The effect of geomagnetic storms on suicide

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ABSTRACT
Objectives: *To correlate geomagnetic storm activity with suicide rates.* ***Design:*** *A retrospective analysis over a 13 year period, Janaury 1980 to December 1992.* ***Setting:*** *Hermanus Magnetic Observatory (data on geomagnetic storm activity), South African Central Statistical Services (data on suicide rates).* ***Subjects:*** *Nil.* ***Outcome measures:*** *Geomagnetic storm activity and suicide rates.* ***Results:*** *A significant correlation (r= 0,6964 ; p< 0,01) was found between the mean total of suicides and the mean average of storm activity during the same period. This correlation was true of both male (r= 0,6301 ; p< 0,025) and female (r= 0,7544 ; p< 0,005) suicides.* ***Conclusions:*** *Geomagnetic storm activity is correlated with suicide, and confirms previous research suggesting an impact of ambient magnetic field activity on behaviour.*

Keywords: *Suicide, Geomagnetic, Depression, Behaviour, Magnetic*

Introduction

The influence of magnetism on the human body and behaviour is not a new concept. Franz Mesmer (1734-18-15), a student of theology, astrology and medicine, had a basic theory that an invisible magnetic fluid emanating from the stars influenced the health of human beings. An imbalance of this fluid in the body causes illness and could be rectified by the touch of a magnetic wand. Later Mesmer became convinced that his hands had possessed magnetic power and that the magnetic fluid also flowed from his own body in the form of 'animal magnetism.

Since the turn of this century empirical studies regarding geomagnetic influences on humans were described.[1,2,3] Kay (1994), found a high correlation between the admission rate of 3449 patients diagnosed as suffering from depression, to a psychiatric hospital in Britain, and geomagnetic data collected over a 10 year period.[4] The majority of studies have centred around the effect of temperature changes on behaviour[5], and on the influence of man-made industrial and domestic electro-magnetic fields on humans and other living systems.[6,7] Industrial and domestic electro-magnetic fields are different from biogeomagnetics, which is the study of possible low-frequency electromagnetic field disturbances from the solar terrestrial environment on humans and other living systems.[8] The main cause of geomagnetic storms is a sudden increase in charged particles emanating from solar flares. These storms can last several hours and are a global phenomenon. Geomagnetic storms follow a seasonal pattern, are most numerous during the equinoxes.[9]

As far as natural geomagnetism is concerned, it is documented that electric storms cause homing pigeons to lose their sense of direction.[10] It is also known that bees[11], bacteria and snails orientate themselves to the natural geomagnetic flow of the earth, different in the opposite hemispheres.[12] In all these species, magnetite, a magnetic crystal, can be found.[13]

Numerous laboratory studies have shown the effects of magnetic fields on living organisms.[14,15] Neurobiochemical studies have shown that energy fields at the same strength as geomagnetic field strengths (GMF), decreases the hydrophobic character of the cell membrane leading to changing permeability.[11,16,17] It has been shown that magnetic fields alter the electrical properties of solutions and their physiological effects.[18] Membrane potential and electrical activity of neurons was shown to be altered when normal physiological solution was replaced by $CaCl_2$ which was exposed to a magnetic field. Frequency dependence of electromagnetic field-induced Calcium-ion efflux from chicken brain tissues have been shown.[19]

There are indications that the pineal gland, which regulates the circadian rhythm and which is involved with the regulation and production of melatonin[20], is a magnetosensitive system.[21] The nightly production and secretion of melatonin by the pineal gland provides information regarding the time-of-day and time-of-year to the rest of the body, thus acting as a time-cued or 'Zeitgeber' function.[22] In mammals the circadian rhythm of melatonin is synchronised by the prevailing light: dark environment with

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the retina of the eyes doing the photoreception required for the induction of this rhythm.[22] Besides visible light, certain ultra violet wavelengths as well as extremely low frequency electric and magnetic fields may be involved with the melatonin rhythm.[22] Circadian abnormalities may result from a failure in the entrainment processes of internal clocks by environmental time cues.[23,24] It has been demonstrated that individuals placed in an underground bunker, thus shielded from the ambient electromagnetic field, showed gradual desynchronization and lengthening of circadian rhythms, which could be re-synchronized when exposed to artificial magnetic fields[25,26,27]

According to Kay[4], storms in spring would enhance the suppressing effect of increasing daylight on melatonin synthesis, leading to a phase advance in the circadian rhythm, while the effect of storms in autumn would tend to be partially compensated for by the pineal response to decreasing light intensity. The pineal gland was shown to be sensitive to changes in magnetic field exposure in laboratory animals.[21] Alteration of the direction of the geomagnetic field is associated with a reduction of spontaneous electrical activity in the pineal gland, induction of ultrastructural changes in the pineal gland, reduction of N-acetyltransferase and hydroxyindole-O-methyltransferase, reduction of nocturnal cyclic adenosine 3,5-monophosphate content in the pineal gland, inhibition of melatonin secretion, increase glucose uptake in the pineal gland, inhibition of rhythmicity of responses of Purkinje cells to melatonin in the cerebellum and to inhibition of the enhanced nocturnal analgesic response to morphine in mice.[21]

Considering the earth's mainly metallic molten core[13] and since the daily heating and cooling of the atmosphere displaces the jet streams north and south, a more or less regular circadian variation in the magnetic field of the earth can be observed on the ground.[28] This could imply that the natural circadian rhythmicity of the earth's magnetic field could have a 'Zeitgeber' or time cued function.[29] However, it is possible that this natural magnetic flow of the earth, can be disturbed by geomagnetic storms.[13]

Geomagnetic storms are mainly caused by a sudden increase in charged high-energy particles and clouds of ionised gas or plasma, emanating from solar flares.[30] Storms are a global phenomena and seem to follow a seasonal pattern, being most numerous during the equinoxes.[31] Storms have been found to desynchronise ambulatory behaviour patterns in rats[32], and in mice are associated with decreased nocturnal analgesic effects of morphine, possibly mediated via the pineal gland.[33]

While a correlation between Seasonal Affective Disorder and suicide in South Africa has been described (Kerr, unpublished data) the effect of geomagnetic influence on suicide still need to be determined. Furthermore, studies correlating geomagnetic influence on depression and suicide still lack in the Southern hemisphere. This study investigates whether the equinoxal increase in geomagnetic storms will correlate with the bimodal annual distribution of incidence of suicide in a South African population..

Method

Dates of all geomagnetic storms during a 13 year period between January 1980 and December 1992 was obtained from the Hermanus Magnetic Observatory, which is representative for the region from which the suicide data was collected, namely all of South Africa.

K indices from this observatory on the days of the geomagnetic storms were used. The K indices are quasi-logarithmic 3-hour means of geomagnetic disturbances on any particular day. Three magnetic field components are continually being registered by the observatory. D, which represents the magnetic declination, H, the horizontal component and Z the vertical component. As it is only necessary to determine size of the disturbance in this study, the Z component was used for correlation, seeing that this component contributes more than 90% to the calculation of the total magnetic field strength.

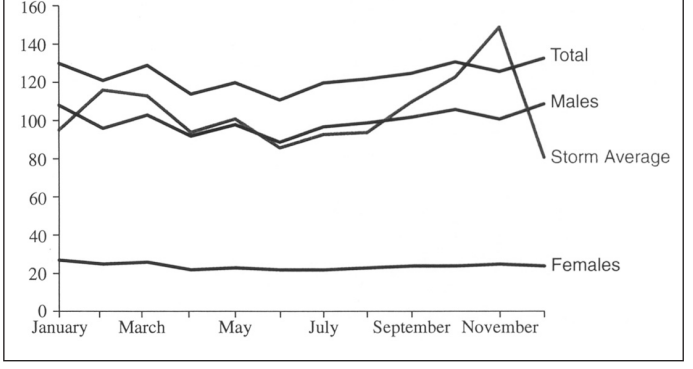
National registered suicide mortality data for the same period, for the whole South African population, was obtained from the South African Central Statistic Services (SACSS). An autopsy performed by a district surgeon is required for all deaths with an unnatural cause. The autopsy report is sent to a magistrate. An inquest is then held, the main aim of which is to establish the cause of death. This cause is then forwarded to the SACSS. Causes of death are classified according to a system based on the ICD-9 (International Classification of Disease)[34], reference E950-959 and E979. Mortality monthly means were calculated in the same way as for the geomagnetic data.

Monthly means for every month was determined, and then a cumulative mean for that specific month over the 13 year period was calculated. This method was used as to eliminate a Type II error. The Pearson's Product Moment Correlation Coefficient method from the Statistix PC package was used to determine correlation.

Results

The relationship between suicide and geomagnetic storm activity is shown in Figure 1. The December and January periods do not show a correlation between geomagnetic storm activity and suicide. In a year by year breakdown of the data, this pattern was observed for every year during those months, suggesting that some other factors may be involved. Temperature may have an effect on depression and suicide.[5] To control for this variant, data for these months have been omitted from the calculations. By calculating in this manner, a significant correlation ($r= 0{,}6964$; $p< 0{,}01$) was found between the mean total of suicides for the remaining ten months, and the mean average of storm activity during the same period. The correlation of male suicide rates separately for this ten month period yielded a significant correlation ($r= 0{,}6301$; $p< 0{,}025$). The number of female victims (287) was four

Figure 1



times less than that for males (1200). However, their correlation with geomagnetic storm activity was highly significant (r= 0,7544 ; p< 0,005).

Discussion

Changes in the environmental magnetic field, which are directly associated with solar activity as well as circadian variants in the earth's magnetic field strengths are capable of disturbing the electrical activity of the brain and could lead to various neuropsychiatric disturbances, such as SAD, depression and suicide. Due to the influence of magnetic fields on the pineal gland, it is possible that these effects are mediated through alterations in pineal melatonin functions.[21] Phase advance in pineal circadian rhythms of melatonin synthesis may be a possible mechanism of causation, or be present as a consequence of 5-hydroxytryptamine or adrenergic system dysfunction associated with geomagnetic disturbances.[4] Effects on cell membrane permeability, calcium channel activity and refined magneto-receptors are suggested as possible underlying biochemical mechanisms.[4]

Transcranial Magnetic Stimulation (TMS) is an experimental therapeutic modality. Experimental studies have shown that magnetic stimulation can cause $5HT_{1B}$ receptor downregulation. Like ECT, TMS can activate immediate early genes. Left Prefrontal TMS has been shown to increase ^{18}FDG uptake with PET scanning. Antidepressant effects of left prefrontal TMS, at high (20Hz) frequency but not right prefrontal TMS has been reported. Younger, right handed patients are more likely to respond. Gabapentin may enhance the therapeutic response to TMS. Right prefrontal TMS may possibly be antimanic.[35,36,37,38,39,40] Controlled data on short term use of TMS in recurrent depression is now available.[41]

From recent research it seems that violent versus non-violent suicide correlates differently with biometeorological influences, with violent suicides showing a stronger correlation.[5,42] Furthermore, gender specific responses to geomagnetic disturbances could be expected as the pineal gland is involved with regulating sexual activities[43], as well as the fact that it plays a role in the varying melatonin levels involved in the menstrual cycle.[44]

It is well documented that temperature has an effect on depression and suicide.[5] As the December / January period is a period characterised by higher temperatures in South Africa, it is possible that this could play a role. Some studies further reports more attempted suicides in the last six months of the year, especially in December.[45,46,47] This study controlled for this variant in a manner reported in other studies.[4] This study did not, however, directly control for the effects of season. Flisher et al (1997) described a seasonal pattern in suicide in South Africa, with a peak in the spring (September/October) or summer and a trough in winter.[48] This pattern was described as being more pronounced for a sub-group that is less urbanized and for another sub-group with a relatively low standard of living.

Conclusion

The results of this study support the hypothesis that a geomagnetic storm activity is associated with suicide rates. This finding was observed in both male and female populations in South Africa. A weakness of this study was that although very accurate and complete data for the geomagnetic part of the study exists, only monthly averages for the corresponding suicide rates could be obtained. Research using daily or weekly suicide figures may yield a tighter correlation. Further investigation to determine possible correlation between geomagnetic storm influence on violent versus non-violent suicides in both male and female populations could also to be undertaken.

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