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Summer in the City: Urban Weather Conditions and Psychiatric Emergency-Room Visits

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The relationship between psychiatric emergency-room visits and meteorological variables was examined for the summer months across 2 consecutive years. Weather involving low barometric pressure and high cloud cover was significantly related to emergency-room visits for depression, and air pollution was correlated with schizophrenia and total visits. Whereas several studies have linked barometric changes to depression, no previous studies have examined or reported a link between air pollution and psychopathology.

Despite a growing interest in the effects of the physical environment on human behavior, researchers have generally neglected to study the impact of meteorological variables on psychological adjustment (Campbell & Beets, 1977). The sparse literature that does exist, however, suggests that there is a surprisingly direct relationship between weather conditions and a variety of disordered behaviors. For example, meteorological conditions have been linked to increases in suicides (Digon & Block, 1966), police incidents (Will & Sells, 1969), accident proneness (Moos, 1964), and psychiatric admission rates (Pantleo, 1970; Steward & Wildman, 1967).

Despite these findings, Pokorny and his colleagues failed to replicate any relationship between weather and suicidal behavior or homicides in several well-controlled studies (Pokorny, 1966; Pokorny & Davis, 1964; Pokorny, Davis, & Haberson, 1963). Appropriately citing the "treachery" of correlational techniques with cyclic data (e.g., seasons of the year) and the problem of inflated error rates arising from the use of large numbers of statistical tests, Pokorny has attributed the positive findings of other investigators to inappropriate experimental designs or chance relationships.

Responding to these concerns, we examined the effects of meteorological variables on one measure of disordered behavior, psychiatric emergency-room visits, while we controlled for cyclic data trends and statistical error-rate inflation. In light of reports that psychiatric admission rates may cycle according to season (e.g., James & Griffin, 1968), data were sampled for the summer months only across a 2-year period. Problems of data complexity and error rate were addressed through the use of multiple dependent measures and time-lagged predictors, which were analyzed with multivariate and univariate statistical procedures. Finally, to remedy an important omission in the literature, we assessed the effects of a variety of air-pollution conditions on emergency-room visits.

Method

A total of 4,025 visits to the Psychiatric Emergency Observation Unit at the Sacramento Medical Center were recorded during June, July, and August, of 1977 and 1978. Each visit was categorized by date of appearance and admitting diagnosis, and was summed to produce frequencies of each diagnostic category for each of 184 days. Diagnostic categories (per DSM-II, American Psychiatric Association, 1968) examined in the present study were Schizophrenia (all types; $n = 1,194$), Depression (all types; neurotic, psychotic and reactive; $n = 604$), Mania (manic depression, manic phase or type; $n = 274$), Neurosis (other than neurotic depression; $n = 121$), Personality Disorder ($n = 431$), Transient Situational Disturbance ($n = 1,260$), and Organic Brain Syndrome ($n = 141$).

Data for this study were collected while John Briere was an intern in clinical psychology at the University of California, Davis, Medical School. Anthony Downes is no longer at the University of Manitoba.

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Local meteorological and air-pollution data for each of the corresponding days were obtained from the National Oceanic and Atmospheric Administration (NOAA) and the Environmental Protection Agency (EPA). Together, these variables consisted of maximum daily temperature, minimum daily temperature, dew-point (measure of absolute humidity), precipitation, haze, barometric pressure, wind speed, sky cover, ozone (O^3), carbon monoxide (CO), sulphur dioxide (SO^2), nitric oxide (NO), nitrogen dioxide (NO^2), other nitrogen oxides (NO^x), and airborne particulates. The variable of sulphur dioxide was eliminated from further analysis, due to the large percentage of missing values in the EPA files.

To reduce the complexity of the data, principal-factors analyses followed by varimax rotations (Nie, Hull, Jenkins, Steinbrenner, & Brent, 1975) were done on the weather and air-pollution data sets, and the resultant factor scores were used as new variables in further analyses. As a final transformation, each factor was timelagged up to 4 days prior to the emergency-room visit, creating five variables per factor (Day 1–Day 5) to assess less immediate relationships between weather, air pollution, and emergency-room visits.

Further statistical analysis involved a three-tiered approach. To control for error-rate inflation, canonical correlation analyses were done on data from Day 1 and each day prior, up to Day 5, relating weather and air-pollution factors to psychiatric diagnoses[1]. When this global analysis indicated a significant relationship for a given day, correlation coefficients were calculated between the relevant meteorological factors and diagnosis rates for that day, along with a summary measure of the total number of psychiatric visits. Finally, when a weather or air-pollution factor was found to correlate significantly with a given diagnosis, correlations were performed between those variables comprising the factor and the diagnosis. To further decrease the experimentwise error rate for these analyses, correlations were considered significant only when $p < .01$ (two-tailed test).

Table 1
Factor Matrices for Weather and Air-Pollution Variable Sets

Significant contributing variables	Factor 1	Factor 2	Factor 3
Weather			
Maximum temperature	*−.86*	*.47*	.19
Dew point	−.09	*.60*	−.02
Barometric pressure	.05	*−.73*	*−.33*
Wind speed	*.66*	−.02	−.04
Sky cover	*.41*	.04	*.34*
Air pollution			
O^3	.03	*.67*	
Particulates	*.87*	.22	
CO	*.78*	.03	
NO	*.88*	*−.36*	
NO^2	*.84*	*.45*	
NO^x	*.99*	.03	

Note. Factor loadings were considered meaningful (italicized) if $C \geq |.30|$. The factor structure for weather accounts for 73.7% of common variance. The factor structure for air pollution accounts for 86.8% of common variance. O^3 = ozone; CO = carbon monoxide; NO = nitric oxide; NO^2 = nitrogen dioxide; NO^x = other nitrogen oxides.

Results

Principal-factors analyses of the weather and air-pollution variable sets resulted in three summer weather patterns and two summer air-pollution patterns whose eigenvalues exceeded 1.0, as shown in Table 1.

Day 1

Canonical analysis of the weather and air-pollution factors with psychiatric diagnoses on Day 1 indicated a significant multivariate relationship between these variables, $\chi^2(35) = 51.92$, $p < .033$. As indicated in Table 2, Depression was significantly related to Weather Factor 3, $r = .22$, $p < .002$, whereas Schizophrenia and total visits were correlated with Pollution Factor 1, $r = .24$, $p < .001$, in each case. Examining each variable separately, Depression was negatively correlated with the barometric-pressure component of Weather Factor 3, $r = -.19$, $p < .01$, and total visits were positively correlated with the following components of Pollution Factor 1: CO ($r = .24$, $p < .001$), NO ($r = .22$, $p < .001$), NO^2 ($r = .19$, $p < .01$), NO^x ($r = .23$, $p < .001$), and airborne particulates ($r = .19$, $p < .01$). No single Pollution Factor 1 variable correlated significantly with Schizophrenia at the .01 level, although NO^x, NO^2, CO, and particulates exceeded $p < .05$.

Day 2

Weather and air-pollution factors 1 day prior to the emergency-room visit were also

[1] Due to the manner in which the data were gathered (i.e., frequency of diagnoses per day rather than on a casewise basis), we cannot rule out the probability of multiple visits by individual patients. Thus, the "independence of observations" assumption of parametric analysis may not be fully satisfied. The effects of this violation were thought to be minor, however, given the large number of diagnoses sampled and the improbability of any systematic bias with regard to meteorological conditions.

Table 2
Correlation Between Various Admission Diagnoses and Meteorological Factors

	Day of admission					1 day prior to admission				
Diagnosis	WF1	WF2	WF3	PF1	PF2	WF1	WF2	WF3	PF1	PF2
Schizophrenia	−.05	.03	.01	*.24*	−.05	−.10	.05	.05	.11	.03
Depression	.05	.15	*.22*	.01	.01	−.08	.17	*.27*	.05	.06
Mania	.02	.10	−.07	.17	−.08	.00	.05	−.16	.11	−.14
Neurosis	−.05	.11	.05	.05	.03	−.10	.15	.02	.05	−.06
Personality Disorder	.01	−.01	−.06	−.00	−.00	−.04	.05	−.07	.00	−.01
Situational Disturbance	−.03	.09	.01	.11	.08	−.16	.01	−.04	.08	.04
Organic Brain Syndrome	.10	.06	.15	.07	−.05	.05	.11	−.02	.00	.03
Total admissions	.01	.17	.11	*.24*	−.02	−.16	.17	.04	.15	.03

Note. WF = weather factor; PF = air-pollution factor. Italicized correlation coeficients are significant at $p < .01$.

related to psychiatric emergency-room diagnosis by canonical correlation analysis, $\chi^2(35) = 53.24$, $p < .025$. As shown in Table 2, this relationship was primarily due to the significant correlation between Depression and Weather Factor 3 one day prior to the emergency-room visit ($r = .27$, $p < .001$), as occurred on Day 1. Examination of the individual variables composing this factor, however, revealed no significant correlations with Depression at the .01 level.

Days 3, 4, and 5

Canonical analyses for Days 3, 4, and 5 revealed no significant associations between diagnosis and weather or air-pollution factors: $\chi^2(35) = 28.61$, *ns*; $\chi^2(35) = 39.19$, *ns*; and $\chi^2(35) = 31.13$, *ns*, respectively.

Discussion

The data presented here indicate a significant relationship between meteorological conditions and psychiatric emergency-room visits for diagnostic groups. In the absence of a well-defined research literature, however, these findings must be interpreted with care. Furthermore, the correlational nature of the data cannot be overlooked, especially in terms of evaluating etiology. Certain relationships in the data appear noteworthy, however, and warrant further discussion.

The primary findings of the present study were (a) a correlation between the weather pattern named "Weather Factor 3" and Depression diagnoses, both on the day of the emergency-room visit (Day 1) and 1 day prior (Day 2), and (b) a relationship between multiple indexes of air pollution (Pollution Factor 1) and emergency-room visits for both Schizophrenia and total visits, on Day 1.

Further analysis of the relationship between Weather factor 3 and Depression indicated that low barometric pressure was directly related to Depression diagnoses on Day 1. The general association between weather involving low atmospheric pressure and dysphoria has some support in the literature. Although Pokorny (1966) found no relationship between barometric pressure and suicidality, Sanborn, Casey, and Niswander (1970) reported a link between low barometric pressure and both suicide rates and psychiatric admissions. Further, Will and Sells (1969) noted that low barometric pressure coupled with high temperature was associated with an increase in the number of citizen complaints to the police, and Digon and Block (1966) found an association between extremes in barometric pressure and completed suicides.

The increase in Schizophrenia diagnosis and total number of psychiatric emergency-room visits during days of increased air pollution is noteworthy, given the absence of any known studies linking air pollution to psychiatric admission rates, suicide rates, or other indexes of disordered behavior. While ozone has been attributed a positive, invigorating effect by anecdotal reports, laboratory studies have generally shown ozone to have no effects at all (e.g., Hore & Gibson, 1968; McGregor, 1976). Kreuger and Reed

(1976), however, summarize biological literature indicating that positive and negative air ions differentially block or stimulate the metabolism of biogenic amines at the synaptic level and thus, perhaps, affect the biochemical substrates of certain behavior patterns. Whether such an explanation is viable in the present case or whether, perhaps, air pollution is merely an irritant contributing to "dysphoria overload" and stimulating emergency-room visits, is unknown. Any etiological considerations are further complicated by the fact that weather or air pollution may impact on diagnosticians as well as patients, thereby affecting emergency-room rates by altering diagnostic behavior. Finally, meteorological effects may be mediated by other undetermined variables that might, in turn, affect the development, presentation, or diagnosis of psychological disturbance.

Although they cannot specify causality, the present data offer empirical support for relationships between meteorologic variables and certain forms of psychopathology. These data also reinforce the notion that psychometeorological relationships are complex phenomena that seem to be best studied with multivariate approaches. Further exploration in this area is necessary both to replicate the relationships reported here and elsewhere across other seasons and years and to investigate causal linkages between weather parameters and human behavior.

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