more frequently admitted in spring and summer [50-54], while persons with depression tend to be admitted in spring and in fall [24, 55].

The time from start of illness until hospital admission for affective disorders is difficult to establish, at least in great populations of patients. Admission to hospital is an administrative act and does not necessarily reflect the start of the illness. In a study Winokur [56] reported that 2/3 of the manias were admitted to hospital during the first month after the illness started. It has been difficult to establish the time relationship between start of illness and admission to hospital for depressions [56]. Time of admission to hospital for depressions could reflect start of illness or it could reflect a worsening of symptoms like increasing danger of suicide or increased anxiety.

A few authors have focused on seasonal variations of the start of illness in affective disorders. An Italian group [57] described a pattern of increased frequency of start of episode in April and in October for bipolar depressions. Wehr and Rosenthal [58] and Goodwin and Jamison [3] have reported much the same pattern in different groups of depressed patients. It seems like both the frequency of start of some depressive episodes and the frequency of admissions for depressive episodes increase at the same time of the year. This could lead to a conclusion that the seasonal pattern of admissions reflects the start of the illness, but given the delay between start of illness and admissions to hospital, identical factors could trigger both the start of an episode in subgroups of patients as well as a change of symptoms in subgroups of already depressed patients, thus resulting in admissions to hospital at the same time of the year.

Several authors have described a seasonal variation of suicides with increased frequency in spring [17-19]. Some of the authors also report a second peak of frequency of suicides in fall. The seasonal variation in admissions for depression and the seasonal variation in suicides seem to be related [24, 59, 60].

Maes et al [62] described a correlation between seasonal variation in serum L-tryptophan and the seasonal variation of suicides in Belgium. Low values of L-

tryptophan in serum have been described both in patients suffering from impulsiveness and aggression, in suicides and among patients suffering from depression.
In addition some reports of seasonal variation in eating disorders have been published [61].

Modifications of seasonal variations

Latitude

Epidemiological studies on SAD have compared seasonal variation of winter depression at different latitudes [6, 49, 63, 64]. SAD seems to be more frequent at higher latitudes and the depression seems to start earlier in fall the further North the population is situated [49]. In some studies the increased frequency with latitude seems to stop north of 60º N [49, 63]. The same pattern of increasing seasonality with increasing latitude is also reported in epidemiological studies of children and adolescents [26, 27].
Hakko et al. [17], analyzed studies reporting seasonal variations of the frequency of suicides with a spring peak and found that a delay of the peak frequency from spring towards summer was related to the distance from equator.

Age

The frequencies of Seasonal Affective Disorder seem to decrease with increasing age in the adult population [14, 15]. In epidemiological studies of children and adolescents, the frequency of SAD-like symptoms seems to increase with age [26, 27]. A confounding factor in studies of adolescents and SAD could be that most psychiatric symptoms increase in frequency with age among teenagers. Still it seems that for SAD, the most affected groups are young adults.
Among adults a variation of seasonal pattern of suicides with age is described [17, 18, 65, 66], a bimodal pattern with peaks in spring and fall among young women and a

unimodal pattern with a spring/summer peak among elder women and among men. Reports of age differences in seasonal variations of admissions to hospital for mood disorders are few [25]. I find that an influence of age on seasonal variation of behavior is likely.

Sex

Higher frequencies of SAD with winter depression among women are found both in clinical samples and in epidemiological studies [7, 14, 15]. Indications of different seasonal distribution of suicides for females and males have been reported, with one peak in spring and another in fall for females, and a single peak in spring for men [16, 17, 65, 67, 68].

Hypotheses of seasonal variation

In hypotheses of seasonal variations of mood and behavior, the winter depression has been most focused. There are similarities between winter depression and hibernation that could indicate a functional adaptation for energy conservation, and hypotheses of the winter/summer difference in mood as an extreme variant of adaptation to variations in climatic conditions have been put forth. The winter depression with increased carbohydrate craving, increased weight, and increased length of sleep could be an extreme variant of biological preparation for a less abundant winter. It costs more energy to get food in winter than in summer. Increased mood, activity, energy and initiative in spring and summer could be useful for survival in societies based on hunting migrating animals, collecting and harvesting or farming. Animals tend to economize on their energy; activity in summer and rest in winter hypothetically provide the most energy-efficient life style under extreme seasonal variations in environment. Another hypothesis is that the winter depression is a lack of adaptation to Northern latitude. Studies from Iceland seem to support such a view; there are fewer inhabitants in Iceland suffering from SAD than expected by latitude and the frequency of SAD among Icelandic immigrants to Canada are lower than in the rest of the population in

Canada [63, 69]. Iceland has been isolated for a long time and there may have been a genetic selection of individuals not suffering from winter depression or winter depression-like symptoms. Modern humans probably migrated out of Africa only 150 000 years ago [70] and the northern parts of Europe were settled 10-12 000 years ago. Little change in our genetically system habituated to equatorial seasons might have been expected over this relative short time [71].

Hypotheses about the increased frequencies of suicides, and of admissions in late spring and fall are few. There are observations of increased mood in the general population at the same time of the year and some authors connect the peaks of frequencies to the equinoxes [3, 58, 72]. To my knowledge there are few studies of human behavior that show annual variations similar to the variations for suicides and admissions. Another hypothesis focuses on disturbances in the sleep/wake rhythm around the equinoxes inducing changes in mood and behavior. There may be a drive for phase advance and delay of the body clock around the equinoxes that may compromise the regulation of mood and behavior among predisposed subjects. Supporting this is the disorganization of the sleep-wake pattern as well as biological circadian biorhythms that have been seen in depressed individuals.

It has been difficult to establish a single hypothesis explaining both the winter/summer difference in mood in epidemiological and clinical studies of SAD with winter depression, and the increased frequency of suicides and admissions for affective disorders in late spring and to a lesser extent in late fall. Some authors focusing on start of a depressive episode believe that some of the depressive episodes start around the equinoxes, giving depressions in summer or winter. They suggest that the summer depressions are more often accompanied by reduced sleep and weight while the winter depressions are more often accompanied by increased sleep and weight as a reflection of the same seasonal variations in sleep and weight as in the rest of the population [3, 58].

Both social [73] and physical environmental factors have been suggested as causes for the seasonal patterns of human behavior. Among physical environmental factors, temperature [18, 41, 74], air pollution [43], atmospheric pressure [75], and changes in light have all been suggested as candidates. At least two hypotheses involving change

in length of day [18, 39, 76] have been put forward; 1. The length of day, with maximum impact at midsummer, is the significant factor. 2. The change in length of day, with maximum impact at the equinoxes, is important [45]. Both hypotheses may include a few weeks delay for the light to sufficiently influence biological systems. As the length of day and the speed with which it changes varies with latitude, the hypotheses lead to an expectation of different frequency patterns at different latitudes. Norway is situated far north with extreme seasonal variations of light and rather low temperatures during summer, thus excluding effects of extremely hot weather. Only a small proportion of the population lives in urban areas affected by heavy air pollution. The country stretches across the latitudes from 58˚N to 72˚N, and appears to be well suited to study seasonality and the influence of light on human behavior.

Study objectives

The main objective of this thesis was to study the existence and pattern of seasonal variation in some forms of human behavior and to study possible covariations between seasonal variation of behavior, and changes in length of day. The influences of latitude, sex and age were also of interest.

Paper 1.

We wanted to study possible seasonal patterns in frequencies of calls to Red Cross Help Line for children and adolescents in Norway. Based on the two hypotheses of light as a precipitating factor for change in behavior, we also wanted to examine a possible association between a seasonal pattern in calls to Red Cross Help-Line and the mean monthly length of day and the mean monthly change in length of day. The influence of age and latitude on seasonal variations in the frequency of telephoning Red Cross Help Line for children and adolescents in Norway were also examined.

Paper 2.

The purpose of this study was to examine seasonal variation in issues connected to psychiatric suffering and social network problems in calls to a help-line for children. Questions concerning sexuality were also examined for seasonal patterns and were

compared to the seasonal variation of births as an expression of sexual activity among adults.

Paper 3.

The aim of this study was to examine possible seasonal variations of violence in Norway. Our expectations were that there would either be one or more peaks in frequency and that the peaks would be seen after the equinoxes when the change in length of day is largest, or alternatively one peak in frequency linked to one of the solstices [17, 67]. We also wanted to examine whether a seasonal variation in frequency of violence would change with latitude; in terms of magnitude of the range of monthly frequencies, in terms of magnitude of the maximal ratio between the observed and the expected monthly frequency, in terms of which months the peaks in frequencies occurred, or in terms of which months the largest increases in violence from one month to the next occurred.

Paper 4.

The aims of this study were to examine if there was any seasonal variation of violence among psychiatric patients acutely admitted to hospital, if such a variation correlated with violence in the general population, and if violence among acutely admitted psychiatric patients correlated with the length of day or the change in length of day.

Paper 5.

The main purpose of this report was to study seasonal variations in admissions for mania, bipolar depression, unipolar depression, and for both types of depressions combined. We also wanted to study possible differences in female and male seasonal patterns and the influence of age. Correlations between monthly frequencies of suicides and admissions for mood disorders were also studied.

Methodological considerations

Settings and populations

All the five papers in this thesis are based on reports of frequencies of incidents. Every incident has been recorded and then reported to a central office; calls to The Norwegian Red Cross, violence and suicides to Statistics Norway and admissions to Sintef Unimed NIS Health Services Research, Trondheim. Lots of people interpret and make choices in such a reporting system. In **Paper 1** all calls to the Norwegian Red Cross Help-Line for children and adolescents in the years 1996 through 1998 were included for the whole country. The Norwegian Red Cross has help-lines in all parts of the country. The number of calls for each of seven cities was independently obtained to reveal possible south-north patterns. The number of children aged 6 to 17 years in Norway was 678,000 with a mean of 56,500 in each age group. In **Paper 2** all calls to the Norwegian Red Cross help-line in South -Trøndelag County, with 260,000 inhabitants, for the years 1991 through 1997 were included. Questions could be raised if the young persons calling in Paper 1 and 2 are representative of all persons at their age. It is also difficult to know if the telephone calls in Paper 1 and 2 reflect activity and curiosity in general, if it reflects help-seeking activity, or both. Based on the issues the children raised in the telephone conversations, it seems like conversations representing activity and curiosity in general outnumbers the conversations representing help-seeking activity.

In **Paper 3** all violent incidents reported to the police in Norway in the years 1991 through 1997 were included. Violent incidents for each of seven cities at different latitudes were independently obtained to reveal possible south-north patterns. The cities included were the largest city in each of the three counties north of the Arctic Circle, and the four largest cities south of the Arctic Circle.

In **Paper 4** all patient-staff incidents at Haukåsen acute and short time psychiatric hospital, with a catchement area of 130,000 persons in South- Trøndelag County, for the years 1990 through June 1997 were included. In the same paper all violent incidents reported to the police in Trondheim, the main city in South-Trøndelag County, in the

years 1991 through 1997 were included. The population in the Police district of Trondheim is 140,000.

The violence recorded by the police in Paper 3 and 4 are probably not representative of all violence in Norway. Domestic violence is probably under-represented since such violence is seldom reported to the police. According to figures from Statistics Norway, in the recorded violence in Paper 3 and 4 young men are over-represented among the offenders.

In **Paper 5** all admissions for mania or depression in a population of 1,800,000 in the years 1992 through 1996 were included. The population at risk lived in the catchment areas of the psychiatric hospitals in Norway that in at least 4 of the 5 years 1992 through 1996, reported a discharge diagnosis for more than 70% of the patients admitted to the hospitals. All suicides in Norway during the years 1969 through 1996 were also included.

In records of admissions 89% were reported with clinical diagnosis.

Data handling

All papers are based on studies of frequency variations of incidents such as violence, telephone calls, admissions to hospital, suicides and births. The observed number of incidents in one month was the sum of incidents in that month for all the included years. The observed monthly frequencies of an incident were compared to the expected monthly frequencies of the same incident. The expected frequencies were defined as equal numbers of incidents happening every day during the included period. The monthly observed to expected ratio of incidents, called the monthly observed to expected ratio in some of the papers, were calculated for each of 12 months. In Paper 2 that concerns seasonal variations of topics in a help line for children and adolescents, the monthly frequencies for each topic were first compared to the expectations of equal number of calls concerning the topic each day, and secondly with the expectation of a seasonal pattern for a specific topic paralleling the seasonal pattern for all calls.

Instruments and definitions

The monthly frequency of incidents in Paper 1, 3 and 4 (telephone calls and violence) were compared to the mean monthly length of day defined as the mean time from sunrise to sunset in a month and to the monthly change in length of day defined as the difference between the mean monthly length of day in one month and the mean monthly length of day in the preceding month. The latter is more precisely an approximation for the average change in length of day around the start of the month. To include both positive and negative change in length of day as equivalent possible stressors, we used the absolute values of monthly changes in length of day in the study. A ranking of the mean monthly length of day and of the monthly change in length of day, which was used in Papers 1, 3 and 4, will give the same sequence in the whole Northern Hemisphere.

The Staff Observation of Aggression Scale (SOAS) [77] used in Paper 4 describe the seriousness of the methods used to inflict injury, the aim of the attack, the consequence of the attack as well as the time and date of the incident. The staff was required to report every incident concerning patient - staff aggression if the staff-member at least felt threatened. We excluded all incident reports not related to patient-staff incidents. Since Palmstierna [77, 78] and Lion [79] found the consistency of incidence reports best for the more serious incidents, we also excluded reports that had not resulted in pain.

In comparing the strength of monthly variations between different age groups and different latitudes the range of the observed/expected ratio were defined as the difference between the maximal monthly observed/expected ratio and the minimal monthly observed/expected ratio.

In all the papers monthly number of incidents is defined as the sum of incidents occurring in that month for all the included years.

Statistics

The chi-square test for multinominals was used to estimate overall deviations between observed and expected monthly frequencies. The null hypothesis was that violent incidents occur with a frequency proportional to the length of the time interval. The

95% (Paper 3) or 99% (Paper 1) confidence intervals were calculated with the method described by Wonnacott and Wonnacott [80]. If the 95% or 99% confidence interval for the observed/expected ratio for a month excludes 1 we can conclude that the frequency for that month differs from the expected frequency.
Pearsons bivariate method was used for parametric correlations. Spearman's rank correlation coefficients (r_s) were used for non-parametric correlations. Significance was evaluated with two-tailed p-level for both correlation methods.

Summary of the papers

Paper 1.

Seasonal variation of children calls to a help-line.

In Paper 1 we wanted to investigate seasonal variations in calls to a help-line for children and correlations with changes in length of day, correlations with latitude and correlations with age. All calls to Red Cross help-line for children in Norway 1996-1998, a total of 691,787 were included. Of these 220,602 calls were recorded as real conversations, defined as calls where the counselor was able to register the callers' sex, age or type of problem. The calls from seven centres were obtained independently to reveal north-south differences. The mean monthly length of day did not correlate significantly with the numbers of calls, but there was a positive correlation between the monthly numbers of calls and the absolute values of the monthly changes in length of day (r_s=0.76, N=12, p<0.01). Introduction of delays by correlating the monthly numbers of calls with the change in length of day for the previous months did not produce enhanced correlation values. The frequency curve of number of calls had one peak in April, one trough in July, one peak in October and one trough in December. The mean number of calls for each month varied between a daily frequency of 886 in April and 436 in July. In the seven centres chosen for analyses, increasing latitude correlated positively with the range of the monthly observed to expected ratios of calls (r_s=0.79, N=7, p<0.05) and with the maximum monthly observed to expected ratio (r_s=0.79, N=7, p<0.05), but not with the minimum monthly observed to expected ratio (r_s= -0.71, N=7, p<0.1).
Comparing different ages, the frequency of calls was highest among 12 to 14 years old

children. Increasing age correlated negatively with the range of monthly observed to expected ratios of calls ($r = -0.94$, $N=11$, $p < 0.001$). From 7 to 15 years of age the reduction in range is nearly linear. All age groups had maximum frequencies in April or May.

There is a seasonal variation in calls from children. The variation correlates with change in length of day and increases with latitude. Both findings support a connection between changes in length of day and changes in behavior. The magnitude of the seasonal variation in calls from children decreases with increasing age.

Paper 2.

A help-line for children and adolescents. Seasonal variations in issues.

In Paper 2 we wanted to investigate seasonal variations in telephone calls to a help-line for children and adolescents as well as possible specific seasonal variation in some of the issues children wanted to talk about.

All 80,983 calls to the Red Cross Help-Line for children in South-Trøndelag County, Norway 1991-1997 were included. Calls for which age, sex or problem areas were identified was defined as conversations (n = 22698).

The mean number of calls each month varied between 1290 in April and 558 in July. The observed monthly number of calls deviated significantly from the expected frequency and peaked in April and in October ($\chi^2=4104.78$, $df=11$, $p<0.0001$). Conversations concerning depression ($n=116$) ($\chi^2=42.49$, $df=11$, $p<0.0001$), anxiety and pain ($n=715$) ($\chi^2=31.38$, $df=11$, $p<0.001$) and neglect ($n=898$) ($\chi^2=26.32$, $df=11$, $p<0.01$) differed from the seasonal pattern of all conversations. These issues were more frequent in January or February and less frequent than other issues in May/June and December while conversations about sexuality ($n=3533$) were over represented in May and July ($\chi^2=45.39$, $df=11$, $p<0.0001$) and correlated positively with the frequencies of births in Norway nine months later ($r=0.724$, $N=12$, $p<0.01$). Conversations about eating disorders ($n=292$) and relations to others ($n=1828$) did not differ significantly from the seasonal pattern of all conversations.

There were seasonal variations in frequencies of calls to a help-line for children with peaks in spring and fall. Conversations related to psychiatric suffering had higher frequencies in winter, and conversations about sexuality were more frequent in summer compared with other issues. The frequency of calls concerning sexuality correlated with the frequency of births with a nine-month delay.

Paper 3.

Seasonal variation of violence in Norway.

The objectives of this study was to examine possible seasonal variations of violence in Norway, if a possible seasonal variation in frequency of violence changed with latitude, and if seasonal variations of violence correlated with changes in length of day. The monthly numbers of police reports of violence from 1991 through 1997 were obtained for all of Norway (4,450,000 inhabitants) and separately for seven cities at different latitudes in Norway.

A total of 82,537 episodes of violence were recorded. There were significant deviations from an equal distribution in the monthly frequencies (χ^2= 343.08, df = 11, $p<0.0001$), with a minimum daily frequency of 28.7 in March and a maximum daily frequency of 35.1 in June. The frequency curve of episodes had one significant peak in May-June and another significant peak in October-November. There were nadirs in March and August and lower than expected values from February until April and in August.

The monthly frequency of violence correlated with the absolute value of monthly change in length of day for the previous month (r_s =0.778, N=12, $p<0.01$), but not with the corresponding month. The mean monthly length of day showed no significant correlations with violence frequency.

All the seven cities included in the analysis had one peak month of violence in late spring and another peak month in fall. For the seven cities, the maximum monthly observed to expected ratio correlated significantly with increasing latitude (r =0.783, N=7, $p<0.05$), but the range of the observed to expected ratios did not vary significantly with latitude. The ranking of the peak months in the spring or the fall did not correlate with latitude. There was, however, a significant correlation between latitude and the

number of the months with the largest increase in violence in spring (r_s =0.896, N=7, $p<0.01$) and in fall (r_s =0.945, N=7, $p<0.01$), indicating that the increase of violence came later further north, even though the peak showed no such displacement.
There is a distinct pattern of seasonal variation in frequencies of violence varying systematically with latitude. This pattern resembles the seasonal pattern of some reports of frequency of suicide and of hospitalization for affective disorders. The frequency of violence correlates with the change in length of day with a delay of one month and peaks some time after the equinoxes.

Paper 4.

Seasonal variation of violence in psychiatric patients and in the general population.

Both among psychiatric patients and in the general population, seasonal variation of mood symptoms and aggression has been described. The aims of this study were to investigate monthly variations in violence among acutely admitted psychiatric patients and in the general population in the same area, and a possible correspondence in the variation in the two populations.
The monthly frequency of 512 patient-staff incidents 1990- June1997 in an acute psychiatric hospital receiving all acutely admitted patients from a population of 130,000, the western half of South Trøndelag county, and 3,431 violent incidents among the general population 1991-1997, in Trondheim city were analyzed for monthly variations in frequencies. There was a correlation ($r=0.63$ N=12 $p<0.05$) between the monthly number of incidents at the hospital and the monthly number of incidents recorded by the police in Trondheim. Among incidents at the hospital there was a peak in May/June and a less pronounced peak in late fall. Among incidents recorded by the police there was a peak in May and a smaller peak in fall. Incidents at the hospital correlated with the monthly change in length of day with a delay of one month ($r=0.71$ N=12 $p<0.01$), but not with the mean monthly length of day.
The correlation of monthly frequency in the two groups could be induced by a change in vulnerability for violent impulses common for the two groups.

Addendum not published in the paper: The correlation between the monthly number of incidents at the hospital and the monthly number of incidents recorded by the police in whole Norway in the years 1991 – 1997 (N = 82,537) were (r=0.75, N=12 p<0.01).

Paper 5.

Seasonal variation of admissions to hospital for mania and depression.

The influence of seasons on major mood disorder is controversial. The aims of this study were to examine possible monthly variations in admissions for mania and depressions in Norway, including how this changes with sex and age, and correlations with frequencies of suicides. All admissions for mania or depression (N=4,341), from a total 35,285 admissions in a population of 1,800,000, during the years 1992-96 were analyzed. Of these admissions, 31,292 (89 %) were recorded with a discharge diagnosis. All suicides in Norway in the years 1969 through 1996 were included in the analyses. There were a total number of 10,670 male suicides and 3,833 female suicides. Admissions for depression had a significant monthly variation for women (χ^2=29.78, df=11, p<0.005) with the highest peak in November and for men (χ^2=19.69, df=11, p<0.05) with the highest peak in April. Among women increasing age correlated negatively with the range of monthly observed/expected ratios (r_s=-0.943, N=6, p<0.01) and with maximal monthly observed/expected ratio (r_s=-0.943, N=6, p<0.01). Dividing the year in four seasons, there was a variation in admissions for mania among men (χ^2=11.85, df =3, p<0,01) with increased frequency of admissions in spring, but not among women. The monthly frequency of suicides varied significantly through the year both for men (χ^2=66.18, df =12, p<0.0001) and women (χ^2=40.72, df =12, p<0.0001). The frequency among men peaked in April and for women in May, women had higher relative values than men in fall. Among men suicides correlated both with admissions for depression (r=0.647, N=12, p<0.05) and admissions for mania (r=0.678, N=12, p<0.05). For both sexes analyzed together there was a tendency towards higher frequencies of admissions for mania, unipolar depression and bipolar depression, and for suicides in spring with a maximum in April. For women there was a tendency towards a second peak in fall with a peak of admissions in November and a peak of suicides in October.

A hypothesized influence of seasons on mood disorders was supported. Younger women seem especially vulnerable. The results correspond with other reports of seasonal variation of admissions for affective disorders and of seasonal variations of suicides.
The correlation among men between the frequency of mania and the frequency of suicides has to our knowledge not been published earlier.

Discussion

Children and adolescents

In Papers 1 and 2 in this thesis, an increased activity of calling a help-line for children and adolescents in spring and to a lesser extent in fall was found. A finding of a seasonal variation that is different from the to descriptions of summer/winter differences in mood and behavior among children and adolescents found both in clinical samples and epidemiological surveys of the winter depression type of SAD. The described seasonal pattern resembles the seasonal pattern of suicides and of admissions to hospital for depression among adults. In studies of growth velocity, differences between spring, fall and the rest of the year have been described, with seasonal variations that have some resemblance to the variation in frequency of telephone calls described in Papers 1 and 2. Children grow fastest in stature in spring. Weight increase is at its maximum in fall. Assuming that telephoning a help-line could reflect aspects of activity in the children and adolescent population. A peak of frequency after the equinoxes could indicate that there is a common etiology for the variation with seasonal variation of behavior among adults described in this thesis.
A limitation in Papers 1 and 2 is that the influence of social and cultural factors is not explored. Norway has a fairly homogenous population and the school year has the same length in the whole country. A possible influence of school holidays and of public holidays is not explored. There are few calls in July and December; both these are vacation months. However, April that includes Eastern vacation has a high frequency

of calls. The seasonal patterns described do not seem to coincide with known variation in psychosocial activities in any very apparent way.
In paper 2 the seasonal pattern of variation in telephone conversations with issues related to psychiatric suffering is compatible with a winter increase in suffering. This finding resembles the variation in frequency of symptoms connected to SAD in epidemiological studies with more suffering during winter than the rest of the year. The seasonal pattern of telephone conversations with issues concerning relations to others did not differ from the seasonal pattern of all conversations. One could assume that the etiology behind the seasonal pattern of issues concerning relations to others is the same as the etiology behind the seasonal pattern of all calls.
Compared to the seasonal pattern of all conversations, conversations about sexuality peaked significantly in May and July and had a trough in March and April. The monthly variation in number of births probably reflects variations in sexual activity among adults. The correlation between conversations about sexuality among these children and adolescents and the frequency of births nine months later in the adult population may indicate that the annual rhythm of sexual interest among children and adolescents continue into adult life. This seasonal variation seems to start in early age. Animals restrict the time of birth of offspring to the most advantageous time of year, usually spring or summer [81]. This is achieved by a regulation of the preceding period of fertility and, in some cases, by delaying implantation of the zygote.

At least two different seasonal rhythms among children seem to exist: 1. A summer/winter difference in depression and suffering described in Paper 2 and consistent with reports of SAD [26, 27, 29, 30] and 2. Increased activity in spring and to a lesser extent in fall described in Paper 1 and Paper 2. This is the much the same periods of the year that among adults is described to have increased frequencies of admissions for affective disorders (Paper 5), increased frequencies of suicides (Paper 5) and of violence (Paper 3 and 4). The increase in telephoning is statistically linked to the largest increases in length of day occurring around the equinoxes.

Violence among adults

A seasonal variation of violence in the general population finds strong support in papers 3 and 4. Frequencies peak in May and in November and seem to be linked to the equinoxes with a delay of one or two months. This resembles variations in some reports of mood and activity in the general population [3, 58, 72]. Seasonal variations in violence among psychiatric patients with a pattern that correlates with the pattern in the general population are described in Paper 4. Some authors link such a variation in the frequency of violence to patients with affective disorders [45, 46]. Other reports of seasonal variation of violence [39, 41, 42] have described increased frequency in summer months and focused on temperature as an explanation. It is possible that different physical factors may influence the frequency of violence at different geographical locations depending on climate. High temperature and variations in air pollution that both have been described to increase the frequency of violence are unlikely to be main factors stimulating violence in Norway.

A significant correlation between the speed of changes in length of day and the frequency of violence one to two months later is described in Paper 3 and 4. There is a drive for phase advance in spring and phase delay in fall of the body clock that may compromise the regulation of mood and behavior among predisposed individuals. A possible reason for this correlation could be that vulnerable individuals react to the fast changes in length of day with disturbances in the sleep - wake rhythm. The resulting stress could result in increased impulsivity, irritability and ultimately mood disorder in the form of mania or depression. Another hypothesis could be that the increase in the frequency of violence is an expression of a generalized increased activity in the population and that the seasonal variation described in Paper 1 and 2 is another expression of the same mechanism. These hypotheses do not contradict each other, and the mechanisms may be supplementary.

Affective disorders

A seasonal variation in admissions for depression with a peak in April among men and a high frequency at the same time for women and a significant peak in November for women are described in Paper 5. Admissions for mania among men tend to peak in

spring when comparing the four different seasons. Suicides are most frequent in spring for both men and women. These findings resemble earlier reports of increased frequency of admissions in spring and fall for mood disorders [24, 25, 82] and increased frequency of suicides in spring [19]. The peak in November among depressed women could be influenced by the start of winter depression in SAD since women are reported to be more vulnerable to this disorder [6, 7]. Late spring is the time of the year that shows greatest frequency of violence in the general population. One could hypothesize that increased activity in spring, especially in men, could result in increased violence in the general population, and increased mood, even mania in vulnerable individuals. In depressed people one could speculate that increased activity could raise anxiety, raise the risk for suicide, and lead to admission to hospital, parallel to the riskful activation phase shortly after starting antidepressant therapy.
An activation of large proportions of the population could also be reflected in increased violence and increased activity in calling to the Red Cross help line.

Latitude.

In the present thesis the influence of latitude is studied in Papers 1 and 3. In Paper 1 the range of the monthly observed to expected ratios grew with increasing latitude and the maximal monthly observed to expected ratio grew with increasing latitude. In Paper 3 the maximum monthly observed to expected ratio grew with increasing latitude and the change from low frequency months to high frequency months came later both in spring and in fall with increasing latitude. The findings are consistent with a hypothesis of an influence of latitude on seasonal variations of behavior.
The seasonal variation of suicides and the influence of latitude have been studied by Hakko et al. [17] describing that the shifting of the peak month from spring to summer was related to the distance from equator.
The frequencies of the winter depression type of SAD have been studied in epidemiological research and the frequency seems to increase with latitude, at least up to 60°N [6, 14, 49, 64]. Results from studies of adults and of adolescents give much the

same results [26, 27]. The start of winter depression also seems to come earlier in fall further north [49]. Such studies are complicated by confounding factors as ethnicity as described in studies comparing the frequency of SAD on Iceland with the frequency of SAD among Icelandic emigrants in Canada.

Both light and other physical conditions, such as temperature change through the year. The summer/winter differences in length of day with maximum length of day at mid summer and minimum length of day at midwinter correspond partially with changes in temperature and it can be difficult to statistically distinguish these two phenomena in research. The speed of changes in length of day is at its maximum at the equinoxes and at its minimum at the solstices. The influence of latitude on light is that both the summer/winter difference in length of day and the speed of changes in length of day increase with latitude. The ranking of the months in a year by mean length of day or by speed of changes in length of day will be the same on the whole Northern Hemisphere.

Age

In Paper 1 a reduction in the range of the monthly observed to expected ratios with increasing age among children is described, a finding more consistent with the described reduction in seasonal variation of growth velocity among children and adolescents than with the increase of SAD like symptoms with increasing age described among adolescents [26, 28]. This indicates that the seasonality in SAD-like symptoms and the seasonality of calling the help-line have different etiologies. In Paper 5 the seasonal variation of admissions to hospital for depression among women is reduced with increasing age. The finding resembles the reduced frequency of SAD with increasing age among adults. The reduced seasonal variation of admissions with increasing age could also represent a continuation of the adolescent pattern described in Paper 1 and share some of the etiology for such a pattern.

Sex

In Paper 5 in the present thesis, sex differences in seasonal variation of admissions for depression were found. There was high peak of frequency in April among men, and a high peak of frequency in November among women. This sex difference in pattern of admissions to hospital resembles the sex difference described by Hakko et al. [17] for suicides in Finland, a country at much the same latitude as Norway.
The seasonal variations for suicides and for admissions for depression are unimodal among men with a peak of frequency in spring, but bimodal among women with a secondary peak of frequency in late fall in some studies. The sex differences described in Paper 5 seem to be consistent with earlier reports of sex differences in seasonal variations of admissions for affective disorders, although the reports are few on this phenomenon [25]. It is difficult to find a good explanation for this difference in seasonal pattern between the sexes, but the frequencies of SAD and subsyndromal SAD are described to be more frequent among women than among men. The peak in fall of admissions for depressions and in suicides among women could reflect the start of winter depression in SAD. An influence of sex on seasonal variation of symptoms is likely.

The influence of changes in length of day

Although social and cultural factors have been discussed in search for an explanation of seasonal variations in psychiatric symptoms, the main focus has been on the physical environment. Temperature, humidity, barometric pressure, pollution and geomagnetic storms have all been mentioned. Most focus has been on changes in length of day and in sun exposure [6, 49, 64] In the present thesis a variation with latitude described in Paper 1 and Paper 3 indicates an influence of variations in length of day on seasonal variation in calling a help-line and in violence, which are both complex behaviors. In epidemiological studies correlations between feeling depressed and the length of day or photoperiod have been described, and more symptoms are found in winter than in

summer. In this thesis a correlation between changes in length of day is described for calls to a help-line for children and adolescents, for violence in the general population, and for violence among psychiatric patients indicating that some kind of influence of speed in changes in length of day on human behavior exist.

Hypotheses of seasonality

In this thesis focus has been on two different seasonal patterns of variation in frequency of behavior and symptoms. Both the summer/winter difference in mood and activity and the spring/fall increase in some forms of suicides and in admissions for mood disorders are known in psychiatry. A few authors have suggested hypotheses that can contain both patterns. Some authors focus on start of illness around the equinoxes resulting in depression in winter or summer among vulnerable individuals [3, 59]. Others refer to the reports of increased mood in large proportions of the population after the equinoxes, and assume that the result could be a start of an affective episode in vulnerable individuals. The increased violence described in Papers 3 and 4 in the present thesis and the increased frequency of calling described in Papers 1 and 2 in the present thesis, could be other expressions of the same process leading to increased activity after the equinoxes. There is a statistical connection between the studied phenomena in Papers 1,3 and 4 and the equinoxes in the present thesis. Only speculations can be given as explanation for such a pattern connected to the equinoxes. One can suggest that the fast changes in length of day and night both in spring and in fall give disturbances in the sleep/wake rhythm in vulnerable individuals, and as a result of that, changes in mood and/or activity. A hypothesis of disturbances in the sleep/wake rhythm or other stressful experiences induced by rapid changes in length of day and night is supported by the correlation between the studied phenomena and changes in length of day. Another hypothesis could be that in spring, humans living under simpler conditions than contemporary man, had to be active to exploit new hunting possibilities or to secure the harvest for the rest of the year, and in fall harvesting and preparations for a cold winter demanded activity. The peaks of frequency in spring and in fall described in this thesis could also represent two different

phenomena not connected to each other and we would need one hypothesis for the peak in spring and another hypothesis for the peak in fall. The peak in spring could for instance be a result of the increased activity in society in spring when the population adapt themselves to longer and brighter days and a better climate. The peak in fall could be another expression of the changes described in greater parts of the population giving winter depression in vulnerable individuals. More research is needed to give further explanations of the seasonal variations in human behavior.

Main conclusions

In Norway:

- The frequency of telephone calls to a help-line for children, of violence, of admissions to hospital for depression and mania, and suicides have a peak of frequency in April to June and a through of frequency in February.
- The monthly frequency of telephone calls to a help-line for children and of violence correlate with the speed of change in length of day
- The seasonal pattern of frequency of telephone calls to a help-line for children and of violence is influenced by latitude.
- The monthly frequency of violence among acutely admitted patients in a psychiatric hospital correlates with the seasonal variation of violence recorded by the police.
- Among adult women the seasonal variation of admissions for depression decreases with age. Among adolescents the seasonal variation of calls to a help-line decreases with age.
- Sex differences in the seasonal pattern of admissions to hospital for depressions exist.
- Among men, the frequency of suicides correlates with the frequency of admissions for depressions and manias.
- A seasonal variation of behavior with increased activity in spring and to a lesser extent in late fall is demonstrated. The pattern differs from the summer/winter difference in epidemiological studies of SAD-like symptoms.

References

[1]. Hippocrates A. Aphorisms. In Hippocrates. Anonymous. Cambridge: Harvard University Press 1931, pp128-9.

[2]. Rosenthal NE, Sack DA, Gillin JC, Lewy AJ, Goodwin FK, Davenport Y et al. Seasonal affective disorder. A description of the syndrome and preliminary findings with light therapy. *Arch Gen Psychiatry* 1984;**41**:72-80.

[3]. Goodwin FK, Jamison KR. Seasonal patterns. Manic-depressive illness. New York: Oxford University Press; 1990, pp 562-71.

[4]. Roccatgliata G. A History of Ancient Psychiatry. New York: Greenwood Press; 1986, pp 143.

[5]. Haggag A, Eklund B, Linaker O, Götestam KG. Seasonal mood variation: an epidemiological study in northern Norway. *Acta Psychiatr Scand* 1990;**81**(2):141-5.

[6]. Rosen LN, Targum SD, Terman M, Bryant MJ, Hoffman H, Kasper SF et al. Prevalence of seasonal affective disorder at four latitudes. *Psychiatry Res* 1990;**31**:131-44.

[7]. Kasper S, Wehr TA, Bartko JJ, Gaist PA, Rosenthal NE. Epidemiological findings of seasonal changes in mood and behavior. A telephone survey of Montgomery County, Maryland. *Arch Gen Psychiatry* 1989;**46**:823-33.

[8]. Husby R, Lingjærde O. Prevalence of reported sleeplessness in northern Norway in relation to sex, age and season. *Acta Psychiatr Scand* 1990;**81**(6):542-7.

[9]. Terman M. On the question of mechanism in phototherapy for seasonal affective disorder: considerations of clinical efficacy and epidemiology. *J Biol Rhythms* 1988;**3**(2):155-72.

[10]. Rosen LN, Rosenthal NE. Seasonal variations in mood and behavior in the general population: a factor-analytic approach. *Psychiatry Res* 1991;**38**(3):271-83.

[11]. Minami J, Kawano Y, Ishimitsu T, Yoshimi H, Takishita S. Seasonal variations in office, home and 24 h ambulatory blood pressure in patients with essential hypertension. *J Hypertens* 1996;**14**(12):1421-5.

[12]. Robinson D, Bevan EA, Hinohara S, Takahashi T. Seasonal variation in serum cholesterol levels--evidence from the UK and Japan. *Atherosclerosis* 1992;**95**(1):15-24.

[13]. James WH. Seasonal variation in human births. *J Biosoc Sci* 1990;**22**(1):113-9.

[14]. Magnusson A. An overview of epidemiological studies on seasonal affective disorder. *Acta Psychiatr Scand* 2000;**101**:176-84.

[15]. Mersch PP, Middendorp HM, Bouhuys AL, Beersma DG, van den Hoofdakker RH. The prevalence of seasonal affective disorder in The Netherlands: a prospective and retrospective study of seasonal mood variation in the general population. *Biol Psychiatry* 1999;**45**(8):1013-22.

[16]. Näyhä S. The bi-seasonal incidence of some suicides. Experience from Finland by marital status, 1961-1976. *Acta Psychiatr Scand* 1983;**67**:32-42.

[17]. Hakko H, Räsänen P, Tiihonen J. Seasonal variation in suicide occurrence in Finland. *Acta Psychiatr Scand* 1998;**98**:92-7.

[18]. Souêtre E, Salvati E, Bélugou JL, Douillet P, Braccini T, Darcourt G. Seasonality of suicides: environmental, sociological and biological covariations. *J Affect Disord* 1987;**13**:215-25.

[19]. Lester D. Temporal variation in suicide and homicide. *Am J Epidemiol* 1979;**109**:517-20.

[20]. Frangos E, Athanassenas G, Tsitourides S, Psilolignos P, Robos A, Katsanou N et al. Seasonality of the episodes of recurrent affective psychoses. Possible prophylactic interventions. *J Affect Disord* 1980;**2**:239-47.

[21]. Tansella M, Williams P, Balestrieri M, Bellantuono C, Martini N. The management of affective disorders in the community. *J Affect Disord* 1986;**11**(1):73-9.

[22]. Skegg K, Skegg DC, McDonald BW. Is there seasonal variation in the prescribing of antidepressants in the community? *J Epidemiol Community Health* 1986;**40**(4):285-8.

[23]. Harris CM. Further observations on seasonal variation. 2. Depression. *J R Coll Gen Pract* 1986;**36**(288):319-21.

[24]. Eastwood MR, Peacocke J. Seasonal patterns of suicide, depression and electroconvulsive therapy. *Br J Psychiatry* 1976;**129**:472-5.

[25]. Eastwood MR, Stiasny S. Psychiatric disorder, hospital admission, and season. *Arch Gen Psychiatry* 1978;**35**(6):769-71.

[26]. Carskadon MA, Acebo C. Parental reports of seasonal mood and behaviour changes in children. *J Am Acad Child Adolesc Psychiatry* 1993;**32**(2):264-9.

[27]. Sourander A, Koskelainen M, Helenius H. Mood, latitude, and seasonality among adolescents. *J Am Acad Child Adolesc Psychiatry* 1999;**38**(10):1271-6.

[28]. Swedo SE, Pleeter JD, Richter DM, Hoffman CL, Allen AJ, Hamburger SD et al. Rates of seasonal affective disorder in children and adolescents. *Am J Psychiatry* 1995;**152**(7):1016-9.

[29]. Rosenthal NE, Carpenter CJ, James SP, Parry BL, Rogers BL, Wehr TA. Seasonal affective disorder in children and adolescents. *Am J Psychiatry* 1986;**143**(3):356-8.

[30]. Magnusson A. Light therapy to treat winter depression in adolescents in Iceland. *J Psychiatry Neurosci* 1998;**23**:118-22.

[31]. Swedo SE, Allen AJ, Glod CA, Clark CH, Teicher MH, Richter D et al. A controlled trial of light therapy for the treatment of pediatric seasonal affective disorder. *J Am Acad Child Adolesc Psychiatry* 1997;**36**(6):816-21.

[32]. Giedd JN, Swedo SE, Lowe CH, Rosenthal NE. Case series: pediatric seasonal affective disorder. A follow-up report. *J Am Acad Child Adolesc Psychiatry* 1998;**37**(2):218-20.

[33]. Boehm KE, Schondel CK, Marlowe AL, Rose JS. Adolescents calling a peer-listening phone service: variations in calls by gender, age, and season of the year. *Adolescence* 1995;**30**:863-71.

[34]. Neinstein LS, Juliani MA, Shapiro J. Suicide. In Adolescent Health Care. A Practical Guide. Neinstein LS. Baltimore: Williams and Wilkins 19953, , pp1116-23.

[35]. Weber GW, Prossinger H, Seidler H. Height depends on month of birth [letter]. *Nature* 1998;**391**:754-5.

[36]. Scannon RE. The First Seriatim Study of Human Growth. *Am J Phys Anthropol* 1927;**10**:329.

[37]. Tillmann V, Thalange NK, Foster PJ, Gill MS, Price DA, Clayton PE. The relationship between stature, growth, and short-term changes in height and weight in normal prepubertal children. *Pediatr Res* 1998;**44**:882-6.

[38]. Attarzadeh F. Seasonal variation in stature and body weight. *Int J Orthod* 1983;**21**:3-5 7-12.

[39]. Tiihonen J, Räsänen P, Hakko H. Seasonal variation in the occurrence of homicide in Finland. *Am J Psychiatry* 1997;**154**:1711-4.

[40]. Maes M, Cosyns P, Meltzer HY, De Meyer F, Peeters D. Seasonality in violent suicide but not in nonviolent suicide or homicide. *Am J Psychiatry* 1993;**150**:1380-5.

[41]. Michael RP, Zumpe D. Sexual violence in the United States and the role of season. *Am J Psychiatry* 1983;**140**:883-6.

[42]. Michael RP, Zumpe D. An annual rhythm in the battering of women. *Am J Psychiatry* 1986;**143**:637-40.

[43]. Feldman HS, Jarmon RG. Factors influencing criminal behavior in Newark: a local study in forensic psychiatry. *J Forensic Sci* 1979;**24**:234-9.

[44]. Wynn R. Polar day and polar night: month of year and time of day and the use of physical and pharmacological restraint in a north Norwegian university psychiatric hospital. *Arctic Med Res* 1996;**55**:174-81.

[45]. Roitman G, Orev E, Schreiber G. Annual rhythms of violence in hospitalized affective patients: correlation with changes in the duration of the daily photoperiod. *Acta Psychiatr Scand* 1990;**82**:73-6.

[46]. D`Mello DA, McNeil JA, Msibi B. Seasons and bipolar disorder. *Ann Clin Psychiatry* 1995;**7**:11-8.

[47]. Wirz-Justice A. Beginning to see the light [comment]. *Arch Gen Psychiatry* 1998;**55**:861-2.

[48]. Lingjærde O, Foreland AR. Winter depression with spring exacerbation: A frequent occurrence in women with seasonal affective disorder. *Psychopathology* 1999;**32**(6):301-7.

[49]. Young MA, Meaden PM, Fogg LF, Cherin EA, Eastman CI. Which environmental variables are related to the onset of seasonal affective disorder? *J Abnorm Psychol* 1997;**106**:554-62.

[50]. Myers DH, Davies P. The seasonal incidence of mania and its relationship to climatic variables. *Psychol Med* 1978;**8**:433-40.

[51]. Parker G, Walter S. Seasonal variation in depressive disorders and suicidal deaths in New South Wales. *Br J Psychiatry* 1982;**140**:626-32.

[52]. Sayer HK, Marshall S, Mellsop GW. Mania and seasonality in the southern hemisphere. *J Affect Disord* 1991;**23**:151-6.

[53]. Takei N, O'Callaghan E, Sham P, Glover G, Tamura A, Murray R. Seasonality of admissions in the psychoses: effect of diagnosis, sex, and age at onset [see comments]. *Br J Psychiatry* 1992;**161**:506-11.

[54]. Carney PA, Fitzgerald CT, Monaghan CE. Influence of climate on the prevalence of mania. *Br J Psychiatry* 1988;**152**:820-3.

[55]. Silverstone T, Romans S, Hunt N, McPherson H. Is there a seasonal pattern of relapse in bipolar affective disorders? A dual northern and southern hemisphere cohort study. *Br J Psychiatry* 1995;**167**:58-60.

[56]. Winokur G. Duration of illness prior to hospitalization (onset) in the affective disorders. *Neuropsychobiology* 1976;**2**(2-3):87-93.

[57]. Faedda GL, Tondo L, Teicher MH, Baldessarini RJ, Gelbard HA, Floris GF. Seasonal mood disorders. Patterns of seasonal recurrence in mania and depression. *Arch Gen Psychiatry* 1993;**50**:17-23.

[58]. Wehr TA, Rosenthal NE. Seasonality and affective illness. *Am J Psychiatry* 1989;**146**:829-39.

[59]. Zung WW, Green Jr RL. Seasonal variation of suicide and depression. *Arch Gen Psychiatry* 1974;**30**(1):89-91.

[60]. Maes M, Meltzer HY, Suy E, De Meyer F. Seasonality in severity of depression: relationships to suicide and homicide occurrence. *Acta Psychiatr Scand* 1993;**88**:156-61.

[61]. Götestam KG, Eriksen L, Heggestad T, Nielsen S. Prevalence of eating disorders in Norwegian general hospitals 1990-1994: admissions per year and seasonality. *Int J Eat Disord* 1998;**23**:57-64.

[62]. Maes M, Scharpé S, Verkerk R, D'Hondt P, Peeters D, Cosyns P et al. Seasonal variation in plasma L-tryptophan availability in healthy volunteers. Relationships to violent suicide occurrence. *Arch Gen Psychiatry* 1995;**52**:937-46.

[63]. Magnusson A, Stefansson JG. Prevalence of seasonal affective disorder in Iceland. *Arch Gen Psychiatry* 1993;**50**:941-6.

[64]. Potkin SG, Zetin M, Stamenkovic V, Kripke D, Bunney Jr WE. Seasonal affective disorder: prevalence varies with latitude and climate. *Clin Neuropharmacol* 1986;**9 Suppl 4**:181-3.

[65]. Näyhä S. Autumn incidence of suicides re-examined: data from Finland by sex, age and occupation. *Br J Psychiatry* 1982;**141**:512-7.

[66]. Preti A, Miotto P. Seasonality in suicides: the influence of suicide method, gender and age on suicide distribution in Italy. *Psychiatry Res* 1998;**81**(2):219-31.

[67]. Meares R, Mendelsohn FA, Milgrom-Friedman J. A sex difference in the seasonal variation of suicide rate: a single cycle for men, two cycles for women. *Br J Psychiatry* 1981;**138**:321-5.

[68]. Lester D, Frank ML. Sex differences in the seasonal distribution of suicides. *Br J Psychiatry* 1988;**153**:115-7.

[69]. Magnusson A, Axelsson J. The prevalence of seasonal affective disorder is low among descendants of Icelandic emigrants in Canada. *Arch Gen Psychiatry* 1993;**50**:947-51.

[70]. Kern HE. Self Made Man.: Human Evolution from Eden to Extinction? New York: John Wiley and Sons Inc.; 1993.

[71]. Sher L. The role of genetic factors in the etiology of seasonality and seasonal affective disorder: an evolutionary approach. *Med Hypotheses* 2000;**54**(5):704-7.

[72]. Okawa M, Shirakawa S, Uchiyama M, Oguri M, Kohsaka M, Mishima K et al. Seasonal variation of mood and behaviour in a healthy middle-aged population in Japan. *Acta Psychiatr Scand* 1996;**94**:211-6.

[73]. Lester D. Seasonal variation in suicide deaths. *Br J Psychiatry* 1971;**118**:627-8.

[74]. Anderson CA. Temperature and aggression: Ubiquitous effects of heat on occurrence of human violence. *Psychol Bull* 1989;**106**(1):74-96.

[75]. Mills CA. Suicides and homicides in their relation to weather changes. *Am J Psychiatry* 1934;**91**:669-77.

[76]. Wehr TA, Rosenthal NE, Sack DA. Environmental and behavioral influences on affective illness. *Acta Psychiatr Scand Suppl* 1988;**341**:44-52.

[77]. Palmstierna T, Wistedt B. Staff observation aggression scale, SOAS: presentation and evaluation. *Acta Psychiatr Scand* 1987;**76**(6):657-63.

[78]. Palmstierna T, Lassenius R, Wistedt B. Evaluation of the Brief Psychopathological Rating Scale in relation to aggressive behavior by acute involuntarily admitted patients. *Acta Psychiatr Scand* 1989;**79**(4):313-6.

[79]. Lion J, Snyder W, Merril,GL. Underreporting of assaults on staff in a state hospital. *Hosp Community Psychiatry* 1981;**32**:497-8.

[80]. Wonnacott,TH, Wonnacott R. Introductory Statistics. New York: John Wiley & Sons; 1990:5, pp 550-5.

[81]. Hastings MH, Herbert J, Martensz ND, Roberts AC. Annual reproductive rhythms in mammals: mechanisms of light synchronization. *Ann N Y Acad Sci* 1985;**453**:182-204.

[82]. Mulder RT, Cosgriff JP, Smith AM, Joyce PR. Seasonality of mania in New Zealand. *Aust N Z J Psychiatry* 1990;**24**:187-90.