SEASONAL, MONTHLY AND WEEKLY VARIATION OF SUICIDE IN PIETERMARITZBURG

AND

THE RELATIONSHIP BETWEEN SUICIDE AND METEOROLOGICAL FACTORS

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ABSTRACT

This study investigated the seasonal, monthly and weekly variation of fatal suicidal behaviour in Pietermaritzburg, as well as the relationship between fatal suicidal behaviour and climate. Secondary analysis was performed on suicide data collected for two unpublished honours theses. Results indicate that there is significant monthly variation in the distribution of fatal suicidal behaviour in Pietermaritzburg, with the expected spring-summer peak and winter trough. This pattern was more pronounced for adults than for the youth or the elderly. There was no significant variation in the weekly distribution of suicide, and suicides did not reach a peak on Monday as has been evidenced in previous research. Instead, the distribution showed a peak on Sunday with a steady decrease towards the end of the week. An increase in humidity, ambient temperature and minimum temperature was associated with an increase in suicide rates. Overall this relationship was stronger for violent, than non-violent suicide. However, a significant negative relationship was found between hours of sunshine and suicide, but this was only significant for non-violent suicide. This study was largely descriptive, and further research is indicated in order to develop a theoretical framework for understanding the temporal distribution of suicide.

DECLARATION

I declare that, unless specifically stated to the contrary, this thesis is the result of my own work.

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Simone Descoins

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CHAPTER ONE: INTRODUCTION

According to the World Health Organisation (WHO), in the last forty-five years suicide rates have increased by 60% worldwide. It is predicted that about one million people will die from suicide in the year 2000. That translates into approximately one death every forty seconds. Even more sobering is the observation that suicide is now one of the three leading causes of death among those aged 15-44 years (WHO, 2000). Suicide is thus a cause for global concern, and this is reflected in the profusion of research in this area.

Epidemiological studies based on census data comprise one of the most popular approaches to the study of suicidal phenomena. Over the years, vast tracts of literature have been produced on suicide in relation to a myriad of variables including sex, age, race, religious affiliation and psychiatric diagnosis (Shneidman, 1992). The general presupposition behind this flurry of research is that a greater understanding of suicidal behaviour will provide insight into means of prevention. One of the many factors that has fallen under scrutiny is the temporal distribution of suicide. This has included investigations into seasonal and monthly variations in suicide rates, fluctuations of suicide by day-of-the-week, day-of-the-month and time-of-day, as well as variations of suicide rates in accordance with the lunar cycle. The focus of this thesis is the seasonal, monthly and weekly distribution of suicide.

The study of the temporal distribution of suicide seems to have arisen out of uncertainty as to whether suicide is better explained in biological or social terms. 'Seasons' in this context can be understood to be 'natural' cycles corresponding to climatic changes. They have however been socially delineated into four three month periods, namely spring, summer, autumn and winter[1]. Weeks and months on the other hand are arbitrary social constructs, uncorrelated with biological processes (Phillips & Ryan, 2000). Although seldom explicitly stated, the underlying assumption in this area of research has been that a seasonal pattern in suicide might indicate either biological or social processes, but monthly or weekly trends must involve non-biological processes.

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[1] The Gregorian calendar is assumed throughout this thesis. There are, however, a number of other calendars such as the Islamic, Jewish and Chinese calendars that are based on different temporal delineations.

Although there is a large body of literature on suicide seasonality in the northern hemisphere[2], in predominantly western[3] settings, the topic has received scant attention in southern hemisphere, and 'non-western' studies. Interest in 'non-western' studies has been sparked by speculation that suicide seasonality might be related to psychosocial processes specific to western culture. Southern hemisphere studies, on the other hand, are deemed useful in determining whether bioclimatic influences observed in the north are a global phenomenon. South Africa thus provides an ideal site for the study of suicide seasonality in that it is a 'non-western' country located in the southern hemisphere. The first, and thus far only, study of suicide seasonality in South Africa conducted by Flisher, Parry, Bradshaw and Juritz (1997) has provided an important body of data against which regional comparisons can be made.

Flisher et al.'s (1997) study of suicide seasonality in South Africa examined seasonality in terms of monthly variation of suicide rates. As has been argued above, monthly variation is best explained in terms of social rather than biological processes. It was thus decided that in addition to a regional replication of this national study, the relationship between climatic variables and suicide rates would be explored as a means of gleaning some information on a possible biological basis for suicide seasonality. The sociological possibilities will be explored further in terms of an examination of fluctuations in suicide rates by day-of-the-week, as there has been very little research in this area.

This thesis, then, is a descriptive study of the seasonal, monthly and weekly variation of suicide in Pietermaritzburg, as well as an investigation into the relationship between suicide rates and climatic variables. A review of the literature on which this thesis is based is presented in Chapters Two to Six. Chapter Two presents the problem of nomenclature in the field of suicidology and outlines the chosen definitions for this thesis; in Chapters Three and Four, previous research into seasonal and monthly, and weekly distribution of suicide is explored; Chapter Five outlines some theoretical approaches to the temporal distribution of

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[2] The terms 'northern' and 'southern' hemisphere used throughout this thesis refer only to geographical positioning north or south of the equator.
[3] In this thesis, 'western' refers to industrialised countries with large populations of western European extraction. This includes countries such as Australia, Canada, Western Europe and the United States (Canetto & Lester, 1998).

suicide and, in Chapter Six, recent research into the patterns of suicide in Pietermaritzburg is reviewed.

A description of the aims and hypotheses that directed this study, the sample under investigation and the means of testing the hypotheses are described in detail in Chapter Seven. Thereafter, the results of the investigation are presented in Chapter Eight. Chapter Nine is devoted to a discussion of the study as a whole, including the implications of the findings, the limitations of the study and implications for future research. Finally, some concluding comments are presented in Chapter Ten.

CHAPTER TWO: CONCEPTUAL CLARIFICATION

A universally accepted nomenclature, or set of commonly defined terms, is needed for suicidology in order to facilitate communication and minimise confusion among those who seek to understand and prevent suicide (O'Carroll, Berman, Maris, Moscicki, Tanney & Silverman, 1996). Unfortunately, however, after more than 25 years of discussion and debate, the problem of nomenclature remains unresolved (Silverman, 1997). In an attempt to resolve the problem of conflicting and ambiguous definitions, O'Carroll et al. (1996) recently proposed a comprehensive nomenclature for suicide-related behaviour. Some of their suggested definitions are presented below:

Suicide / Completed Suicide: Death from injury, poisoning, or suffocation where there is evidence (either explicit or implicit) that the injury was self-inflicted and that the decedent intended to kill himself/herself.

This definition of "suicide" is taken from the Centers for Disease Control's (CDC) Operational Criteria for the Determination of Suicide (OCDS) (Rosenberg et al., 1988, in O'Carroll et al., 1996).

Suicide Attempt with Injuries: An action resulting in nonfatal injury, poisoning, or suffocation where there is evidence (either explicit or implicit) that the injury was self-inflicted and that the decedent intended at some (nonzero) level to kill himself/herself.

Suicide Attempt: A potentially self-injurious behaviour with a non-fatal outcome, for which there is evidence (either explicit or implicit) that the person intended at some (nonzero) level to kill himself/herself. A suicide attempt may or may not result in injuries.

Suicidal Act: A potentially self-injurious behaviour for which there is evidence (either explicit or implicit) that the person intended at some (nonzero) level to kill

himself/herself. A suicidal act may result in death (completed suicide), injuries, or no injuries.

Instrumental Suicide-Related Behaviour: Potentially self-injurious behaviour for which there is evidence (either explicit or implicit) that (a) the person did not intend to kill himself/herself (i.e., had zero intent to die), *and* (b) the person wished to use the *appearance* of intending to kill himself/herself in order to attain some other end (e.g., to seek help, to punish others, to receive attention).

Suicide-Related Behaviour: Potentially self-injurious behaviour for which there is explicit or implicit evidence *either* that (a) the person intended at some (nonzero) level to kill himself/herself, *or* (b) the person wished to use the *appearance* of intending to kill himself/herself in order to attain some other end. Suicide-related behaviour comprises suicidal acts and instrumental suicide related behaviour.
(p. 247)

O'Carroll et al.'s (1996) proposed nomenclature has received much attention and their definitions for "suicide" and "suicide attempt" have been adopted by the World Health Organisation (WHO, 2000). These definitions are based on the concepts of outcome, self-infliction and intent to die (O'Carroll et al., 1996). Although the notion of intent is considered by many to be central to the concept of suicide (e.g. Shneidman, 1992), it remains a point of contention. Canetto and Lester (1998), for example, criticise the terms 'attempted suicide' and 'completed suicide' for confounding intent and outcome. "They suggest that individuals who survive a suicidal act attempted and failed to kill themselves, and that people who die from suicidal behaviour intended such death" (Canetto & Lester, 1998, p. 166). Although O'Carroll et al. (1996) assert that their intended focus is on concepts and definitions rather than on the terms themselves, Canetto and Lester's (1998) objection raises the important point that outcome is not necessarily a good indicator of intent. While O'Carroll et al. (1996) address the problem of intent in their differentiation between 'suicide attempt' and 'instrumental suicide-related behaviour', it is presupposed that intent is always discernable where there is non-fatal suicidal behaviour. Furthermore, the definition for completed suicide excludes the possibility that suicidal behaviour may have a fatal outcome even if there was no intention to bring about death.

Canetto and Lester (1995, in Canetto & Lester, 1998) suggest the terms 'fatal' and 'nonfatal' suicidal behaviour. The emphasis here is on outcome, which is easily discernable, rather than on intent, which is not. These are terms that have been adopted for use in this thesis. Although Canetto & Lester, 1998) offer no precise definitions for these terms, it is suggested that an adaptation of O'Carroll et al.'s (1996) might suffice:

Fatal Suicidal Behaviour: Death from injury, poisoning, or suffocation where there is evidence (either explicit or implicit) that the injury was *wilfully* self-inflicted.

For the purposes of this thesis '*wilfully*' has been inserted to exclude instances in which the person may have been coerced into injuring themselves.

Non-Fatal Suicidal Behaviour: A potentially self-injurious behaviour with a non-fatal outcome. Non-fatal suicidal behaviour may or may not result in injuries.

These are the terms and definitions that have been adopted for the purposes of this thesis. For convenience, however, 'suicide' will be used to refer to fatal suicidal behaviour where there is no need for differentiation between fatal and non-fatal suicidal behaviour.

CHAPTER THREE: SEASONAL & MONTHLY DISTRIBUTION OF SUICIDE

A review of the literature on the seasonal and monthly distribution of suicide is presented in this chapter. Initially, the historical origin of this area of research is described, thereafter, recent research in the northern and southern hemispheres is explored. This is followed by a description of some of the variables that have been related to suicide seasonality. Finally, some of the methodological issues in the study of suicide seasonality are outlined.

Hippocrates, revered as the father of modern medicine, believed autumn to be the universal season of melancholy (Adams, 1938). Thus, long before the days of empirical demography, it was presupposed that suicides would culminate in the dull autumn months. This was common belief until Morselli published the first comparative study of the monthly distribution of suicide in 1879 (Durkheim, 1970). He observed that throughout most of Europe the number of suicides increased from the beginning of the year until June, and then steadily decreased to the end of the year. He further observed that a maximum number of suicides occurred in summer and a minimum in winter. Morselli attributed this asymmetrical distribution of suicides to the direct influence of climatic variables, in particular temperature, on the brain. He postulated that it was the change in temperature in spring and early summer that afflicted the organism still under the influence of the cold weather.

In 'Le Suicide', Durkheim (1970) also noted the effect of seasonal change on suicidal behaviour but argued that climatic variables affected the distribution of suicide only in as far as they influenced the ebb and flow of social life. He stated that suicide is more commonly committed during the day than at night and found that there was a close positive correlation between duration of daylight and monthly suicide rates. In other words, an increase in the hours of daylight corresponded to an increase in suicide rates. From this he concluded that the duration of daylight and its impact on social interaction was the determining factor for the distribution of suicide throughout the year. He found further support for his theory in his observation that seasonal variation was less noticeable in big cities where artificial lighting regulates the working day, but collective life is more irregular and less intense. In addition, big cities evidenced a spring rather than a summer peak, which Durkheim explained in terms

of the summer migration of 'chief public personages' and the consequent slowing down of public life.

Durkheim's (1970) often cited 'Le Suicide' is regarded as one of the most ambitious attempts to explain suicide rates and it is still deemed to be of major importance in the field (Taylor, 1982). He openly states that the main aim of the book is to demonstrate the truth of his sociological theories and he proceeds to do this with dogmatic zeal. In the chapter devoted to 'Suicide and Cosmic factors' , which deals with the seasonal and monthly distribution of suicide, he does not so much investigate this relationship, but sets out to prove the sociological basis of the temporal distribution of suicide. As Nisbet points out, "...the idea, the plot, and the conclusion of suicide were well in Durkheim's mind before he examined the parish registers" (1963, in Taylor, 1982, p.11). Although his arguments are extremely one-sided, his challenge of Morselli's bioclimatic theory with his sociodemographic one[4] has set the stage for a continuing debate that has precipitated some valuable research.

Since the nineteenth century, researchers have found that suicide increases during the warmer months of the year. While Morselli attributed this distribution to the influence of climatic variables on the brain, Durkheim (1970) asserted that seasons influenced the ebb and flow of social life, which in turn determined suicide rates. Variations on this debate continue into the present day. A general overview of current research into the seasonal and monthly distribution of suicide in the northern and southern hemispheres is presented below.

3.1   Suicide seasonality in the northern hemisphere

Later studies of suicide seasonality have confirmed Morselli and Durkheim winter nadir, but found that the peak incidence was in spring (Massing & Angermeyer, 1985). An overview of several studies of suicide seasonality in both the northern & southern hemispheres can be found in Appendix I. In Belgium 1979-1987, Finland 1961-1989, Sweden 1981-1989, France 1978-1982, Germany 1968-1977, Italy 1969-1994 and USA 1972-1985 suicide rates reached

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[4] The terms bioclimatic and sociodemographic are explained in detail in Chapter 5.

a peak April-May (spring) and fell to a low December – February (winter) (Altamura, VanGastel, Pioli, Mannu & Maes, 1999; Dixon & Shulman, 1983; Hakko, Rasanen, & Tiihonen, 1998; Horton & Stack, 1984; Lester & Frank, 1990; Maes, Cosyns, Meltzer, De Meyer & Peeters, 1993; Maes, De Meyer, Thompson & Peeters, 1994; Massing & Angermeyer, 1985; Micciolo, Williams, Zimmerman-Tansella & Tansella, 1991; Micciolo, Zimmerman-Tansella, Williams & Tansella, 1989; Näyhä, 1982, 1983; Preti & Miotto, 1998; Rihmer, Rutz, Pihlgren & Pestality, 1998; Sanborn & Sanborn, 1978; Souêtre, Salvati, Belugou, Douillet, Braccini & Darcourt, 1987; Wenz, 1977). Exceptions have been found in the UK, Ireland and Israel. No studies have found significant suicide seasonality in the UK and although an August (summer) peak was observed in Ireland, this was not statistically significant (Meares, Mendelson & Milgrom-Friedman, 1981; Reid, Smith & Greene, 1980; Salib & Gray, 1997).

Schreiber, Dycian, Kaplan and Bleich (1993) found seasonality of suicide in Israel 1984-1990, with a peak in December (winter) and a nadir in October (autumn). They suggest that their unusual findings may be the result of three consecutive Jewish holidays during September-October. A reduction of suicide rates prior to and during national holidays has previously been demonstrated in the US (Phillips & Lui, 1980). The nadir, then, is associated with the build-up prior to and during the holidays, and the peak is possibly linked to their 'after-effects'.

Unfortunately, no published accounts of suicide seasonality were available for China, India or Eastern Europe.

3.2 Suicide seasonality in the southern hemisphere

Although relatively few studies on suicide seasonality have been conducted in the southern hemisphere, the trend appears to be consistent with that found in the northern hemisphere. Significant seasonal variation in suicide has been found in Australia 1968-1993 (Chew & McCleary, 1995; Hassan, 1994; Yip, Chao and Ho, 1998), South Africa 1978-1989 (Chew &

3.3   Factors related to the Seasonal Distribution of Suicide

3.3.1   Sex and suicide seasonality

Seasonal change appears to have a more marked influence on male than female suicides (Eastwood & Peacocke, 1976; Massing & Angermeyer, 1985; McCleary, Chew, Hellsten & Flynn-Bransford, 1991; Micciolo, Williams, Zimmerman-Tansella, & Tansella, 1989, 1991; Preti, 1997). It has been suggested that this is the result of the different action of bioclimatic factors on the neurohormonal systems of the two sexes (Linkowski, Martin & De Maertelaer, 1992; Meares et al., 1981). Some studies have also noted different seasonal distributions of suicides for males and females. Males typically evidence a single spring peak, while female suicides have two peaks, one in spring and one in autumn. This has been observed in England and Wales (Meares et al., 1981), Finland (Näyhä, 1982, 1983), Italy (Micciolo et al., 1989, 1991; Preti & Miotto, 1998) and Sweden (Rihmer et al., 1998). In New South-Wales, Australia, 1971-1976, Parker and Walter (1982) also found spring and autumn peaks in female suicides. However, Yip et al. (1998) found a unimodal distribution in female suicides in Australia and New Zealand between 1981-1993. It is thus possible that, like suicide seasonality in general, the bimodal distribution is on the wane. Yip et al. (1998) suggest that this may be due to the changing role of women in society.

The bimodal distribution of female suicides has generally not been observed in non-Western countries. Flisher et al. (1997) in South Africa and Ho et al. (1997) in Hong Kong and Taiwan, for example, failed to demonstrate a biseasonal peak of female suicides, giving rise to speculation that the second, autumn peak may relate to psychosocial processes specific to western culture (Preti & Miotto, 1998).

It has been suggested that the commencement of the academic year in autumn in western countries may intensify feelings of loneliness in women who are separated from their children (Näyhä, 1982). The summer suicide peak observed by Flisher et al. (1997) seems to support this theory as it corresponds to the commencement of the academic year in South Africa. However, the cornerstone of this theory rests on the assumption that a sufficiently

large number of women who commit suicide have school-going children to determine the seasonal distribution of female suicide. A more plausible explanation might be that the autumn peak for females is related to the seasonal variation in communal activities found particularly in females or to variation in social support (Micciolo et al., 1991; Näyhä, 1982; Preti, 1997).

Alternatively, Micciolo et al. (1989) suggest that their observation of a second, autumn peak might be related to the finding that male unemployment, which occurs frequently in autumn in Italy, has been found to be correlated with suicide incidence in their wives. It has also been suggested that the autumn peak could be determined by gender-specific circannual biological rhythms related to bioclimatic variables.

Näyhä (1983), in the only study to include marital status as a variable, observed that the autumn peak of female suicides was more prominent among married and widowed women than single or divorced women in Finland, and speculated that this might be related to certain personality characteristics that influence the chance of marrying or marrying successfully. He did not elaborate on this theory, but following from Linkowski et al.'s (1992) theory, it is possible that the impact of bioclimatic factors will vary across the various personality types. Different personality traits have been associated with variations in levels of a number of hormones and with fluctuations in the levels of several neurotransmitters, e.g. 5-HT. These in turn appear to be influenced by certain climatic variables (Kaplan, Sadock & Grebb, 1994; Maes et al., 1993a, 1995; Pine, Trautman, Shaffer, Cohen, Davies, Stanley & Parsons, 1995).

The temporal distribution of male suicides has also been found to vary with marital status. Näyhä (1983) observed that while single and married males evidenced the expected early summer peak (May-June), the suicide peak for widowed and divorced males was found to be autumn.

Numerous studies, however, have found no gender differences in suicide seasonality (Chew & McCleary, 1995; Lester & Frank, 1988; Reid, Smith & Green, 1980; Sanborn & Sanborn, 1978; Souêtre et al., 1987). Only three studies have reported a bimodal distribution of

suicides for both males and females (Eastwood & Peacocke, 1976; Lester & Frank, 1988; Souêtre et al., 1987). Eastwood and Peacocke (1976) in Canada and Souêtre et al. (1987) in France reported peaks in spring and autumn. Eastwood and Peacocke (1976) related this distribution to their finding of spring and autumn peaks in hospital admissions for depression. Lester and Frank (1988), on the other hand, observed spring and late summer peaks in suicide rates in the USA. They relate the spring peak to feelings of hopelessness resulting from the realisation that spring has not released them from "…the social isolation and depression brought about by the cold weather" (ibid., p.116). Similarly, feelings of hopelessness are intensified in late summer upon the realisation that "…spring and summer did not bring about a change in life circumstances" (ibid., p.116). This is similar to Gabennesch's (1988) broken promise theory, which is discussed in detail in section 5.1.2.

3.3.2   Age and Suicide Seasonality

Age has also been found to be a determining factor in suicide seasonality with the elderly and the young evidencing more statistically significant seasonality. Marked seasonality in elderly suicides, with the expected spring-summer peak and winter low, has been found in the US (Lester & Frank, 1988; McCleary et al., 1991), in Italy (Preti & Miotto, 1998), in France (Souêtre et al., 1987) and in the UK (Salib, 1997). Preti and Miotto (1998) cite Chew and McCleary's (1994) theory that decreased surveillance and accessibility of lethal means are the key elements in suicide risk. They suggest that surveillance of the elderly may decrease in summer when the younger generations spend more time socialising outdoors, increasing the risk of elderly suicide in this season.

McCleary et al. (1991) also found marked seasonality in teenage male suicides but with a peak in winter and a low in summer. Preti and Miotto (1998), on the other hand, found that those under 24 did not evidence statistically significant suicide seasonality, although a winter peak was also observed. In contrast to this, some studies have noted a bimodal distribution of suicides for those under the age of 25, with spring and autumn peaks similar to those found for females (Näyhä, 1982; Preti & Miotto, 1998; Souêtre et al., 1987). This too has been related to the commencement of the academic year and its incumbent pressure (Näyhä, 1982).

3.3.3   Method of Suicide and Suicide Seasonality

Aggression and impulsivity have long been associated with suicidal behaviour (Lidberg, Tuck, Asberg, Scalia-Tomba & Bertilsson, 1985). This is supported by findings that suicide victims, murderers and subjects with very hostile behaviour all evidence dysfunctional serotonin (5-HT) neurotransmission (ibid.). Violent suicides in particular have shown a strong relationship with variations in 5-HT related functions (Roy, 1992). Smolensky (1983) noted seasonality in violent crimes with a peak in spring in common with suicide seasonality. This led to speculation that suicide by violent and non-violent means may differ in temporal distribution. Violent suicide (ICD-9: 953-958, WHO, 1978) has typically been found to show a clear seasonal trend, with the expected spring peak and winter nadir, whereas non-violent suicide (ICD-9: 950-952, WHO, 1978) has less marked seasonality (Maes et al., 1993a,b, 1994, 1995; Massing & Angermeyer, 1985; Preti & Miotto, 1998). The evidence seems to suggest that seasonality in violent suicides may be the determining factor in overall suicide seasonality. Likewise, the sex difference in the temporal distribution of suicide has been outlined in the previous section, with males evidencing stronger suicide seasonality than females. Males are also much more likely to commit suicide by violent means than females (Linkowski et al., 1992). This seems to suggest that male violent suicides may be responsible for the observed pattern of suicide seasonality.

In contrast to Smolensky (1983), Maes et al. (1993a) found no significant seasonality for homicide and no relationship between violent suicide and homicide. Furthermore, while a relationship has been found between violent suicide and certain climatic variables, in particular temperature, no such relationship existed for non- violent suicide or homicide (Maes et al., 1994). This calls into question the notion that aggressive impulses are the common underlying feature of both homicide and suicide (Maes et al., 1993a). It has been suggested that it is the combination of violent behaviour and suicide, rather than violent (i.e. homicide or violent suicide) or suicidal (i.e. violent or non-violent suicide) behaviour that is associated with annual meteorological rhythms. This combination of violent behaviour and suicide would therefore determine the seasonal nature of violent suicide (Maes et al., 1994).

In Australia, Yip et al. (1998) found a seasonal trend for suicide by hanging, but found no evidence of method seasonality in their New Zealand sample. Choice of suicide method was not taken into consideration in the other southern hemisphere studies.

Sex and age effects have been found in the temporal distribution of suicide by method. Maes et al. (1993a) observed that the ratio of violent to non-violent suicides increased significantly with age, and that violent suicides evidenced a March-April (spring) peak in younger persons and an August (late summer) peak in the elderly.

Lester and Frank (1988) found a spring peak for suicides by poison and a bimodal distribution for suicide by hanging or firearm for male suicides. Females evidenced spring and autumn peaks for suicide by poison and hanging, and summer and late autumn peaks for suicide by firearm. Males appear to be more likely to commit suicide by violent means than females, which perhaps explains the stronger seasonal variation in male suicides (Maes et al., 1993a). Ho, Chao and Yip (1997) have suggested the possibility that a particular suicide method (or methods) preferred by western females, but seldom used by Asian females, might account for the biseasonal pattern found in western female suicides.

3.3.4 Geographical location and Suicide Seasonality

Consistent with Durkheim's early findings, recent studies have noted that suicide seasonality is more pronounced in rural than urban populations, lending support to the sociodemographic explanation (Chew & McCleary, 1995; Micciolo et al., 1989, 1991; Souêtre et al., 1990). Furthermore, in Italy where seasons are more pronounced in the north than in the more temperate south, there is a trend for suicide seasonality to increase in a southerly direction. Micciolo et al.(1991) suggest that the higher levels of industrialisation in the north counteract the effect of climatic factors.

In his analysis of suicides in Japan 1900-1941 and 1947-1982, Abe (1987) found that although suicide seasonality was still present, it had decreased markedly. He found that this decrease in suicide seasonality was correlated with rising per-capita gross domestic product

and showed that a similar trend was occurring worldwide. These findings are supported by a recent cross-national study of suicide seasonality and per-capita GNP in 28 nations (Chew and McCleary, 1995).

Näyhä (1982) examined suicide seasonality by occupation and found a unimodal summer peak only in those engaged in predominantly outdoor occupations. Those employed in an office environment, with less contact with the natural environment, evidenced an autumn peak.

Lester and Frank (1990), however, have refuted the international generality of the finding of greater suicide seasonality in urban settings with their finding that the spring peak in suicides was significant in both urban and rural areas of the USA. However, these authors only examined data for a one-year period, 1980, which is perhaps too short a period to gain any real insight into suicide seasonality.

3.3.5 Race and Suicide Seasonality

Although suicide seasonality has been studied around the globe and across many nationalities, only the South African and Zambian studies specifically examined race as a variable. Rwegellera (1978) found no significant seasonal variation in suicide for 'Africans' or 'Europeans' in Zambia. Although not statistically significant, the race groups did differ, however, in the distribution of suicides, with 'African' suicides reaching a peak December – March (the hot, wet season) and 'European' suicides peaking April-July (the dry, cold season).

In South Africa, Flisher et al.(1997) found that for both blacks and coloureds the winter trough and summer peak were more pronounced than for whites and Indians. Flisher et al.(1997) suggest that this is consistent with findings of greater seasonality in rural than urban populations and in agricultural than industrialised populations, since a larger proportion of black South Africans live in rural areas than any other population group (Chew & McCleary, 1995; Micciolo et al., 1991; Souêtre et al., 1990). Chew and McCleary (1995) found that the

magnitude of spring to winter ratio was significantly negatively correlated with per capita gross national product (GNP). This may explain why greater seasonality was observed for coloureds even though they are not less urbanized, since their standard of living is lower than that of white or Indian population groups (Flisher et al., 1997).Due to the scarcity of research, the relationship between race and suicide seasonality remains inconclusive. Further research would be needed before any trends could be detected.

3.4   Methodological Issues

While an attempt has been made to compare the results of the numerous studies in this field, this has been hampered by the different methodological approaches favoured by various researchers. Although most studies have analysed data by means of chi-square and ANOVA, it has been argued that these methods only suggest differences in the variables across the months or seasons, rather than providing evidence for seasonal "variation" (Maes et al., 1995). More recent studies have focussed on the detection of circannual rhythms and on the inspection of the chronogram's peaks and lows, which should coincide with specific seasons. This has been done by means of statistical techniques such as spectral or harmonic analysis (Maes et al., 1993a; Micciolo et al., 1989).

CHAPTER FOUR: WEEKLY DISTRIBUTION OF SUICIDE

A summary of the literature regarding the weekly distribution of suicide is presented in this chapter.

There have been relatively few studies of the weekly distribution of suicide. The first known study was published by De Guerry in France in 1835 (Durkheim, 1970). He noted that suicide was committed with greater frequency from Monday to Thursday than during the rest of the week. Both Morselli and Durkheim attributed this phenomenon to social factors, although their emphasis was slightly different. Morselli's extremely classist explanation of the phenomenon centres on the notion of the 'workman' escaping from sad thoughts during a weekend of gluttony and revelry, and having to return to work with these thoughts intensified by the effects of drunkenness, the 'remorse for prodigality' and a dislike of work (ibid.). Durkheim on the other hand emphasised the intensity of social life during the week compared with the peace and calm of the weekend (ibid.).

Later studies also noted the decrease in suicide over the weekend as well as a marked increase at the beginning of the week, with a maximum on Monday (Dixon & Shulman, 1983; MacMahon, 1983; Maldonado & Kraus, 1991; Massing & Angermeyer, 1985). McCleary et al.(1991) confirmed the Monday peak, but this was only significant in middle-aged suicides, as did Hassan (1994), but this was significant only in male suicides. The sociodemographic explanation for the 'Monday effect' is supported by Hassan's (ibid.) finding that during those weeks in which Monday was a Public Holiday, suicides decreased on Monday and increased on Tuesday. Israel is an exception, however, with most suicides occurring on a Sunday and the least on Friday (Modan, Nissenkorn & Lewkowski, 1970). More recently, although Altamura et al. (1999) found a trend towards fewer suicides over the weekend, they found no significant effect of day of the week on suicide count.

None of the research into the weekly distribution of suicide explicitly states whether the day of the suicidal act or the day of the suicide death is being investigated. Since all of the papers base their investigations on mortality data, one might assume that it is the latter. The

explanations for the Monday effect, however, have centred on why the suicidal act takes place on that particular day. The underlying assumption is that the death from suicide necessarily occurs on the same day as the suicidal act, which is clearly not always the case, and needs to be specified more clearly in future research

CHAPTER FIVE: THEORETICAL APPROACHES TO THE TEMPORAL
DISTRIBUTION OF SUICIDE

The debate over different explanations for seasonal trends continues into the present, with the sides in the debate still resembling the same sociodemographic and bioclimatic positions held respectively by Durkheim and Morselli in the century before last (Chew & McCleary, 1995). The sociodemographic explanation suggests that suicide seasonality co varies with sociodemographic factors and that suicide seasonality will be higher in places where the intensity of social life is more seasonal (ibid.).

Adherents of the Bioclimatic explanation argue that suicide seasonality co varies with bioclimatic factors. According to this theory, suicide seasonality will be most variable in places where the contrast between the seasons is most pronounced (ibid.). This is supported by Chew and McCleary's finding that populations in or near the tropics evidence less suicide seasonality (ibid.).

5.1   Sociodemographic Explanations

Proponents of the sociodemographic explanations range from those who dismiss the influence of climate outright, to those who acknowledge that weather exposures may exert an effect on behaviours such as suicide, but argue that sociological variables predominate.

While numerous sociological theories of suicide have been proposed (e.g. Stack, 1998), a full review of these is beyond the scope of this thesis. Only the few sociological theories that have been linked to seasonality will be reviewed briefly below. Some of the sociological factors associated with suicide that lend support to the sociodemographic explanation are as follows: membership of certain religious or social groupings; marital status; work or economic problems and lack of social support (Kaplan et al., 1994; Maris, 1997).

The sociodemographic explanations proposed by Massing and Angermeyer (1985) and by Gabennesch (1988) appear to be the only attempts to relate and explain both monthly and weekly variation in suicide as expressions of the same underlying dynamics.

5.1.1   Anomia

Massing and Angermeyer (1985) argue that the monthly and weekly distribution of suicide is best explained in terms of Durkheim's concept of anomia. They suggest that suicide is most likely to occur at times when the discrepancy between an individual's needs and expectations and the available means of gratification are greatest. This is most likely to occur at times of increased social interaction, in spring or during the working week, which precipitates a comparison between the individual and others, possibly highlighting a discrepancy between their own ends and means (ibid.). A variation of this theory is Lester & Frank's (1988) suggestion that increased social interaction leads to increased exposure to frustration and conflict, and that the resultant stress may provoke suicidal behaviour. There is, however, little evidence to support the assumption that social life increases in intensity in spring and on a Monday. Massing and Angermeyer (1985) also proposed an explanation for the 'Monday effect', which follows on from Morselli's classist notion of the recalcitrant worker returning to work after a weekend of revelry. They speculate that the recent increase in the number of suicides at the beginning of the week could be the result of the longer work-free weekend, which may make the resumption of work more difficult for some.

5.1.2   Broken-Promise Effect

Gabennesch's (1988) theory of the temporal distribution of suicide also deals with disappointed expectations. His theory is based on the concept of relative deprivation, which suggests that a dysphoric mood is the result of a negative discrepancy between how one feels and how one expects to feel. If an impending event holds much promise and heightens expectations without actually producing any positive change in the suicidal person's condition, they might well exceed their "suicide threshold" due to a more acute sense of relative deprivation – the broken promise effect. He asserts that temporal beginnings, such as

spring, or the start of a new week, are examples of such positive events with the potential to promise more than they actually deliver (ibid.). However, research on peoples' perceptions and experiences of temporal beginnings is needed to test this hypothesis. According to Gabennesch (ibid.), a suicidal person might delay a suicidal act in the hope that that a new temporal cycle might herald a fresh start. Unfortunately, this is not always the case and the resultant disappointment might be too much for the person to bear.

Gabennesch (ibid.) cites the observation that suicides decrease towards the end of the month and increase at the beginning (Lester & Frank, 1987; MacMahon, 1983), and Phillips and Liu's (1980) finding of a dip in suicide on and just before a major holiday with a peak immediately after it as further support for his argument. In this light, the troughs immediately preceding each peak are seen to be periods of anticipation prior to the new temporal cycle. He concedes that one might expect the same pattern to occur at the beginning of the calendrical cycle and suggests that "...in a *seasonal* sense the new year arrives in spring" (1988, p. 135). He further argues that monthly suicide rates do in fact decrease towards the end of the year and begin to ascend in January and February. On closer examination of the literature, however, it seems that contrary to Gabennesch expectations, suicide rates are at their lowest in January and February in certain places (Lester & Frank, 1988; Massing & Angermeyer, 1985; Näyhä, 1982, 1983). Furthermore, while spring may previously have been the *new year* and perhaps still is in more agricultural communities, the excitement, celebration and flurry of new year's resolutions surrounding January 1st suggest that this temporal new beginning may be the more significant in western countries where the Gregorian calendar is observed. His theory loses further credibility when one considers that a peak in suicides at any time of the year could be explained in terms of a 'new beginning', e. g. the start of the school year, the beginning of the fiscal year etc (Phillips & Ryan, 2000). Gabennesch does grant, however, that the experience of the 'broken promise' is subjective and that the strength of the broken promise effect in not universal but varies across demographic categories.

5.2   Bioclimatic Explanations

The cornerstone of the bioclimatic explanation lies in the assumption that annual rhythms in behaviour are based on endogenous biological rhythms, which are determined by yearly rhythms in environmental factors (Haus & Touitou, 1992). There has been considerable research in this area and support for this theory can be found in the link between suicide and meteorological variables, physical health and psychopathology.

5.2.1   Climate and Suicide

Notions of the interrelatedness of climate and human emotions are firmly rooted in our language and culture. Numerous songs and poems have been devoted to the weather and its impact on our lives and relationships. Inclement weather is commonly referred to as 'gloomy', 'depressing' and 'miserable', while 'pleasant', 'cheerful' are used for bright, sunny days.

The relationship between meteorological factors and various psychiatric disorders has repeatedly been demonstrated (North, Pollio, Thompson, Spitznagel & Smith, 1998; Sobel, Anisman & Hamdy, 1998). Some mood disorders, for example, have been found to follow a seasonal pattern, with depressive episodes commonly occurring in winter. People evidencing this pattern, known as seasonal affective disorder (SAD), have been found to respond to light therapy, leading to speculation that there may be some relationship between the dark winter months and the onset of the depressive episode (Kaplan, Sadock & Grebb, 1994). Furthermore, Arya (1999) has noted the deleterious effect of weather variables, high ambient temperature and high humidity in particular, on the potency and bioavailability of prescribed psychotropic agents. There is also some evidence to suggest that the annual rhythm of suicides may be correlated, instantaneously or with some lag, with certain climatic variables. However, research into the relationship between specific weather variables and suicidal behaviour has yielded inconclusive and often contradictory findings. Unfortunately, while most of the authors in this area of research refer to previous studies, none has attempted to explain the discrepancies in results.

5.2.1.1 <u>Temperature</u>

Of all climatic variables, temperature has most often been associated with suicidal behaviour. An increase in temperature has generally been associated with an increase in completed suicides, particularly those by violent means (Durkheim, 1970; Linkowski et al., 1992; Maes et al., 1994; Preti & Miotto, 1998). Interestingly, while Linkowski et al. (1992) also found a positive relationship between ambient temperature and suicide, this relationship was only statistically significant for women. Suicide rates have been found to be highest in the months in which the greatest increase in temperature occurs, for example, February in Italy and May in Belgium (Altamura et al., 1999; Maes et al., 1994). They have also been found to increase with diurnal variation in temperature (Salib & Gray, 1997). The effect of temperature on suicide rate is not necessarily immediate, and an increase in temperature over a few weeks has been found to be a significant predictor of violent suicide (Maes et al., 1994). In contrast to these findings, Preti (1998) and Souêtre et al. (1990) also found a significant relationship between temperature and suicide, but in the opposite direction.

In their study of suicide in New York 1974-1979, Dixon and Shulman (1983) found no statistically significant the relationship between meteorological parameters and suicide. This may have been because each year was analysed individually rather than examining the period as a whole. Alternatively, people living in New York, a very large city, might be less exposed to weather changes than those living in less metropolitan areas. They did however observe a trend towards a greater number of suicides when warm fronts passed over, inducing rapid changes in temperature.

For the most part then, evidence suggests that a marked increase in temperature corresponds to an increase in suicide.

5.2.1.2 <u>Sunlight</u>

While most studies have found a positive relationship between suicide and hours of sunlight, this remains contentious (Durkheim, 1970; Preti, 1997). More specifically, a significant

positive relationship between hours of sunlight and suicide was found for both males and females in the US (Lester, 1996), and the UK (Salib & Gray, 1997; Salib, 1997). This is consistent with the findings of Maes et al. (1994) in Belgium, and Preti and Miotto (1998) in Italy, but only for violent suicide. In contrast to this, Souêtre et al. (1990) and Tietjen and Kripke (1994) found a negative relationship between sunlight duration and suicide. This was supported by Preti and Miotto (1998), but only for male non-violent suicide, while Linkowski et al. (1992) found a negative relationship only for violent suicide.

Surprisingly, Preti (1998), using what appears to be the same data set used in his 1997 paper, found a negative relationship between hours of sunlight and suicide rate. No attempt was made to explain this discrepancy and the only evident differences between the two studies are that the 1997 paper refers to Italy as a whole, whereas the 1998 paper specifies 17 Italian towns under scrutiny, and the Spearman test was used in the former, whereas regression analysis was used in the latter. In Israel, Schreiber et al. (1993) also observed a negative relationship between hours of sunlight and suicide, but only when the latter was phase advanced by 1-2 months. An increase in suicide rates was thus associated with a decrease in hours of sunlight during the previous 1-2 months. They do not attempt to explain this finding. Interestingly, Tietjen and Kripke (1994) found an increase in suicide after periods of decreased sunshine in Sacramento, but not in L.A. County. They suggest that this may be explained in terms of the positioning of the respective weather stations in relation to the counties as a whole, with the single L.A. weather station failing to reflect the 'coastal weather micro-climes'. Similar problems may have arisen in other research in this area, however few papers comment on the position of the weather station in relation to the area from which suicide data was collected. Lastly, Linkowski et al. (1992) found no relationship between non-violent suicide and sunlight duration for either males or females.

Preti has suggested that the relationship between sunlight and suicide rate may be the result of sunlight acting on "…specific biological systems linked to the neurochemical circuits which regulate mood and emotions" (1997, p. 128). The relationship between affective disorders and suicide is discussed in 'Seasonality and psychopathology' below.

5.2.1.3 Rainfall

A negative relationship between rainfall and suicide has generally been found (Lester, 1996; Preti, 1997; Preti & Miotto, 1998). However, once again, Preti's (1998) later finding of a positive relationship between rainfall and suicide is at odds with his previous report of a negative association. Maes et al. (1994), on the other hand, found no significant relationship between suicide rates and rainfall.

5.2.1.4 Humidity

Humidity has typically been negatively correlated with suicide (Maes et al., 1994; Salib & Gray, 1997; Preti & Miotto, 1998). However Linkowski et al. (1992) found a positive relationship between violent suicide and humidity, as did Salib (1997) for male and female elderly suicides.

5.2.1.5 Wind

In the US, Lester (1996) found that low wind speed corresponded with higher suicide rates, while Maes et al. (1994) found no such relationship. A higher incidence of suicide has also been linked to hot dry weather associated with *sharav* in Israel and *fohn* winds in Germany and Switzerland (Osewald, 1939 and Sulman, 1982, in Maes et al., 1994).

5.2.1.6 Air Pressure

In what is believed to be the first statistical investigation into the relationship between weather and suicide, Mills (1934) reported a strong relationship between falling air pressure and rising suicide incidence. Maes et al. (1994) reported no significant relationship between air pressure and suicide, while Linkowski et al. (1992) found that it was negatively correlated to suicide.

5.2.1.7 Summary of Climate and Suicide

The discrepancies in the above research could be explained by the fact that most researchers have examined the relationship between suicide and individual weather variables. It is more likely, however, that these variables act in concert and that the synergistic effect of various climatic variables is greater than that of individual weather variables (Maes et al., 1994). Furthermore, discrepancies may be explained in terms of differing approaches to the temporal relationship between climate and suicide. Some authors have argued that it is likely that the effects of weather variables on suicide are short-term, rather than seasonal, especially in places where weather variance is short-term rather than seasonal (Tietjen & Kripke, 1994). Others favour the ecological approach and assert that "...a distribution of particular weather variables over long periods of time may have an impact on the long-term distribution of mood disorders and suicidal behaviour." (Souêtre et al., 1990, p. 261).

Overall, the data suggests that suicide rates are higher in warm, dry places that are more exposed to the sun. Furthermore, the effect of climatic variables appears to be more pronounced on violent suicides than non-violent suicides (Linkowski et al., 1992; Maes et al., 1993a). This may explain findings of greater seasonal variation in violent suicides.

5.2.2 Biochemistry and suicide

It has been suggested that bioclimatic factors may affect circannual rhythms in specific biochemical processes that are associated with vulnerability or resistance to stressors (Maes et al., 1993a, 1995). There is evidence that these processes may involve dopamine and serotonin metabolism (Parker & Walter, 1982; Souêtre et al., 1990). These neurotransmitters are also thought to be involved in self-injurious behaviour, with serotonin (5-HT) considered the most important. Since it is not possible to measure serotonin levels directly, researchers have had to find substances whose levels correlate with serotonin levels. Two commonly used methods are measuring serotonin metabolite levels in the CSF and measuring the number of imipramine binding sites on platelets.

There is some evidence to suggest that alterations in presynaptic serotonin (5-HT) activity, including decreased plasma total L-tryptophan levels, may be an important predisposing factor for depressed mood, major depression and suicidal behaviour. L-tryptophan is the precursor amino acid from which 5-HT is synthesised (Kaplan, Sadock & Grebb, 1994; Maes et al., 1995). Maes et al. (1995) found significant seasonal variation in the availability of plasma L-tryptophan to the brain, with low levels occurring in spring. Lower L-tryptophan availability is related to higher ambient temperature, increased relative humidity and lower air pressure (ibid). In light of the literature on the relationship between hours of sunlight and depression and suicide, it is interesting that no significant relationship was found between levels of plasma L-tryptophan and the light-dark span (ibid.). The availability of plasma L-tryptophan to the brain is also related to total serum protein level. It has therefore been suggested that seasonality in L-tryptophan availability may be partly a reflection of seasonal variation in dietary habits (ibid.; Preti, 1998).

Platelet imipramine B_{max} binding sites are thought to label proteins that actively participate in 5-HT reuptake (Pine et al., 1995). According to Pine et al., "...decreased CNS 5-HT function may produce compensatory decreases in neuronal imipramine binding, with parallel decreases on platelets" (ibid., p. 923). Furthermore, low imipramine B_{max} has repeatedly been linked to depression, which is a major risk factor for suicide. [^{3}H] imipramine binding density has shown significant seasonality in those who have engaged in non-fatal suicidal behaviour, with a nadir in late winter/ early spring (ibid).

The seasonal variation in 5-HT markers suggests seasonality in 5-HT availability, with serotonin lows corresponding to the suicide seasonal peak (Maes et al., 1993a).

5.2.3   Seasonality and psychopathology

There appear to be pronounced circannual rhythms in various aspects of psychopathology, but not in the normal population (Maes et al., 1993b). Psychiatric patients in turn are five times more likely to commit suicide than the general population (Tanney, 1992). The conditions most commonly associated with suicide are affective disorders, alcoholism and

schizophrenia (Hawton, 1987; Henriksson, Aro, Marttunen, Heikkinen, Isometsa, Kuoppasalmi & Lonnqvist, 1993). This has given rise to speculation that the seasonality of suicidal behaviour can be explained in terms of the seasonal distribution of mental disorders that involve suicidal ideation (Souêtre et al., 1987; Maes et al., 1993b). The seasonal nature of depression in particular has been widely observed. Hospitalisation rates for severe depression have been found to peak in spring and autumn and a link has been found between seasonality in severity of depression and suicide (Eastwood & Peacocke, 1976; Kasper & Kamo, 1990; Maes et al., 1993a). Furthermore, the prescription of electro convulsive therapy (ECT), indicated in the treatment of endogenous depression, has been found to vary during the year, also with peaks in spring and autumn (Eastwood & Peacocke, 1976). Affective disorders in turn are the diagnoses most commonly associated with suicide (Hawton, 1987). Furthermore, Williams and Pollock (1993) have suggested that depressive features occurring in any psychiatric diagnosis constitute the "final common pathway" to suicidal behaviour. This seems to suggest that the seasonal nature of suicide might be, at least in part, a reflection of the seasonal nature of depressive suicides (Rihmer et al., 1998).

Rihmer et al. (ibid.) have suggested that decreasing suicide seasonality may be linked to a reduction of depressive suicides due to successful treatment of depression with anti-depressants. In their study of suicide seasonality on the island of Gotland in Sweden, they found significant seasonality between 1981-1989 when the prescription of antidepressants on the island was relatively low and stable. However, seasonality practically disappeared 1990-1996, coinciding with a fourfold increase in the prescription of antidepressants during the same period. The greatest relative decrease in suicides was notably in spring (ibid.). Unfortunately, no firm conclusions can be drawn from these findings since the sample size was extremely small. The seasonality of depression, however, has been contested. Hardt and Gerbershagen (1999) found no significant monthly effect for depression for males or females in Germany.

5.3   Sociodemographic vs. Bioclimatic explanations

While many of the above explanations are compelling, they are based on the premise that there is in fact a temporal distribution of suicide. The literature reviewed, however, seems to suggest that for most individuals the risk of suicide is randomly distributed throughout the year.

There is a large body of literature that offers support for the bioclimatic explanation. Sociodemographic explanations, on the other hand, are more difficult to confirm. The difficulty in this area of research lies in the probability that suicide is multi-determined and that no single factor is likely to be relevant in all cases. Suicidal behaviour is more likely to fall into a number of subgroups with clinical, biochemical and psychopathological and genetic differences (Salib & Gray, 1997). In an attempt to marry the sociodemographic and bioclimatic theories, Tietjen and Kripke have suggested that "sociological variables interact with an underlying annual biometeorological source to produce suicide seasonality" (1994, p.161).

CHAPTER SIX: SUICIDE IN PIETERMARITZBURG

A summary of the research into suicide in Pietermaritzburg over the last 10 years is presented in this chapter. Comparative reference is made to national and international findings. This provides a backdrop for the present study of seasonal, monthly and daily variation of suicide in the Pietermaritzburg region.

Research into fatal suicidal behaviour in Pietermaritzburg has focussed on the white and Indian, and more recently black, population groups (Goltman, 1997; Naidoo, 1993). Given the paucity of reliable, published data on suicide in the black population group, Goltman's (1997) survey of suicides 1988-1996 among the black population of Pietermaritzburg has been of particular importance in dispelling the popular misconception that suicide is a rarity among black people (Wassenaar, Pillay, Descoins, Goltman & Naidoo, 2000). Unfortunately, there have been no studies of suicide in the coloured population group in this region, which is a deficit that needs to be addressed.

The average annual suicide rate in Pietermaritzburg is reported to be 14.12/100 000, which is slightly lower than the international suicide mortality rate of 16/100 000 (ibid.; WHO, 2000). The mean rate for male suicides was 12.02/100 000, and for female suicides, 2.1/100 000 (Wassenaar et al., 2000). Both are relatively low compared with national and international data (Flisher & Parry, 1994; Stack, 1998; WHO, 2000). The rate for US male suicides, for example, was reported to be 19.9/100 000, and for female suicides, 4.6/100 000 (Stack, 1998). The male to female ratio across the race groups was 5.7:1 (Wassenaar et al., 2000). This is slightly higher than most international male to female ratios, which generally range between 2:1 and 5:1 (Williams, 1997). The Peoples' Republic of China, Kuwait, and São Tomé and Príncipe (a republic in the Gulf of Guinea) are the only countries where the suicide rate for females exceeds that of males (WHO, 2000).

Suicide rates in Pietermaritzburg are highest for whites (15.5/100 000), then Indians (14.9/ 100 000) and lowest for blacks (13.48/100 000). The rates for black, white and Indian males were very similar, but female suicides evidenced more variation. Indian female suicide rates

were the highest at 2.8/100 000, followed by white female suicides at 2.45/100 000. Black females evidenced the lowest overall suicide rate of 1.96/100 000 (Wassenaar et al., 2000). The rates for white males and females in Pietermaritzburg are noticeably lower than corresponding rates for the country as a whole. Indian female suicide rates were slightly lower than national rates, whereas Indian male suicide rates were higher (Wassenaar & Naidoo, 1995). The reported rates for both black males and females in Pietermaritzburg are considerably higher than reported both nationally and internationally (Lester, 1998; Mkhize, 1992; Wassenaar et al., 2000). Lester (1998) and Levin (1992) report exceptionally low suicide rates for black South Africans at 3-4/100 000. Mkhize (1992), on the other hand, reported black suicide rates in the eastern Cape to be 11.6/100. It has been suggested that these low rates might be attributable to the historical unreliability of national mortality data for black South Africans and that the real rates are likely to be closer to 14/100 000 (Wassenaar et al., 2000).

Black and Indian females were found to be at the highest risk for suicide between the ages of 15-24, whereas the rates for white female suicides were highest in the 25-34 age group. The highest rate for all males was between the ages of 25-34 years (Wassenaar & Naidoo, 1995; Wassenaar et al., 2000). This is supported by both regional and national data (Flisher & Parry, 1994; Wassenaar & Naidoo, 1995; Wassenaar et al., 2000). Females thus seem to be at greater risk during adolescence, while males are more susceptible during early adulthood (Wassenaar et al., 2000). Although the white male suicide rate between 25-34 years is lower than for white South African males, the rate for Indian males is generally higher than national rates (Wassenaar & Naidoo, 1995). Indian female suicide rates are similar in Pietermaritzburg and South Africa as a whole in the high-risk age group, whereas white female suicide rates in Pietermaritzburg in the 25-34 age group are lower than national figures (ibid.). Indian and black and white female suicide rates, for Pietermaritzburg and South Africa as a whole, showed a steady decrease with age (Mkhize, 1992; Wassenaar & Naidoo, 1995; Wassenaar et al., 2000). White male suicide rates in Pietermaritzburg, however, increased sharply after age 65. While this was not found for all white South African males, it is consistent with international trends which indicate that until recently, the elderly constituted the highest risk group for suicide (Wassenaar & Naidoo, 1995; WHO, 2000). Traditionally, the highest suicide rates have been found among elderly males. The suicide rate among young people, however, has been increasing at such a rapid rate that in a third of the countries recently

reviewed by the World Health Organisation, young people were at the highest risk of suicide (WHO, 2000).

With regard to method of suicide, black males and females in Pietermaritzburg predominantly use hanging, as do Indian males (Goltman, 1997; Wassenaar & Naidoo, 1995). The method of suicide favoured by Indian females on the other hand is ingestion, followed by hanging (Wassenaar & Naidoo, 1995). White males and females both predominantly use firearms (ibid.). For the most part these findings concur with national and regional observations (Flisher & Parry, 1994; Mkhize, 1992). Choice of suicide method tends to vary internationally according to what is "...accessible, familiar and acceptable..." in the individual's community (Canetto & Lester, 1998, p.171). The tendency for whites in South Africa to use firearms is consistent with trends in the US and Canada (ibid.).

Although overall suicide rates are slightly lower in Pietermaritzburg compared with national and international data, the epidemiological patterns are very similar to those found elsewhere. It is therefore likely that the temporal distribution of suicides in Pietermaritzburg will follow national and international trends.

CHAPTER SEVEN: METHODOLOGY

7.1   Introduction

The theoretical and research background for this study has been outlined in chapters one to five. This chapter details the actual empirical study. The aims and hypotheses, the sample, and the testing procedure are described

It has been suggested that a greater understanding of the temporal distribution of suicide could shed some light on the aetiology of suicide and hence offer some direction for prevention (Näyhä, 1982). This process necessarily involves comparing and contrasting the findings of other studies in the area. Unfortunately, as reported in section 3.4, there has been little consistency in the methodologies previously used to investigate seasonal, monthly and daily trends in suicides, thus rendering direct comparisons extremely difficult.

The aim of this study was to investigate seasonal, monthly and daily variation of suicide in Pietermaritzburg and to discern what effect, if any, meteorological factors have on the distribution of suicide. Following Lester and Frank (1988), Meares et al. (1981), Rihmer et al. (1998), Schreiber et al. (1993) and Yip at al. (1998), suicide data was initially analysed for seasonal and monthly variation by means of the chi-square statistic. No significant variation was found[6]. However, in order to facilitate comparison between regional and national findings in this area of research, it was decided that it would be best to follow, as closely as possible, the methodology used by Flisher et al. (1997). Flisher et al. (ibid.) have published the only detailed report on seasonal variation in suicide in South Africa. The study used mortality data for the whole of South Africa 1980-1989, and examined the effect of month, race, age and gender on suicide counts (ibid.).

It must be noted that the methodology used by Flisher et al. (ibid.), and the chi-square statistic initially used in this study, essentially measure the differences in variables across the

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[6] Printouts are available from the author on request

months, rather than true seasonal "variation" (Maes et al., 1993a; Micciolo et al., 1989). The difference between "seasonality" as a social construct and "seasonality" as a naturally occurring phenomenon has been discussed in Chapter One. This study, then, examines the former since "season" is taken to be the aggregate of three months (e.g. spring = September + October + November in the southern hemisphere), and a month is a cultural invention (Phillips & Ryan, 2000). In order to examine the association between suicide and "natural" cycles, this study also examines the relationship between suicide rates and variations in climatic variables.

In addition to the comparison between Flisher et al. (1997), this is the first South African study to examine:

- the effect of method on suicide seasonality

- the weekly distribution of suicide

- the relationship between climate and suicide.

7.2   Seasonal and Monthly Variation

The first goal was to investigate seasonal and monthly trends in the distribution of suicides in Pietermaritzburg and to ascertain if and how age, gender, race and method chosen for suicide influence these trends.

7.2.1   Hypotheses

a   Ha: There is asymmetry in the seasonal distribution of suicides in Pietermaritzburg.
Ho: There is no seasonal variation in the distribution of suicides in Pietermaritzburg.

b   Ha: The seasonal distribution of suicides is different for males and females.

Ho: The seasonal distribution of suicides no different for males and females.

c   Ha: Seasonal distribution of suicide is influenced by age.

Ho: Age has no effect on the seasonal distribution of suicide.

d   Ha: Violent suicides show greater seasonality than non-violent suicides.

Ho: Method of suicide does not influence seasonality.

e   Ha: Seasonal distribution of suicide is influenced by race.

Ho: Race has no effect on the seasonal distribution of suicide.

7.2.2   Suicide data

The present study involves secondary analysis of suicide data collected for two unpublished honours theses. The findings of these studies and their relation to national and international findings are discussed in Chapter Six. The first data set comprises confirmed suicides from white and Indian population groups extracted from the Pietermaritzburg Magisterial inquest registers for the period 1982-1992 (Naidoo, 1993). 89 suicides were recorded for the white population group and 103 suicides were recorded for the Indian population group for 1982-1992. The second data set contains confirmed suicides of people of African descent from the Pietermaritzburg Magisterial district for 1988-1996 (Goltman, 1997). Although a total of 206 subjects were identified for this group, documentation for three could not be traced (ibid.). Data was thus available for 203 African suicides for 1988-1996. The following information was extracted: race, sex, date of death, age and method of suicide. "Pietermaritzburg" is defined here as the Pietermaritzburg Magisterial District, an area of approximately 1077 sq Kilometres (Naidoo, 1993).

Statistical analysis for seasonality is based on suicide counts for the 5 years (1988-1992) for which data was available for all 3 race groups.

7.2.3   Procedure

The term 'suicide' is used to denote all deaths reported as due to suicide or self-inflicted injury. Classification of suicides was made according to a system based on the International Classification of Diseases (ICD-9) (World Health Organisation, 1978): 950, poisoning by solid or liquid substances; 951, poisoning by gases in domestic use; 952, poisoning by other gases and vapours; 953, hanging; 954, submersion; 955, firearms and explosives; 956, cutting and piercing instruments; 957, jumping from high places; 958, other and unspecified means, including jumping before a moving object, burns, scalding, electrocution and crashing of motor vehicle. Following Maes et al. (1994), non-violent suicide (950-952) was distinguished from violent suicide (953-958).

The total number of suicides in a particular month in all 5 years (1988-1992) was analysed (i.e. January 1988 + January 1989 + ...+ January 1992). This was done to minimise the influence of bias caused by extreme counts in any particular year.

Population group was defined according to the now repealed Population Registration Act of 1950 which divided the South African population into four groups: black, white, Indian and coloured (South African Institute of Race Relations, 1992). In Pietermaritzburg in 1992 38% of the population was classified as black, 27% white, 28% Indian and 7% coloured (Central Statistical Services, personal communication, 2000). Unfortunately, no data was available for coloured suicides so they have not been included in this study.

Age was grouped into three broad categories, namely: < 25 (youth); 25-54 (adult) and 55+(elderly), rather than 15-24; 25-34; 35-44; 45-54; 55-64; and 65+ as used by Flisher et al. (1997) because of the small sample size.

White, Indian and African suicide data for Pietermaritzburg 1988-1992 were cross-classified into a multidimensional contingency table (12 x 3 x 2 x3), with the first dimension being month, the second age, the third sex, and the fourth race.

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Notation: S = sex
              M = month
              R = race
              A = Age

Letters M, A, S and R denote the main effects of the factors; and M*A, M*S, etc denote both the main effects and their interactions (i.e. M*A = M+A+M.A).

Following Flisher et al. (1997) log-linear modelling was performed to investigate the effects of month, race, age and sex on the suicide counts. Log-linear modelling is well suited to studying the relationships between categorical variables, which are treated alike as response variables (Addy, 1992; Dobson, 1991; McConway, Jones & Taylor, 1999). Goodness of fit of the model was measured by the Pearson chi-squared statistic (Dobson, 1991).

Following Preti and Miotto (1998), ANOVA was used to ascertain if the method of suicide (i.e. violent or non-violent) influenced the seasonal distribution of suicide in Pietermaritzburg. The data for each month of each season (for spring: September, October, November, and so on) were taken into account for the period 1988-1992.

7.3   Weekly Distribution of Suicide

The second goal was to ascertain daily trends in the distribution of suicides.

7.3.1   Hypotheses

Ha: The weekly distribution of suicide shows a maximum on Monday and a minimum on the weekend.

Ho: There is no daily variation in the weekly distribution of suicide.

7.3.2   Suicide data

The same data set as above was used, including the entire 13 year period 1983-1995. Although this data set is uneven as regards race-representation, race has not been included as a variable so limiting analysis to the 5 year period used in 7.2 was unnecessary. The years 1982 and 1996 were excluded, as the data for those years was incomplete (Goltman, 1997; Naidoo, 1993).

7.3.3   Procedure

The total number of suicides on any given day of the week for each year (i.e. the total count of suicides recorded for all Mondays in 1983, all Mondays in 1984 etc.) was analysed for daily variation by means of the Friedman test (Marascuilo & McSweeney, 1977).

7.4   Climate and Suicide

This study also aimed to verify whether the climate, apart from its seasonal change, is associated with suicidal behaviour.

7.4.1   Hypotheses

a   Ha: There is a relationship between number of suicides and hours of sunshine.
      Ho: No relationship exists between number of suicides and hours of sunshine.

b   Ha: There is a relationship between number of suicides and ambient temperature.
      Ho: There is no relationship between number of suicides and ambient temperature.

c   Ha: There is a relationship between suicide rates and maximum temperature.

Ho: There is no relationship between suicide and maximum temperature.

d   Ha: There is a relationship between suicide rate and minimum temperature.

Ho: There is no relationship between suicide and minimum temperature.

e   Ha: There is a relationship between number of suicides and relative humidity.

Ho: There is no relationship between number of suicides and relative humidity.

f   Ha: There is a relationship between suicide rate and amount of rainfall.

Ho: There is no relationship between number of suicides and amount of rainfall.

g   Ha: The relationship between suicide and climatic variables is influenced by method of suicide.

Ho: Violent and non-violent suicides do not differ with respect to their relationship with climatic variables.

7.4.2   Weather data

Daily information on hours of sunshine, maximum and minimum temperature, relative humidity and amount of rainfall for Pietermaritzburg 1988-1992 was supplied in the form of an electronic data file by the South African Weather Bureau.

7.4.3   Procedure

Daily ambient temperature was calculated as the average of daily maximum and minimum temperatures.

Weekly averages were then calculated for hours of sunshine, ambient temperature, maximum and minimum temperature, relative humidity and amount of rainfall for each week of the period 1988-1992. Weekly averages, rather than actual daily weather values, were used as previous research has indicated that weekly and monthly averages or tendencies show the strongest relationship to suicide rates (Dixon & Shulman, 1983).

These were then correlated with weekly numbers of all suicides, violent suicides and non-violent suicides for the same period using the Pearson product-moment correlation coefficient (Howell, 1989; Souêtre et al., 1989).

Weekly suicide rates were also correlated with weekly weather averages for the previous week in order to ascertain whether the effect of climatic variables might be delayed rather than instantaneous.

7.5   Summary

The aims and hypotheses that directed this study, the sample, and the testing procedure have been described in this chapter. The results of the testing of these hypotheses are outlined in Chapter Eight.

CHAPTER EIGHT: RESULTS

8.1   Introduction

In this chapter, the results of the study are presented. The results of the analysis of seasonal and monthly variation of suicide are presented first. This is followed by an analysis of the weekly distribution of suicide. Then, the correlational analysis of suicide and certain climatic variables is summarised. Lastly, a summary of the results is presented and discussed in relation to the hypotheses of this study and to more general aspects of the study as a whole. The hypotheses presented in chapter six may be summarised as follows:

There is seasonal variation in the distribution of suicides in Pietermaritzburg. This seasonality is influenced by age, sex, race and method of suicide. There is also variation in the weekly distribution of suicides. Suicide rates are highest on Mondays and then steadily decrease, reaching a low over the weekend.

With regards to climate, suicide rates vary with changes in humidity, temperature, hours of sunshine and rainfall. Furthermore, the relationship between suicide and climatic variables is related to method of suicide.

8.2   Results

8.2.1   <u>Seasonal and Monthly Distribution of Suicide</u>

There were a total of 214 African, white and Indian suicides in Pietermaritzburg 1988-1992 (Goltman, 1997; Naidoo, 1993). The relevant demographic features are presented in Table 1.

Table I.   Demographic features for deaths due to suicide in Pietermaritzburg (1988-1992) (N=214)

		N	%
Sex	Male	175	81.8
	Female	39	18.2
Population group	Black	108	50.5
	White	42	19.6
	Indian	64	29.9
Age Group*	<25	53	24.9
	25-54	136	63.8
	55+	24	11.3
Method	Violent	189	88.3
	Non-violent	25	11.7
Month	January	23	10.7
	February	19	8.9
	March	23	10.7
	April	17	7.9
	May	13	6.1
	June	15	7.0
	July	16	7.5
	August	6	**2.8**
	September	19	8.9
	October	24	**11.2**
	November	17	7.9
	December	22	10.3
Season	Spring	60	28.0
	Summer	64	**29.9**
	Autumn	53	24.8
	Winter	37	**17.3**

- peak incidence   - lowest incidence

* The age of one black, male suicide victim was not recorded in the inquest registers and is therefore unknown.

An aggregate of all suicides for each month 1988-1992 indicates that suicides reached a peak in October and a trough in August. The peak season was summer and the nadir, winter. The peak month does not correspond to the peak season as the seasonal total was calculated as the sum of suicides in the three months of that season. Therefore, although the peak month falls in spring (September, October, November), only 28% of suicides occurred in spring as opposed to 29.9% in the summer (December, January, February). The monthly distribution of suicides for each year 1988-1992 is depicted in Figure 1. Descriptive statistics are presented in Table II.

Figure 1. Suicide by Month 1988-1992

Suicide by Month 1988 - 1992
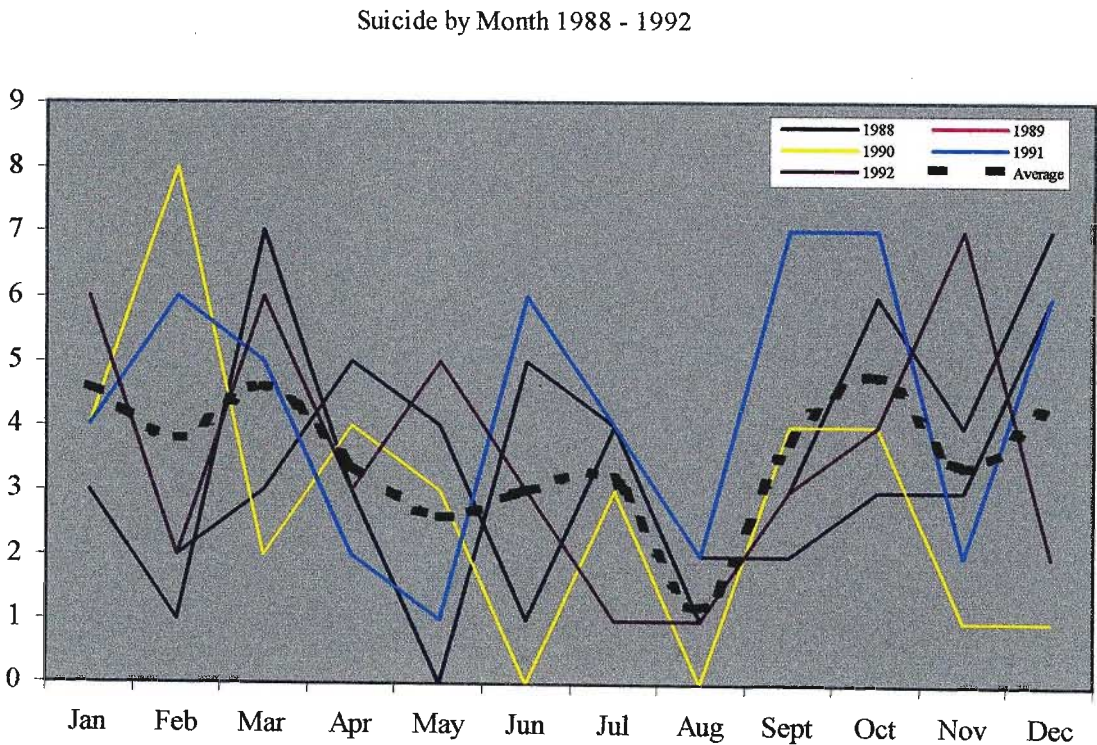
Table II.   Descriptive Statistics of the monthly distribution of suicides in
Pietermaritzburg 1988-1992

Month	Mean	Std Deviation	Min	Max
Jan	4.6	1.3416	3	6
Feb	3.8	3.0332	1	8
Mar	4.6	2.0736	2	7
Apr	3.4	1.1402	2	5
May	2.6	2.0736	0	5
Jun	3	2.5495	0	6
Jul	3.2	1.3038	1	4
Aug	1.2	0.8367	0	2
Sep	3.8	1.9235	2	7
Oct	4.8	1.6432	3	7
Nov	3.4	2.3022	1	7
Dec	4.4	2.7019	1	7

Following Flisher et al. (1997), log-linear modelling was performed to investigate the effects
of month, race, age and sex on the suicide counts. The investigation of the statistical
significance of partial and marginal effects (Table III) showed that a provisional log linear
model using the stepwise procedure of model selection is:

M*A + S +R + A.S

where M = month

A = age

S = sex

R = race

ANOVA table for sex by age by race by month with suicide count as dependent variable

Effect	Df	Partial association Chi-square	Prob	Marginal association chi-square	Prob
Sex (S)	1	100.4	0.0000		
Race (R)	2	28.8	0.0000		
Age (A)	2	121.2	0.0000		
Month (M)	11	19.7*	0.0496		
SR	2	5.0	0.0821	2.3	0.3166
SA	2	18.5**	0.0001	8.6*	0.0136
SM	11	16.3	0.1304	13.6	0.2559
RA	4	16.7**	0.0022	9.5*	0.0497
RM	22	30.3	0.1114	31.9	0.0791
AM	22	67.5**	0.0000	54.9**	0.0001
SAR	4	8.1	0.0879	7.3	0.1209
SRM	22	17.25	0.7494	23.7	0.3631
SAM	22	23.40	0.3794	32.5	0.0693
RAM	44	44.05	0.4695	39.0	0.6854

* significant at p < 0.05

** significant at p< 0.01

The suicide count was found to vary significantly with sex (S), race (R), Age (A) and month (M). Significance for race was to be expected given that a large portion (38%) of the population in Pietermaritzburg is black.

Since the aim of this study was to investigate suicide seasonality, only the monthly effect and its' interactions were investigated further. After the preliminary selection of the model, the M.A interactions were examined in more detail. The final model adopted was:

$G*A+A*R+A_{25\text{-}54}May + A_{25\text{-}54}Jun + A_{25\text{-}54}Jul + A_{25\text{-}54}Aug + A_{25\text{-}54}Nov + A_{25\text{-}54}Dec$

where the last 6 terms account for the only significant age by month interactions. Overall fit of the model was good ($x^2 = 357.7$, df $= 44$, P < 0.001).

The model shows that variance in monthly trends was not significantly influenced by race or sex. The monthly effect is, however, significant and independent of any sex, race or age classification. Age by month interactions were only significant for May, June, July, August, November and December in the 25-54 age group.

The monthly distribution of suicides by age is presented in Figure 2.

Figure 2.   Age and Suicide by Month

Age & Suicide by Month
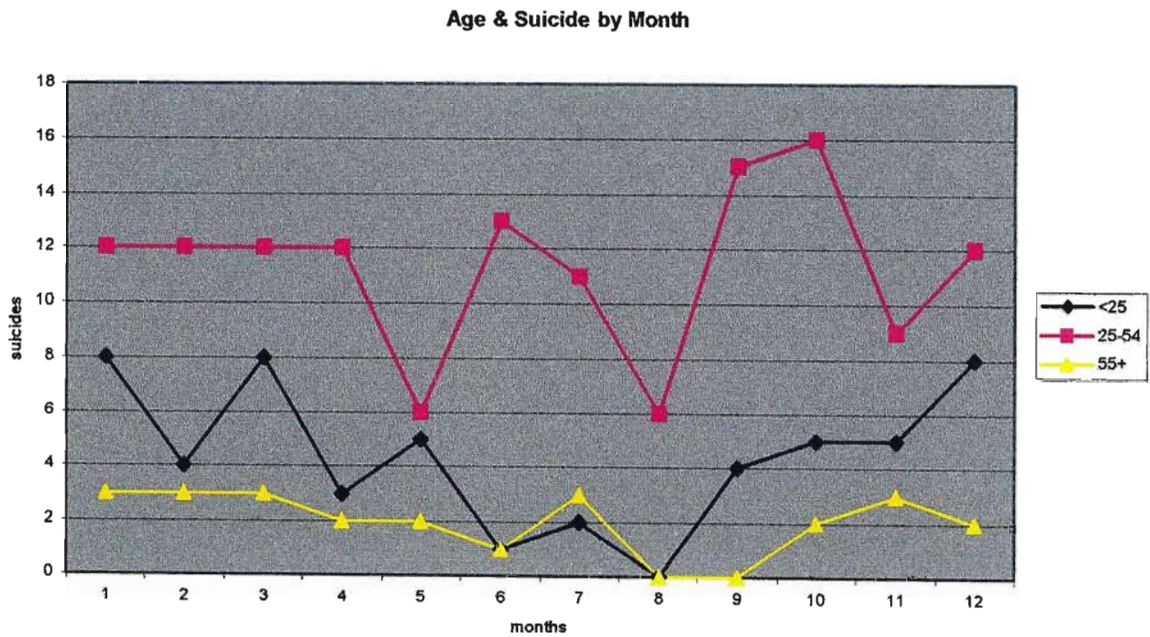
The monthly distribution of suicides differed for the three population groups investigated, although this was not statistically significant (Figure 3). Black suicides reached a peak in March and December; Indian suicides reached a peak in January and February; and white suicides peaked in October. The trough for black, Indian and white suicides was uniformly in

August. The highest number of suicides occurred in summer for blacks and Indians, and spring for whites, while the trough period for all three was in winter.

Figure 3.   Race and Suicide by Month

Race & Suicide by Month
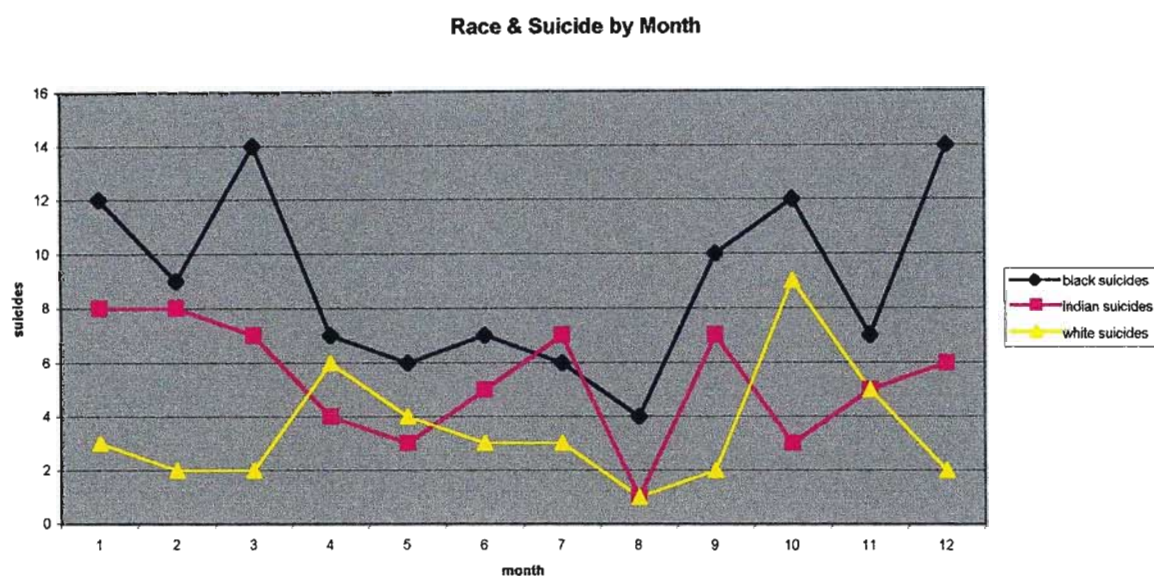
As can be seen in Figure 4, the temporal distribution of suicides was similar for males and females. Although not statistically significant, both males and females evidenced a summer peak and winter trough. The lowest number of suicides occurred in August for both sexes, while male suicides reached a peak in March and most female suicides occurred in January. Furthermore, both males and females evidenced a second, less clearly defined peak in October.

Figure 4.   Sex and Suicide by Month
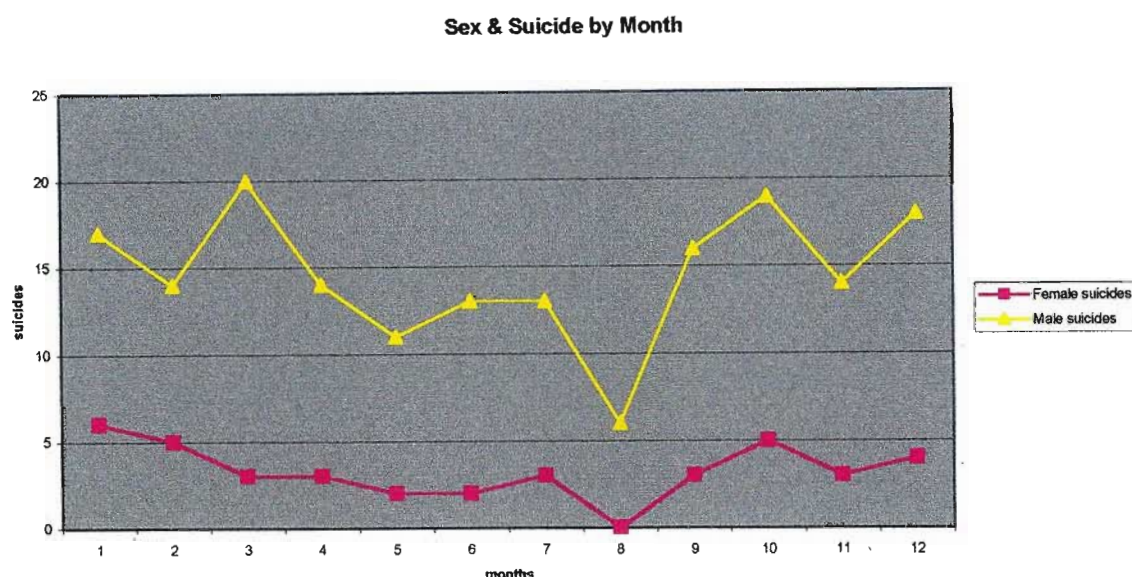
Sex & Suicide by Month

ANOVA was used to ascertain if the method of suicide (i.e. violent or non-violent) influenced the seasonal distribution of suicide in Pietermaritzburg. The results, presented in Table IV, indicate that neither violent (ICD-9, 953-958, WHO, 1978) nor non-violent (ICD-9, 950-952, WHO, 1978) suicides show significant seasonal asymmetry for either sex.

Table III.   Seasonal differences in suicides by methods (violent vs. non-violent) in Pietermaritzburg 1988-1992

	Winter		Spring		Summer		Autumn		ANOVA (df =3/56	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	F	P
Males										
NV	0.467	0.640	0.733	1.033	0.733	0.884	0.667	0.900	0.31	0.817
V	3.867	2.696	5.533	3.543	5.000	3.854	4.933	3.218	0.65	0.587
Female										
NV	0.333	0.617	0.067	0.258	0.067	0.258	0.133	0.352	1.50	0.225
V	0.667	0.816	0.867	1.187	1.133	1.356	1.133	0.990	0.63	0.598

N. V. = non-violent suicides   V = violent suicides

Most violent suicides occurred in October and the least in August. There were no non-violent suicides in August, March and October in 1988-1992. The peak month for non-violent suicides was December. The monthly distribution of violent and non-violent suicides is presented in figure 5.

Figure 5.   Method and Suicide by Month

Method & Suicide by Month
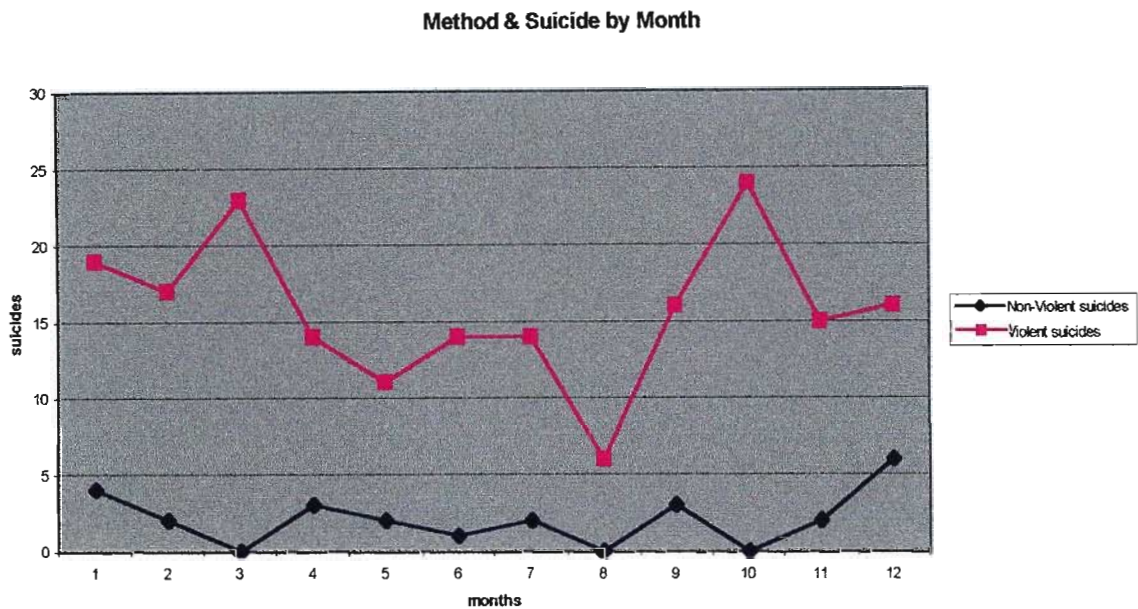
8.2.2   Weekly Distribution of Suicide

The distribution of suicides during the course of the week shows a peak on Sunday and a steady decrease towards the end of the week (Figure 6). The Friedman test (13years x 7 days) was conducted to determine whether there were any systematic differences in the number of suicides occurring on any given weekday.

Figure 6.   Weekly distribution of Suicide in Pietermaritzburg 1983-1995
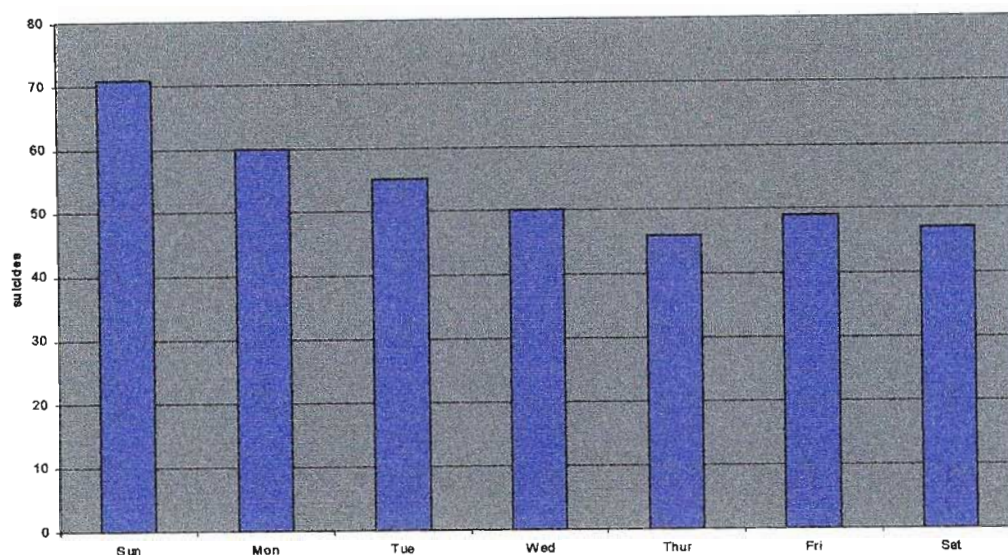
Table IV.   Descriptive Statistics of the daily distribution of suicides in Pietermaritzburg 1983-1995

	Mean	Std. Deviation	Minimum	Maximum
Sun	5.4615	2.4703	2.00	9.00
Mon	4.6154	2.9023	1.00	12.00
Tues	4.1538	3.7382	.00	13.00
Wed	3.8462	2.3397	.00	8.00
Thurs	3.6154	2.0631	.00	8.00
Fri	3.5385	2.9893	.00	11.00
Sat	3.3846	1.8046	1.00	6.00

The results of the Friedman test (Table VI) show that the hypothesis of identical distributions of the number of suicides over the seven days of the week was rejected. The post hoc procedures recommended by Marascuilo and McSweeney (1977), however, indicate that any two days' means have to differ by 3.00450 to reach significance. The largest difference, between Sunday and Friday (Table VII), is less than this, so no two days differ significantly.

Table V.   Friedman Test

N	13
Chi-Square	13.128
Df	6
Asymp Sig	.041

Table VI.   Rank

	Mean Rank
Sun	5.50
Mon	4.69
Tues	3.65
Wed	4.04
Thurs	3.88
Fri	3.04
Sat	3.19

8.2.3   Climate and Suicide

The results of the correlation analysis of weekly counts of all suicides, violent suicides and non-violent suicides with weekly averages of weather variables are presented in Table VIII, and the correlation of weekly counts of all suicides, violent suicides and non-violent suicides with weekly averages of weather variables from the previous week are presented in Table IX. For conciseness, only the significant correlations have been included in the tables. Correlation coefficients of all variables are presented in Appendix 2

Table VII.   Pearson product-moment correlation coefficients of weekly suicide rates and weekly averages of weather variables.

	Suicide	V	NV	Hum	Sun
Suicide Pearson Correlation (N) Sig. (2-tailed)	1.0000 (262) p= .	.9433 (262) p= .000	.3168 (262) p= .000	.1984** (248) p= .002	-.0956 (229) p= .149
V Pearson Correlation (N) Sig. (2-tailed)		1.0000 (262) p= .	-.0160 (262) p= .797	.1512* (248) p= .017	-.0474 (229) p= .476
NV Pearson Correlation (N) Sig. (2-tailed)			1.0000 (262) p= .	.1643* (248) p= .010	-.1481* (229) p= .025

* significant at $p < 0.05$ ** significant at $p < 0.01$

V = violent suicide   NV = non-violent suicide   Hum = humidity

Sun = hours of sunshine

The results suggest that there is a strong, positive relationship between suicide and humidity. Humidity was associated with all suicides ($r = .198$, $p<0.01$), violent ($r = .151$, $p<0.05$) and non-violent ($r = .164$, $p<0.05$), during the same week. There was also a positive relationship between suicide and the humidity of the previous week ($r = .175$, $p<0.01$). This relationship was stronger for violent suicides ($r = . 156$, $p<0.05$), than non-violent suicides.

With regards to temperature, all suicides and violent suicides were significantly correlated with ambient temperature ($r = .139$, $p<0.05$ and $r = .127$, $p<0.05$ respectively) and minimum temperature ($r = .183$, $p<0.01$ and $r = . 17$, $p<0.01$ respectively) during the previous week, but not during the same week. The relationship between humidity and temperature, and suicide rate in the following week is presented in Figure 7.

Interestingly, there was a significant negative correlation between hours of sunshine and non-violent suicide during the same week (r= -.148, p<0.05), but not during the previous week. There was no significant relationship between hours of sunshine and violent suicides, nor with violent and non-violent suicides together.

Table VIII.   Pearson product-moment correlation coefficients of weekly suicide rates and weekly averages of weather variables from the previous week.

	Suicide	V	NV	Hum	Temp	Min
Suicide						
Pearson Correlation	1.0000	.9433	.3168	.1754**	.1390*	.1829**
(N)	(262)	(262)	(262)	(247)	(244)	(251)
Sig. (2-tailed)	p= .	p= .000	p= .000	p= .006	p= .030	p= .004
V						
Pearson Correlation		1.0000	-.0160	.1559*	.1271*	.1698**
(N)		(262)	(262)	(247)	(244)	(251)
Sig. (2-tailed)		p= .	p= .797	p= .014	p= .047	p= .007
NV						
Pearson Correlation			1.0000	.0815	.0516	.0605
(N)			(262)	(247)	(244)	(251)
Sig. (2-tailed)			p= .	p= .202	p= .422	p= .340

* significant at p < 0.05   ** significant at p< 0.01

V = violent suicide   NV = non-violent suicide   Hum = humidity

Temp = ambient temperature   Min = minimum temperature

Figure 7.   Weekly Suicide Rates and Weekly Weather Averages 1988-1992

Weekly Suicide Rates and Weekly Weather Averages 1988-1992
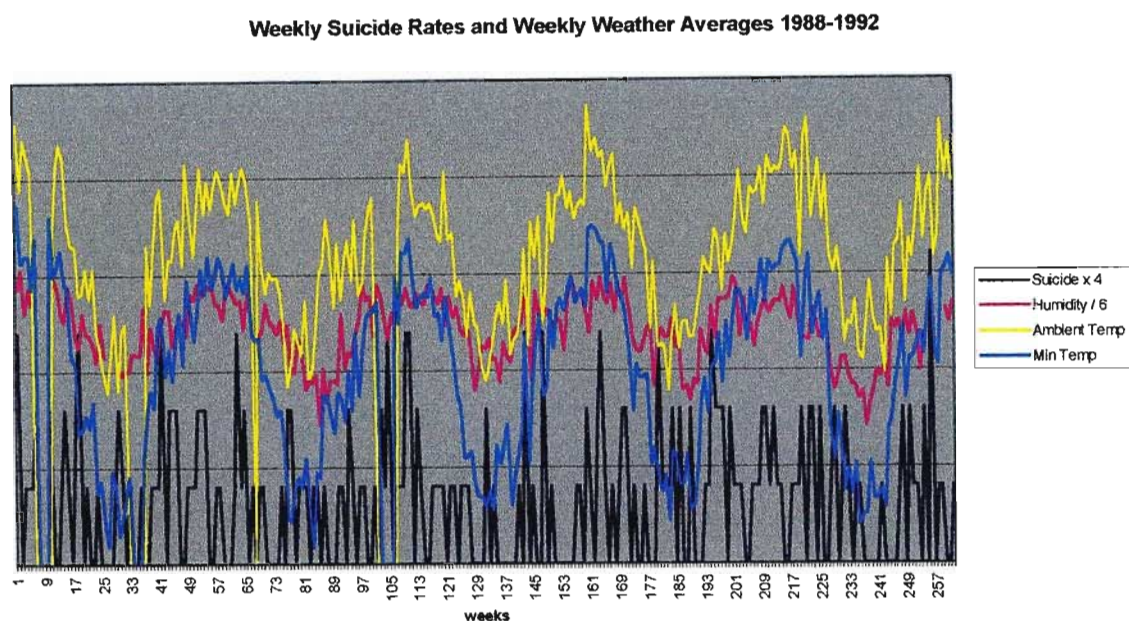
8.3   Summary

8.3.1   Seasonal and Monthly Distribution of Suicide

There is significant seasonal variation in the distribution of suicides in Pietermaritzburg, with the expected summer peak and winter trough (Flisher et al., 1997). The highest mean number of suicides occurred in October and the lowest in August. The monthly distribution of suicides is influenced by age, with significant monthly variation occurring only in the 25-54 age group. Contrary to expectations, seasonal variance is not significantly influenced by sex, race or method. There was also no evidence of the bimodal distribution of female suicides that has often been observed in northern hemisphere countries (Micciolo et al., 1989, 1991; Näyhä, 1982, 1983).

8.3.2   Weekly distribution of Suicide

There is no significant variation in the weekly distribution of fatal suicides in Pietermaritzburg. Suicides did not reach a peak on Monday as was expected. Instead, the distribution shows a peak on Sunday and a steady decrease towards the end of the week.

8.3.3   Climate and Suicide

Overall, it seems that weekly averages of weather variables are associated with weekly suicide rates. There is a stronger association between suicide rates and the weather in the preceding week, than between suicide and weather during the same week. The effect of weather is therefore likely to have a delayed, rather than instantaneous effect. An increase in minimum temperature, average temperature and humidity grade appears to correspond to an increase in weekly suicide rates. Furthermore, there is a negative relationship between hours of sunshine and suicide, but this is only significant for non-violent suicides. No significant relationship was found between suicide and rainfall or maximum temperature.

CHAPTER NINE: DISCUSSION

9.1   Introduction

This study set out to investigate seasonal, monthly and daily variation of suicide in Pietermaritzburg and to discern if any relationship exists between meteorological factors and suicide rates. This chapter presents a discussion of the findings of this study, with comparative reference to national and international research outlined in Chapters Three, Four and Five.

9.2   Seasonal and Monthly Distribution of Suicide

Suicide in Pietermaritzburg evidences significant seasonal variation with the expected spring-summer peak and winter nadir. This is consistent with research findings in both the northern and southern hemispheres (Altamura et al., 1999; Chew & McCleary, 1995; Dixon & Shulman, 1983; Hakko et al., 1998; Hassan, 1994; Horton & Stack, 1984; Lester & Frank, 1990; Maes et al., 1993a, 1994; Massing & Angermeyer, 1985; Micciolo et al., 1989, 1991; Näyhä, 1982, 1983; Preti & Miotto, 1998; Rihmer et al., 1998; Sanborn & Sanborn, 1978; Souêtre et al., 1987; Wenz, 1977). More specifically, the significant monthly variance of suicide in Pietermaritzburg is in accordance with the findings of Flisher et al. (1997) who used mortality data for the whole of South Africa. However, the October[7] peak and August trough are at odds with the January peak and June trough observed for the whole of South Africa (ibid.).

Variance in monthly trends was not significantly influenced by sex, race or method. Age by month interactions were significant, however, but only for the 25-54 age group. This is

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[7] It is important to note that throughout this discussion, monthly peaks and troughs will not necessarily correspond to seasonal peaks and troughs. Seasonal totals have been calculated as the sum of suicides in the three months of that season. For example, in this instance, although the peak month falls in spring, the peak season is summer since the sum of suicides in December, January and February exceeds the sum of suicides in September, October and November.

contrary to the findings of Flisher et al. (ibid.). They did not observe any significant differences in monthly trends according to sex and age group, but noted significant race by month interactions. For both blacks and coloureds, the winter trough and summer peak were more pronounced than for whites and Indians (ibid.). They did not investigate the effect of method of suicide on seasonal distribution. An explanation for the discrepancy in national and regional results, using the same methodology, is not readily apparent. It may be a function of the small sample size used in this investigation (214 as opposed to 16 389 in the national study), or that the ten year period investigated by Flisher et al. (ibid.) yielded more reliable results than the five year period in this investigation. Further regional studies would be needed before any conclusions could be drawn.

In this study, only adults (25-54 years old) evidenced significant suicide seasonality. Although most international research has also found age to be a determining factor in suicide seasonality, it is generally youth and elderly suicides that evidence more significant seasonality (Lester & Frank, 1988; McCleary et al., 1991; Näyhä, 1982; Preti & Miotto, 1998; Salib, 1997; Souêtre et al., 1987). However, adults represented 63.8% of all suicides in this study, and it is possible that the suicide count for the youth and the elderly was too low for seasonal variation to be detected. Adult suicides followed the expected pattern and reaching a peak in October (spring) and falling to a low in May (autumn) and August (winter).

Although they were not statistically significant, distribution trends according to sex, race and method of suicide will be discussed below. Variance in monthly trends was not significantly influenced by sex, and males did not evidence more marked suicide seasonality than females. This is consistent with national findings (Flisher et al., 1997). Most international studies, however, have noted significantly more seasonal variance for male suicides (Eastwood & Peacocke, 1976; Massing & Angermeyer, 1985; McCleary et al., 1991; Micciolo et al., 1989, 1991; Preti, 1997).

Although the monthly variance was not significant, the distribution of suicides was similar for males and females. The lowest number of suicides occurred in August for both sexes, while male suicides reached a peak in March and most female suicides occurred in January.

Both males and females evidenced a second, less clearly defined, peak in October. With regards to seasonal distribution, a summer peak with a secondary spring peak and a winter trough was observed for both males and females. The bimodal distribution of female suicides, with a peak in spring and a secondary peak in autumn, has been well documented. Conversely, male suicides have generally shown a unimodal distribution (Meares et al., 1981; Micciolo et al., 1989; 1991; Näyhä, 1982; 1983; Parker & Walter, 1982; Preti & Miotto, 1998; Rihmer et al., 1998). Furthermore, the bimodal distribution of female suicides is thought to relate to psychosocial processes specific to western culture as it has not generally been observed in non-western countries (Ho et al., 1997; Preti & Miotto, 1998). Flisher et al.'s (1997) failure to detect a secondary peak for either male or female suicides in South Africa seemed to support this theory. The bimodal distribution for both male and female suicides in Pietermaritzburg is thus something of an anomaly.

Most of the proffered explanations for the bimodal distribution of suicides are based on the assumption that it is a gender specific phenomenon (Micciolo et al.,1989; 1991; Näyhä, 1982; 1983; Preti & Miotto, 1998; Yip et al., 1998). They are therefore, by definition, redundant in this case. Only Eastwood and Peacocke (1976) in Canada, Lester and Frank (1988) in the USA and Souêtre et al. (1987) in France have reported a bimodal peak for both sexes. It is possible that the spring peak could be explained in terms of feelings of despondency resulting from the realisation that spring has not brought about the hoped for new beginning and change in life circumstance. Similarly, the summer peak could result from disappointment that the new year has not heralded a fresh start, or that spring and summer have passed and winter awaits, with no change in the social isolation and depression brought on by the previous winter (Gabennesch, 1988; Lester & Frank, 1988). Alternatively, as suggested by Eastwood and Peacocke (1976), the bimodal peak may correspond to peaks in admission rates for depressive disorders in Pietermaritzburg. It is not possible to verify this theory since no studies have been conducted on the seasonal distribution of psychiatric hospital admissions in Pietermaritzburg. This would be an interesting topic for future investigation.

Perhaps, in a quest for gender specificity, attention needs to be focussed on why females evidence a primary suicide peak in January, whereas male suicides evidence a primary peak in March. It is possible that the spring and summer peaks for female suicide are consistent

with one of the sociodemographic explanations for these peaks in the northern hemisphere. The second peak has been related to changes in social activity caused by the commencement of the academic year, which occurs in autumn in the northern hemisphere, and in summer (January) in South Africa (Flisher et al., 1997; Näyhä, 1982). Although the primary and not the secondary peak occurred in January in Pietermaritzburg, one could argue that, in Pietermaritzburg, the effect of the commencement of the academic year outweighs the effect of spring. This is, however, based on the presupposition that a sufficiently large number of women who engage in fatal suicidal behaviour have school-going children. The March peak in male suicides, on the other hand, could be related to the aftershock of the stress and tension surrounding the end of the financial year (at the end of February in South Africa). Again, this presumes that a high percentage of males who engage in fatal suicidal behaviour are negatively affected by the financial year-end. Both of these explanations are based on gender stereotyping, and however distasteful, given the patriarchal nature of South African society, they are not entirely implausible.

In the national study, monthly variation was significantly more pronounced for black suicides than for white or Indian suicides (Flisher et al., 1997). In this study, there were no significant differences in the monthly trends according to race. Although only few studies of suicide seasonality have examined race as a variable, Flisher et al.'s (ibid.) finding of greater seasonality for black suicides is consistent with international observations that greater seasonality is associated with lower standard of living, and a high percentage of the population living in rural areas (Abe, 1987; Chew & McCleary, 1995; Micciolo et al., 1989; 1991; Souêtre et al., 1990). Over 65% of black South Africans live in rural areas and their standard of living is lower than that of white and Indian South Africans (South African Institute of Race Relations, 1992). Unfortunately, the data required to examine seasonal variation for blacks, whites and Indians of differing urbanization or economic status was not available.

The monthly distribution of suicides differed for the three population groups, but this was not statistically significant. Black suicides reached a peak in March and December (summer), Indian suicides reached a peak in January and February (summer), and white suicides peaked in October (spring). The trough for black, Indian and white suicides was uniformly in August

(winter). In this study, black and Indian suicides evidenced a similar distribution, whereas Flisher et al. (1997) observed a similar distribution for white and Indian suicides, which was different from that of black suicides.

There were considerably more violent suicides (88.3%) than non-violent suicides (11.7%) in Pietermaritzburg. This is consistent with international findings (Altamura et al., 1999). Most studies in the area have found more marked seasonality for violent (ICD-9: 953-958, WHO, 1978) than non-violent (ICD-9:950-952, WHO, 1978) suicide (Maes et al., 1993a; 1993b; 1994; 1995; Massing & Angermeyer, 1985; Preti & Miotto, 1998). The findings of this study, however, indicate that neither violent nor non-violent suicides show significant seasonal asymmetry for either sex. Flisher et al. (1997) did not examine method of suicide and seasonality, so it is not possible to ascertain whether this anomaly is peculiar to Pietermaritzburg, or whether it pertains to South Africa as a whole.

As has been mentioned in sections 3.4 and 7.1, the different methodological approaches favoured by various researchers have hampered direct comparison of the numerous studies in this field. Many studies, such as this one, have examined seasonality by testing for differences in the variables across the months or seasons (Maes et al., 1995). The most commonly used statistical technique in this approach has been the chi-square statistic. And, most researchers in Europe and North America have found statistically significant suicide seasonality using this approach (Altamura et al., 1999; Lester & Frank, 1988; Meares et al., 1981; Rihmer et al., 1998; Schreiber et al., 1993; Yip et al., 1998). While this study did find significant monthly variation in suicide in Pietermaritzburg using the same statistical techniques as Flisher et al. (1997), an analysis of the same data set by means of the chi-square statistic failed to detect significant seasonal or monthly variation. The fact that monthly variation in suicide in Pietermaritzburg was only found to be statistically significant when a more sophisticated statistical technique was employed (log-liner modelling as opposed to chi-square) seems to suggest that seasonal variation in suicide might be less marked in Pietermaritzburg than in Europe and North America. This is consistent with Chew and McCleary's (1995) observation, based on their cross-national study of 28 nations, that seasonality is uniformly low in populations in or near the tropics (0-30 degrees north or south of the equator), or near the Arctic circle. Pietermaritzburg is situated 29 35 S.

Methodological issues aside, a comparison between the results of this study and national and international data suggests that suicide seasonality is certainly not a clear-cut phenomenon. It seems that although suicide rates for certain groups may be higher during the warmer months, for most individuals, the risk of suicide is randomly distributed throughout the year.

9.3   Weekly Distribution of Suicide

There were no significant differences in number of suicides in relation to days of the week in Pietermaritzburg. This is consistent with the findings of Altamura et al. (1999) in Italy, although several other studies have reported significance (Dixon & Shulman, 1983; MacMahon, 1983; Maldonado & Kraus, 1991; Massing & Angermeyer, 1985). Research conducted in the USA, Australia, Italy and Germany indicates that the greatest number of suicides occur in the beginning of the working week, with the most on Mondays and the least on Saturdays (Altamura et al., 1999; Dixon & Shulman, 1983; Hassan, 1994; MacMahon, 1983; McCleary et al., 1991; Maldonado & Kraus, 1991; Massing & Angermeyer, 1985). Pietermaritzburg appears to be an exception, with suicides reaching a peak on Sunday and steadily decreasing towards the end of the week. Unfortunately, there are no other South African studies of the weekly variation of suicide, so it is uncertain whether this is a regional or national phenomenon. The only other exception is Israel, where most suicides occur on Sundays and the least on Fridays (Modan et al., 1970).

One possible difficulty in studying weekly variation of suicide is the potential discrepancy between the day of the suicidal act and the date of death. All of the above studies, including this one, have based their analysis on mortality data. The day of the suicidal act, however, may have been a day, or even several days, before the date of death. These studies then, essentially measure the weekly variation of deaths due to suicide, rather than the weekly variation of suicidal acts. Most of the attempts at explaining the weekly variation of suicide, however, have focussed demonstrating why the suicidal act occurred on a particular day. Another difficulty lies in the possibility of delays in the recording of the death by suicide. For example, a suicidal act may occur on a Friday, the resultant death may occur on Sunday and the death-by-suicide might only be recorded on a Monday.

9.4   Climate and Suicide

In an attempt to ascertain whether climate is associated with suicide, weekly averages of hours of sunshine, ambient temperature, maximum and minimum temperature, relative humidity and amount of rainfall were correlated with weekly suicide rates. As has been mentioned in section 5.2.1, previous research into the relationship between specific weather variables and suicidal behaviour has yielded inconclusive and often contradictory findings. It was thus to be expected that the results of this study, while consistent with the findings of certain studies, are completely at odds with others. The results of this study suggest that an increase in minimum temperature, ambient temperature and humidity grade correspond to an increase in weekly suicide rates. Overall, violent suicide evidenced a stronger relationship with suicide rates than non-violent suicide. There was, however, a negative relationship between hours of sunshine and suicide rates, but this was only significant for non-violent suicides. There was a stronger association between suicide rates and the weather in the previous week, than between suicide and weather in the same week. This suggests that the relationship between weather and suicide is delayed, rather than an instantaneous. No significant relationship was found between suicide and rainfall, or maximum temperature.

This positive relationship between temperature and suicide, particularly violent suicide has been well documented (Durkheim, 1970; Linkowski et al., 1992; Maes et al., 1994; Preti & Miotto, 1998). Furthermore, the effect of temperature on suicide rate is not necessarily immediate, and an increase in temperature over a few weeks has been found to be a significant predictor of suicide (Maes et al., 1994). Only Preti (1998) in Italy, and Souêtre et al. (1990) in France, found a negative relationship between suicide and temperature. Although there has been some discrepancy in the findings of studies of suicide seasonality, for the most part suicide rates have been found to increase during the warmer months of the year (spring and summer). This seems to support the positive relationship between suicide and temperature. Interestingly, suicide rates were not associated with fluctuations in maximum temperature, but evidenced a strong relationship with minimum temperature.

Of all climatic variables, the strongest relationship was found to exist between humidity and suicide rate. A comparison between these results and international findings, however, reveals

that the relationship between humidity and suicide is contentious. The positive relationship between humidity and suicide rates in this study is supported by Linkowski et al.'s (1992) finding of a positive relationship between violent suicide and humidity, and Salib's (1997) finding of a positive relationship between male and female, elderly suicides and high humidity. Generally, however, humidity has been negatively correlated with suicide (Maes et al., 1994; Preti & Miotto, 1998; Salib & Gray, 1997). It is possible that neither high nor low humidity is specifically associated with suicide rates, but rather that suicide rates are associated with fluctuations in humidity from whatever is regionally ambient.

A negative relationship was found between hours of sunshine and suicide rates, but this was only significant for non-violent suicides during the same week. There was no significant relationship between non-violent suicides and hours of sunshine in the previous week and no significant relationship between violent suicide and hours of sunshine. Preti and Miotto (1997) also found a negative relationship between sunlight duration and non-violent suicide, but only for males. Souêtre et al. (1990) and Tietjen and Kripke (1994) found a negative relationship between sunlight duration and all suicides. Linkowski et al. (1992), on the other hand, also found a negative relationship, but only for violent suicides. They found no significant relationship between non-violent suicide and hours of sunlight (ibid.). Lastly, Schreiber et al. (1993) found a delayed negative relationship between hours of sunshine and suicide. Mostly, however, a positive relationship has been found between suicide rates and hours of sunshine (Durkheim, 1970; Lester, 1996; Maes et al., 1994; Preti, 1997; Preti & Miotto, 1998; Salib, 1997; Salib & Gray, 1997).

A positive relationship was found between suicide rates and rainfall, but this was not statistically significant. Maes et al. (1994) also found no significant relationship in this regard. Most studies, however, have found a significant negative relationship between suicide and rainfall (Lester, 1996; Preti, 1997; Preti & Miotto, 1998).

The relationship between meteorological variables and suicide has generally been explained in bioclimatic terms. Climatic variables are thought to affect circannual rhythms in specific biochemical processes that are associated with mood and emotions (Maes et al., 1993a; 1995; Preti, 1997). It is equally possible, however, that social activities vary according to the

weather and that it is these variations in social activity and the corresponding variations in social support that render certain individuals more vulnerable to suicide. Whether one favours a sociodemographic, or bioclimatic explanation, however, the synergistic effect of a number of climatic variables is likely to be greater than that of any individual weather variable (Maes et al., 1994). Overall, the data suggests that in Pietermaritzburg, suicide rates are higher when it is warmer, more humid and there is less sunlight, and that suicides are less likely to occur in cooler, dryer weather. There is a need for a more complex, holistic model to account for some of the findings described above.

9.5   Implications of Findings

The results of this study support Flisher et al.'s (1997) observation that the pattern of suicide seasonality observed in northern hemisphere countries is also present in South Africa. The possibility of fatal suicidal behavior appears to increase in the warmer months of the year. Furthermore, suicide rates appear to rise with increases in temperature. Although spring, summer and increases in temperature are natural phenomena, and are neither changeable nor escapable, these findings suggest that people who are already a high suicide risk need to be managed with extra caution during these times (Rihmer, 1996).

9.6   Limitations of Research

The main limitations of this study relate to the recording of suicide data. The data has been obtained from a secondary source thus increasing the element of human error in the recording procedure. Furthermore it is likely that district surgeons and inquest magistrates might not record suicides as such in cases where e.g.: there is any uncertainty as to cause of death; death does not immediately follow the suicidal act or the suicide is concealed by the family or by doctors wishing to protect family members. Apartheid era (pre-1994) data, in particular, must be viewed with caution (Wassenaar et al., 2000). Under-reporting of suicides in certain population groups is suspected. This has been discussed in more detail in chapter 6. Given the above, it is possible that the suicide rates cited in this study will be an undercount. Although

ascertainment bias possibly results in lower recorded suicide rates, it is unlikely to directly influence suicide seasonality or the relationship between meteorological variables and suicide (Ho et al., 1997).

Also, the date of death given in the inquest register is not necessarily the date of the suicidal act, nor is there any certainty that there are no delays in the recording procedure so that a fatal suicide on a Sunday, for example, may be only be recorded on a Monday. Alternatively, a suicidal act on a Friday might only result in death on the Sunday. While errors in daily records of suicide are unlikely to have a marked influence on monthly numbers of suicides, they are likely to influence data on the weekly distribution of suicide. In addition, certain information was missing from the data set, but given the retrospective nature of the study, omissions were difficult to clarify.

Another limitation of this study is the relatively small sample size. In order to be useful, predictive models such as the log linear model must be based on reasonably large samples (Addy, 1992). Furthermore, the 5 year period used in the log-linear model is possibly too brief to give an accurate reflection of seasonal trends in Pietermaritzburg.

With regards climate and suicide, the findings must be considered in light of the methodological limitations of this section of the study. The first problem lies in the use of autocorrelation. This refers to the fact that while the units of analysis used in calculating correlation coefficients are presumed to be independent of one another, given the calendrical nature of the data this is unlikely to hold true. The second problem relates to the geographical positioning of the weather station at Cedara Agricultural College from which the meteorological data was gathered in relation to the area from which suicide data was obtained. Although nominally in the region of the Pietermaritzburg Magisterial District, it could be argued that the data represents a microclimate rather than the whole region of concern.

9.7   Implications for Future Research

The problem of nomenclature in suicidology has been found to extend to the study of suicide seasonality. It is suggested that in future research, the concept of seasonality needs to be more explicitly defined. Furthermore, the use of a commonly agreed upon methodological approach would facilitate comparison between the various international studies.

It is suggested that future research on suicide in Pietermaritzburg needs to include suicide data from the coloured population group in order to make up for the previous lack of focus on this population group.

Perhaps the most striking finding of this study was the uniformly low suicide rates in August. Further investigation into possible causes for this trough might shed some light on factors that protect against suicidal behaviour

National and regional studies on the weekly distribution of suicide in South Africa would help to determine if the Sunday peak in suicide rates is peculiar to Pietermaritzburg or whether it pertains to the country as a whole.

There have been no other South African studies on climatic variables and suicide. Future research is needed to verify the findings of this study.

9.8   Summary

The results of this study were discussed in relation to national and international data. Overall, the findings of this study concur with those of previous research in that suicide rates were found to be higher in the warmer months of the year. The suicide peak on Sunday was something of an anomaly since, internationally, most suicides have been found to occur on Monday. Lastly, the limitations of this study were considered and implications for further research advanced.

CHAPTER TEN: CONCLUDING COMMENTS

This study set out to determine if the frequently observed spring-summer and Monday suicide peaks were present in Pietermaritzburg. In addition, the relationship between suicide rates and climatic variables was examined with the aim of shedding some light on the inconclusive and contradictory findings of previous research in the area.

Secondary analysis of suicide data collected for two unpublished honours theses was performed in order to test the hypotheses of this study. It was hypothesised that the seasonal distribution of suicide in Pietermaritzburg would be asymmetrical and that this distribution would vary with age, sex, race and method of suicide. It was also hypothesised that suicide rates would be highest on Mondays and lowest over the weekend. Lastly, it was hypothesised that there would be a significant relationship between suicide rates and hours of sunshine, ambient temperature, maximum and minimum temperature, relative humidity, and amount of rainfall and that these relationships would be influenced by method of suicide.

The results of this study support several of the above hypotheses, but most were not supported. There is significant seasonal variation of suicides in Pietermaritzburg with the expected spring-summer peak and winter trough found elsewhere in the world. The monthly variation of suicide is influenced by age, with significant monthly variation occurring only among adults. However, contrary to expectations, seasonal variance in Pietermaritzburg is not significantly influenced by sex, race or method of suicide.

There is no significant variation in the weekly distribution of suicide in Pietermaritzburg. Suicides reached a peak on Sunday rather than Monday and suicides rates were not lower over the weekend than during the rest of the week. In fact, the mean suicide rate for Saturday and Sunday was roughly equal to that of Monday and Tuesday.

Lastly, a significant positive relationship was found between suicide, and temperature and humidity and there was a negative relationship between hours of sunshine and non-violent suicide. Overall, there was a stronger relationship between climatic variables and violent

suicide than non-violent suicide. No significant relationship was found, however, between suicide and rainfall or maximum temperature.

Overall, the spring-summer peak and winter trough described in previous research was confirmed, as was the positive relationship between temperature and suicide rates. The association between temperature and suicide aside, the observed relationship between climatic variables and suicide rates seems to have added to the confusion, rather than provided clarity on the matter. Furthermore, there was no significant weekly variation in the distribution of suicide in Pietermaritzburg.

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APPENDIX II

Pearson product-moment correlation coefficients of weekly suicide rates and weekly averages of weather variables.

	Suicide	V	NV	Hum	Ambient	Min	Max	Rainfall	Sun
Suicide									
Pearson Correlation	1.0000	.9433	.3168	.1984**	.0838	.1216	-.0049	.0627	-.0956
(N)	(262)	(262)	(262)	(248)	(248)	(252)	(252)	(262)	(229)
Sig. (2-tailed)	p= .	p= .000	p= .000	p= .002	p= .191	p= .054	p= .938	p= .312	p= .149
V									
Pearson Correlation		1.0000	-.0160	.1512*	.0916	.1095	.0226	.0331	-.0474
(N)		(262)	(262)	(248)	(248)	(252)	(252)	(262)	(229)
Sig. (2-tailed)		p= .	p= .797	p= .017	p= .153	p= .083	p= .721	p= .594	p= .476
NV									
Pearson Correlation			1.0000	.1643*	-.0122	.0506	-.0811	.0945	-.1481*
(N)			(262)	(248)	(248)	(252)	(252)	(262)	(229)
Sig. (2-tailed)			p= .	p= .010	p= .849	p= .423	p= .199	p= .127	p= .025

* significant, p < 0.05   ** highly significant, p< 0.01

V = violent suicide   NV = non-violent suicide   Hum = humidity
Min = minimum temperature   Max = maximum temperature   Sun = hours of sunshine

One week lag of Pearson product-moment correlation coefficients of weekly suicide rates and weekly averages of weather variables.

	Suicide	V	NV	Hum	Ambient	Min	Max	Rainfall	Sun
Suicide									
Pearson Correlation	1.0000	.9433	.3168	.1754**	.1390*	.1829**	.0722	.0219	-.0899
(N)	(262)	(262)	(262)	(247)	(244)	(251)	(251)	(261)	(229)
Sig. (2-tailed)	p= .	p= .000	p= .000	p= .006	p= .030	p= .004	p= .254	p= .724	p= .175
V									
Pearson Correlation		1.0000	-.0160	.1559*	.1271*	.1698**	.0640	.0222	-.0925
(N)		(262)	(262)	(247)	(244)	(251)	(251)	(261)	(229)
Sig. (2-tailed)		p= .	p= .797	p= .014	p= .047	p= .007	p= .312	p= .721	p= .163
NV									
Pearson Correlation			1.0000	.0815	-.0516	.0605	.0327	.0025	-.0051
(N)			(262)	(247)	(244)	(251)	(251)	(261)	(229)
Sig. (2-tailed)			p= .	p= .202	p= .422	p= .340	p= .606	p= .968	p= .939

* significant, $p < 0.05$ ** highly significant, $p < 0.01$

V = violent suicide   NV = non-violent suicide   Hum = humidity
Min = minimum temperature   Max = maximum temperature   Sun = hours of sunshine