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Research Article

Weather Variations and Hospital Admissions for Depressive Disorders: A Case Study in Hanoi

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Abstract

Studies from developed countries have shown season and weather influencing mood disorders, but it is not known whether such associations exist in tropical/sub-tropical low- and middle-income countries. This study from Vietnam examined the seasonal pattern of hospital admissions for depressive disorders andits relationship to daily weather variations, after stratifying for age, sex, and geographic area. Daily admission data from 2008 to 2012 were collected from Hanoi Mental Hospital in which 619 first-episode admissions for depressive disorders were diagnosed by the International Classification of Diseases 10 criteria for mood disorders (F30–F39). A negative binominal time series regression model for daily counts of eventswasestablished to analyze the relationship between weather variations, seasonality and daily hospital admissions for depressive disorders after adjusting for time trends. Our findings showed a general tendency for more admissionsin 2010 as well as between May and December, with a seasonal bi-annual high between May-June and November-December. Males were more affected by high ambient temperature and sunshine-hours. Elevated ambient temperature was significantly related to increasing admissions RR=1.05 (1.01 – 1.09) over the same or following day. The relationship between hours of sunshine and the number of cases indicateda significant linear associationin menwhen the number of hours of sunlight per day was over each one hour RR=1.06 (1.02 – 1.11). High temperatures and high numbers of sunshine hours had a strong positive relationship to admission with a delay of 0–13 days. For these associations, men and ages below 40 years appeared more susceptible.

INTRODUCTION

The impact of seasonal variations in climatic conditions on patients with mental disorders has been recognized for many centuries [1-3]. Research on seasonality of psychiatric disturbances is fraught with difficulties, including differences in geographic latitude and differences between the northern and southern hemispheres [3].

Depressive disorders have become increasingly common with about 350million people suffering from depression worldwide in recent years [4]. Admissions for depression in women have been shown to undergo significant monthly variations [4, 5]. The prevalence of depression in the US is about 2.6%–9.2%, and the large range can potentially be explained by significant climatic and social differences with in the country. Countries in the EU have prevalence rates for depression with 2.2%, 3.8%, 3.9%, and 4.4% in Switzerland, Iceland, Sweden, and Italy, respectively [6].

Studies in the northern hemisphere have shown seasonality of admissions for bipolar disorder and depressive disorder with a clear peak becoming evident in the winter months, but very fewstudies have been undertaken in the southern hemisphere [7]. Most of the previous studies on depressive disorder and seasonalityhave reported evidence of a spring/summer peak incidence for mania [2,3, 8-10]. For example, hospital admissions for mania in England revealed a summer peak, while studies in Australia and New Zealand indicated a similar peak with the highest rate of mania in the spring/summer season [8]. However,

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other studies have failed to identify a seasonal pattern for hospital cases of mania or a consistent seasonal pattern of relapse for bipolar affective disorder I [2,7, 9-11]. In nations in tropical and subtropical climate regions, like India, admissions to hospitals for mania weremore frequent in monsoon and winter months [3]. Furthermore, studies in Egypt and Brazil found seasonal patterns for admissions for mania peaking in June and August [12, 13]. Contrary to previous findings in these countries, most studies have reported peaks for depression coming with either spring or autumn [2]. Some previous studies have shown a correlation between depressive episodes and seasonality [2,14],but a limitation of hospital case studies for depressive episodes might be that hospital admissions are more closely associated with the severity of the sickness and the risk of suicide [2].

Weather variability such as daily ambient temperature, relative humidity, and daily hours of sunshine have also been found to be predictive of hospital admissions for mental disorders [15,16]. Most previous studies, however, studied seasonality and stated that mechanisms by which seasonality triggered mood disorders were neurobiological variations related to the photoperiod because the sharpest increase in hospital cases for mania were associated with the length of the photoperiod from February through March [4,5,12,14]. However, the influence of weather variability and seasonal patternshave not been appropriatelydisentangled despite the fact that they are strongly interconnected. To understand the climatic influence on the disorder , studies need to be performed in different regions around the world with distinct climatic differences adjusted for social conditions and latitude [12,17]. Studies on depressive disorders related to weather fluctuations in Vietnam are important because they address, in this context, novel climatic and social contexts that have not been well investigated. Such studies can shed light on how such associations with climatic fluctuations can lead to better climate change risk assessments and adaptation measures.

This study investigated temporal patterns in the first time admissions for depressive disorders (including: manic episodes, bipolar affective disorders, depressive episodes, and recurrent affective disorders) and their association with daily weathervariability and season in Hanoi, Vietnam, after stratifying for age, sex, and geographic area.

MATERIALS AND METHODS

Hospitalization data

A database from the Hanoi Mental Hospital covering five years from 2008 to 2012 was obtained that included all patients with mental diseases in the Hanoi catchment area. Hospital admissions were diagnosed according tothe International Classification of Diseases 10 (ICD 10) by a physician, and each patient was provided a principal disease code. Admissionswere identified in the database by a principal diagnosis of episodes. According to ICD 10, mood disordersare classified from F30 to F39 including manic episodes, bipolar affective disorders, depressive episodes, recurrent depressive disorders, persistent mood affective disorders, other mood affective disorders, and unspecified mood affective disorders. Depressive disorders included different forms in which three of the most common types were described such as major depression, dysthymic disorder, and forms of depressive disorder with slightly different characteristics, including *psychotic depression, postpartum depression, seasonal affective disorder, and bipolar disorder* (also called manic-depressive illness) [17,18]. The different types of diseases vary in their number of symptoms as well as their severity and persistence. Most admissions for mood disorders during the study period were limited to ICD 10 codes F30–F33. Thus we chose to only consider depressive disorders including manic episode (ICD 10 code F30), bipolar affective disorder (ICD 10 code F31), depressive episode (ICD 10 code F32), and recurrent depressive disorder (ICD 10 code F33). In total, the analysis covered 619 patients having their first time visit to the hospital for the investigated health problem from 2008 to 2012.

Meteorological data

Located at 21°2′0″N105°51′00″E, Hanoi has typically subtropical weather with four defined seasons in which the warm period is from May to September. Meteorological data including daily mean ambient temperature, daily number of sun hours, and daily mean relative humidity were collected from monitoring 5 stations including Nguyen Van Cu, Đien Bien Phu, Ba Đinh square, Lang, and Long Bien in Hanoi.

Statistical analysis

The daily frequency of admissions for bipolar affective disorders and depressive episodes was aggregated per day over a time period of five years (2008–2012). Using a negative binominal regression model for time series, a relationship was estimated for the average of the collective values between the occurrence of daily admissions and lags of ambient temperature, relative humidity, and hours of sunshine. To estimate and to adjust for annual and seasonal time trends, we included factors for month and year as explanatory variables.

A log-linear function was used to determine the relationship between weather variables and admissions. Furthermore, weather parameters were included as the mean over 0–1 day, 0–6 days, and 0–13 days to account for potential delayed exposure effects. The time series model included 1827 days and 619 admission events for depressive disorders from 1 Jan 2008 to 31 Dec 2012. Moreover, we analysed daily hospital admissions for depressive disorders collectively as well as after stratifying for age, sex, and geographic location. We did not adjust for multiple testing, and thus consider this more an exploratory study. Resulting relative risks (RRs) are presented along with 95% confidence intervals. Statistical analyses were conducted using the statistical software package Stata v12.

RESULTS AND DISCUSSION

Study population

The study sample consisted of 619 subjects diagnosed with first time depression disorders (ICD 30-33) from 2008 to 2012. The mean age was 39 years and ranged from 11 yearsto 86 years. The majority of the subjects (351, 56.7%) were 18 to 40 years old. The group younger than18years was the smallest with 19 patients (3.0%), and the group older than 40 yearsconsisted of 249 cases (40.3%). Three hundred fifty-one (57%) patients were women and 268 (43%) were men, and 324 (52%) were living in rural areas and 291 (47%) were living in urban areas (Table 1). Moreover, 7 (1.1%), 368 (59.4%), 235 (38%), and 9 (1.5%) patients experienced manic episodes, bipolar affective disorders, depressive episodes, and recurrent depressive disorders, respectively. Admissions for bipolar affective disorders were, therefore, 1.5 times higher than for depressive episodes (Table 2).Moreover, there were 15 (F31.0) cases of bipolar disorder in the phase of hypomanic illness, 81 (F31.1 and 31.2) cases of bipolar disorder in the phase of manic illness, and 18 (F31.3, F31.4, and F31.5) cases of bipolar disorder in the phase of depressed illness (Table1). In addition, 79% of the patients had been admitted to the unit of mental health, 13.6% of the cases had been admitted to the unit of general health, and emergency unit admissions of both women and men were equal at 3% each (Table 2).

Weather variations

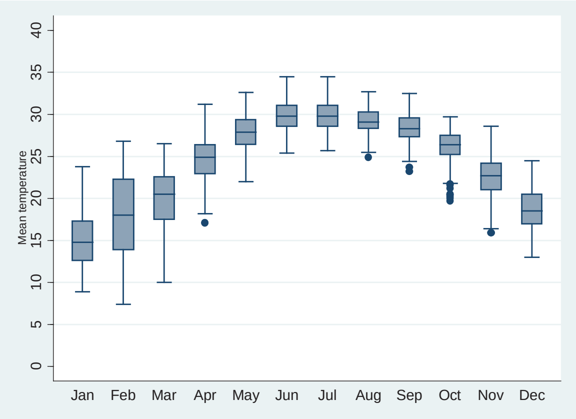
Figure 1 describes the mean monthly values of the weather including mean temperature, mean humidity and hours of sunshine. The mean daily ambient temperature was 24°C. In the summer season, the mean humidity was quite high averagingabout 78%. Located in a subtropical region, the study areahad a seasonal sunshine pattern with the annual high occurring in the summer and the annual low in the winter.

Association between weather variations and hospital admissions for depressive disorders

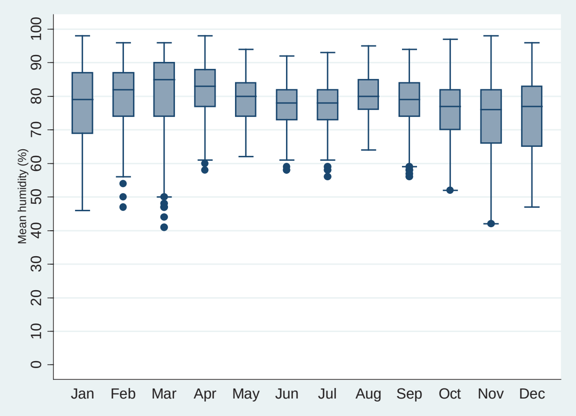
The admissions for F30-31 and F32-33are illustrated in Figure 2 and show fairly similar seasonal patterns. The seasonal trends in hospital cases for F30-31 demonstrated an increase from May to December and peaks in May (spring/summer) and in November (early winter). The estimated peaks and lows of visits for depressive disorders coincided with springs/summers thatwere hotter and dryer, especially from May to June in 2010,

Table 1: Descriptive statistics of the study population of 619 patients with a median age of 38.8 ± 14.5 years admitted for depressive disorders at the Hanoi Mental Hospital from 2008 to 2012.

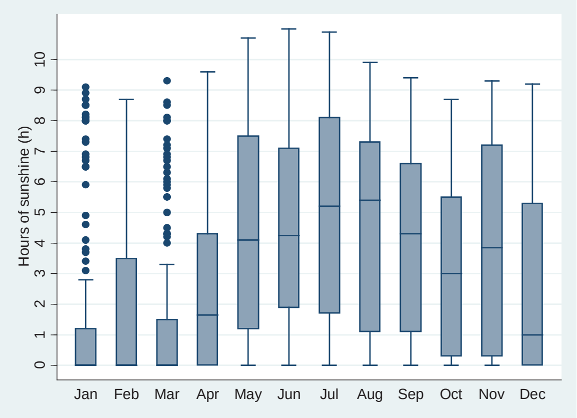
	Frequency	Percent (%)
Ages (years)		
11 – 18	19	3
18 – 40	*351*	*56.7*
41 - 70	238	38.4
> 70	11	1.9
Sex		
Female	*351*	*57*
Male	268	43
Location		
Urban	291	47
Rural	*324*	*52.3*
Unknown	4	0.7
Depressive disorders among the group over 18 years		
F 31	*351*	*56.7*
F 32	223	36.0
F 31.0	15	2.42
F31.1&31.2	81	13.1
F31.3, F31.4,&31.5	18	2.9
All cases	619	100



Mean temperature (oC): Mean =24.3, SD=± 5.6, Min=7.4 and Max=34.5



Mean humidity (%): Mean =78.2, SD=± 9.8, Min=41 and Max=98



Hours of sunshine (hours): Mean =3.3, SD= ± 3.3, Min=0 and Max=11

Figure 1 Mean values of temperature, humidity, and hours of sunshine for each month of the period from 2008 to 2012.

Table 2: Frequency of admissions for specific depressive disorders at different clinical units.

ICD code Clinical units	F30	F31	F32	F33	All
Unit of mental health	4 (0.65%)	285 (46%)	197 (31.82%)	3 (0.45%)	489 (79%)
Unit of general health	3 (0.45%)	40 (6.46%)	35 (5.66%)	6 (1.04%)	84 (13.57%)
Emergency unit for female patients	0 (0%)	21 (3.39%)	1 (0.16%)	0 (0%)	22 (3.55%)
Emergency unit for male patients	0 (0%)	18 (2.95%)	2 (0.32%)	0 (0%)	20 (3.23%)
Unit of patients abusing drugs and substances	0 (0%)	4 (0.65%)	0 (0%)	0 (0%)	4 (0.65%)
All	7 (1.1%)	368 (59.4%)	235 (38%)	9 (1.5%)	619 (100%)

Table 3: Relative risk and 95% confidence intervals ( ) ofadmissions for depressive disorders per year and month during five years (2008–2012) estimated from a negative binominal regression model for binary time series.

Time	Population	F31 among age 18-70	F32 among age 18-70	Female	Male	Urban	Rural	Age 18-40	Age 41-70
Year 2008	1	1	1	1	1	1	1	1	1
Year 2009	1.32 (0.93 – 1.88)	1.34 (0.91 – 2.0)	2.15 (0.86 – 5.37)	1.42 (0.91 – 2.22)	1.2 (0.71 – 2)	1.19 (0.75 – 1.89)	1.49 (0.9 – 2.47)	1.29 (0.8 – 2.06)	1.6 (0.93 – 2.76)
Year 2010	2.6* (1.89 – 3.58)	1.53* (1.04 – 2.25)	12.61* (5.71 – 27.8)	2.83* (1.9 – 4.23)	2.36* (1.49 – 3.74)	2.1* (1.38 – 3.18)	3.25* (2.07 – 5.1)	2.9* (1.91 – 4.39)	2.9* (1.76 – 4.78)
Year 2011	2.47* (1.79 – 3.4)	1.74* (1.2 – 2.54)	10.09* (4.54 – 22.4)	2.29* (1.51 – 3.45)	2.69* (1.71 – 4.24)	2.1* (1.39 – 3.19)	2.92* (1.85 – 4.61)	2.57* (1.68 – 3.93)	2.97* (1.81 – 4.89)
Year 2012	2.1* (1.51 – 2.91)	1.84* (1.27 – 2.67)	5.86* (2.57 – 13.3)	2.22* (1.47 – 3.35)	1.96* (1.22– 3.15)	1.7* (1.11 – 2.62)	2.6* (1.63 – 4.12)	2.26* (1.47 – 3.47)	2.36* (1.41 – 3.94)
Jan	1	1	1	1	1	1	1	1	1
Feb	1.32 (0.81 – 2.15)	1.35 (0.74 – 2.46)	1.15 (0.54 – 2.46)	1.32 (0.73 – 2.38)	1.32 (0.62 – 2.79)	1.75 (0.89 – 3.44)	1.02 (0.53 – 1.98)	0.89 (0.46 – 1.71)	1.95 (0.99 – 3.88)
Mar	1.25 (0.77 – 2.04)	1.6 (0.9 – 2.83)	0.8 (0.4 – 1.76)	1.09 (0.59 – 1.98)	1.56 (0.76 – 3.17)	1.45 (0.73 – 2.89)	1.13 (0.6 – 2.14)	1.16 (0.63 – 2.13)	1.43 (0.7 – 2.9)
Apr	1.03 (0.62 – 1.71)	1.22 (0.7 – 2.25)	0.65 (0.3 – 1.53)	1.12 (0.61 – 2.05)	0.88 (0.4 – 1.99)	1.57 (0.8 – 3.11)	0.66 (0.32 – 1.36)	0.99 (0.52 – 1.86)	0.96 (0.44 – 2.08)
May	1.67* (1.05 – 2.66)	1.69 (0.96 – 2.99)	1.29 (0.62 – 2.69)	1.48 (0.84 – 2.61)	1.98 (1 – 3.93)	1.87 (0.97 – 3.6)	1.54 (0.84 – 2.82)	1.3 (0.72 – 2.35)	1.84 (0.94 – 3.63)
Jun	1.48 (0.92 – 2.39)	1.32 (0.73 – 2.4)	1.47 (0.72 – 3.01)	1.57 (0.89 – 2.76)	1.38 (0.66 – 2.87)	1.65 (0.84 – 3.25)	1.37 (0.74 – 2.54)	1.44 (0.8 – 2.59)	1.33 (0.65 – 2.75)
Jul	1.06 (0.64 – 1.75)	1.14 (0.62 – 2.1)	0.64 (0.3 – 1.51)	1.13 (0.63 – 2.07)	0.93 (0.42 – 2.05)	1.2 (0.6 – 2.45)	0.95 (0.5 – 1.83)	0.91 (0.5 – 1.72)	1.15 (0.55 – 2.42)
Aug	1.48 (0.92 – 2.37)	1.56 (0.88 – 2.78)	1.21 (0.6 – 2.54)	1.13 (0.62 – 2.05)	2.03* (1.03 – 4.03)	1.61 (0.82 – 3.15)	1.37 (0.74 – 2.54)	1.46 (0.82 – 2.61)	1.3 (0.63 – 2.67)
Sep	1.54 (0.96 – 2.48)	1.28 (0.7 – 2.33)	1.57 (0.77 – 3.22)	1.5 (0.85 – 2.66)	1.61 (0.79 – 3.29)	1.45 (0.72 – 2.89)	1.61 (0.88 – 2.96)	1.43 (0.8 – 2.58)	1.33 (0.65 – 2.74)
Oct	1.55 (0.97 – 2.47)	1.43 (0.8 – 2.56)	1.48 (0.73 – 3.03)	1.41 (0.8 – 2.5)	1.79 (0.89 – 3.61)	1.78 (0.92 – 3.45)	1.41 (0.76 – 2.6)	1.25 (0.7 – 2.27)	1.79 (0.9 – 3.53)
Nov	2.01* (1.28 – 3.17)	1.91* (1.09 – 3.33)	1.8 (0.9 – 3.6)	1.62 (0.93 – 2.85)	1.04 (0.54 – 2)	2.39* (1.26 – 4.51)	1.79 (0.99 – 3.25)	1.75 (1.0 – 3.09)	2.06* (1.06 – 4.03)
Dec	1.52 (0.95 – 2.44)	1.42 (0.8 – 2.56)	1.23 (0.6 – 2.59)	1.14 (1.63 – 2.07)	2.72* (1.4 – 5.27)	2.14* (1.12 – 4.07)	1.1 (0.6 – 2.1)	1.41 (0.8 – 2.55)	1.22 (0.6 – 2.53)

(*p < 0.05)

and winter seasons that were colder (Figures 2; Table 3). Peaks in admissions were found in 2010 in all groups in which admissions for F32 among adults increased sharply in RR=12.61 (5.71 – 27.8) (Table 3). Furthermore, there was a significant increase in ambient temperature as well as events of extreme heat in 2010 (Table 5).

Our results showed a rising trend in the number of admissons over time (Table 3). There was a sharp difference in cases admitted to the Hanoi Mental Hospital from 2008 to 2009 compared to 2010 to 2012. For depressive disorders in the age group of 18–40 years, a significant increaseis estimated in May-June compared to January-February (Table 3). In addition, there was a statistically significant seasonal pattern among women with peaks in June and November, while among men with peaks in August as well as December. Rural populations appeared to suffer more seasonality in admissions with peaks in August (late summer) and November (early winter) (Table 3).

In this study, we used time series regressionusing anegative binominal link function to analyze the short-term relationship between daily hospital admission and weather variables including

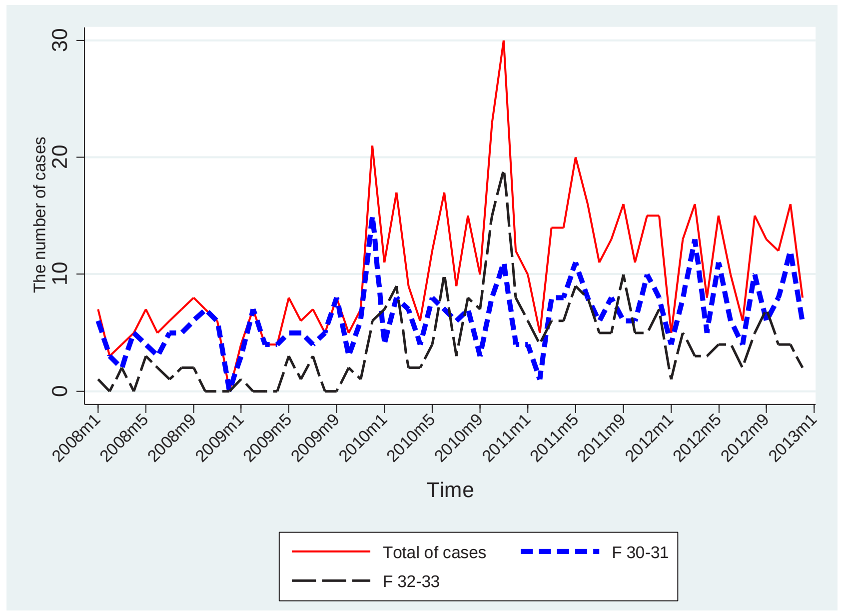


Figure 2 Time series of monthly cases for depressive disorders from 2008 to 2012.

temperature, relative humidity, and hours of sunshine in which weather variables were divided into lags of 0-1 day, 0-6 days and 0-13 days for temperature, relative humidity and the daily hours of sunshine (Table 3). All RRs in the text and tables related to temperature should be interpreted as linear associations per one degree Celsius increase in temperature.

Linear associations between admissions for depressive disorder and ambient temperature show that there were statistically significant relationships in all groups. Admissions among all population had higher relative risk (RR=1.05 (1.01 – 1.09) in which cases for F31 and F32 among the group 18-70 years of age had also high risks with RRs of 1.06 (1.02 – 1.11) and 1.06 (1 – 1.12) respectively. Moreover, there were relative increases in admissions for higher mean temperature (1°C) for groups of men (RR= 1.06 (1.006 – 1.12), population aged 18-40 (RR=1.06 (1.008 – 1.11), and residents in urban areas (RR=1.08 (1.03 – 1.14). Cases among other groups had slightly higher RRs from RR=1.02 to RR=1.05.

The number of admissions for depressive disorders in all groups, and especially for the population aged 18–40 and residents in urban areas, were positively correlated to mean temperature at time lags of 0–1 day, 0-6 days and 0-13 days [for population (RR= 1.05 (1.009 – 1.09); RR=1.04 (0.99 – 1.09; and RR=1.02 (0.97 – 1.08), respectively), for F31 among the group 18-70 years of age (RR=1.07 (1.02 – 1.12); RR=1.07 (1.006 – 1.13); RR=1.001 – 1.15), for group aged 18 – 40 (RR=1.07 (1.02 – 1.12); RR= 1.06 (1 – 1.13); RR=1.08 (1 – 1.16), for urban residents (RR = 1.08 (1.03 – 1.14); RR=1.07 (1.002 – 1.14); and RR=1.05 (0.98 – 1.14) per lag strata].For 0–13 days, an increase was observed especially for men (RR = 1.08 (1 – 1.18) (Table 4).

Humidity and admissions for depressive disorders did not appear to be significantly correlated to associations with weather variables (Table 4).

Linear relationships between admission and hours of sunshine are shown in Table 4. The number of hospital visits had positive correlations to hours of sunshine among populations, admissions for F32 among the group 18-70 years of age, men and the group aged 40-70 with RRs = 1.04 (1.00 – 1.07), 1.08 (1.03 – 1.14), 1.06 (1.02 – 1.11), and 1.05 (1.008 – 1.1) respectively per 1 hour increase. Moreover, cases for F32 had high risk with RR of 1.08 (1.02 – 1.15) at time lag0–1day. While, there was a slight increase in other groups with RRs= 1.02 – 1.04 (Table 4). RRs for admissions of urban residentswere large (RR = 1.06, 1.06, and 1.04per lag strata) (Table 4). All admissions had a positive relation to the indicator, especially with a lag of 0–13 days in which cases amongmen had higher RRs especially at time lags of 0–1 day and 0-13 days (RR = 1.07 (1.02 – 1.11), and RR= 1.1 (0.99 – 1.23) per lag strata).

DISCUSSION

Patients in different age groups were studied in terms of their hospital admissions for depressive disorders, and our results showed that the group aged 18–40 years accounted for the highest number of cases (351 (56.7%)). This increases the evidence supporting the assumption that depressive disorders occur much more frequently in those aged 20 to 40 years [4,5]. There werealso differences in gender patterns of hospital admissions for depressive disorders during the study period. The results indicated that the admitted number of female cases were usually greater and followed a seasonal patternin contrast to the admissions for men [4,5]. Research from Canada showedthat women were at higher risk for developing depressive symptoms, but the findings of that study suggested no gender difference in seasonality of depression [19]. We found that people living in rural areas had less seasonalityin depressive disorders than those living in urbanareas although the number of admissions for residents in rural areas was higher than these for people in

Table 4: Relative risks and confidence intervals ( ), describing the association of depressive disorders admissions and weather variables in different lag strata based on negative binominal time series regression model. All estimates are adjusted for time trends and seasonality by factor variables of month and year.

Variables	**RR (95% CI)**			
	Mean temperature (°C)			
	Mean temperature	**Lag 0-1 day**	**Lag 0-6 days**	**Lag 0-13 days**
Population	1.05* (1.01 – 1.09)	1.05* (1.009 – 1.09)	1.04 (0.99 – 1.09)	1.02 (0.97 – 1.08)
F 31 among age 18-70	1.06* (1.02 – 1.11)	1.07* (1.02 – 1.12)	1.07* (1.006 – 1.13)	1.07* (1.001 – 1.15)
F 32 among age18-70	1.06 (1 – 1.12)	1.05 (0.98 – 1.11)	1.01 (0.94 – 1.1)	0.98 (0.89 – 1.08)
Female	1.05* (1.001 – 1.09)	1.05* (1.001 – 1.1)	1.02 (0.97 – 1.09)	0.98 (0.91 – 1.05)
Male	1.06* (1.006 – 1.12)	1.05 (0.99 – 1.11)	1.05 (0.98 – 1.13)	1.08 (1 – 1.18)
Urban	1.08* (1.03 – 1.14)	1.08* (1.03 – 1.14)	1.07* (1.002 – 1.14)	1.05 (0.98 – 1.14)
Rural	1.02 (0.97 – 1.08)	1.02 (0.97 – 1.07)	1.005 (0.94 – 1.07)	0.99 (0.92 – 1.07)
Age 18-40	1.07* (1.02 – 1.12)	1.07* (1.02 – 1.12)	1.06 (1 – 1.13)	1.08 (1 – 1.16)
Age 41-70	1.05 (1 – 1.1)	1.04 (0.99 – 1.1)	1.02 (0.96 – 1.09)	0.98 (0.91 – 1.06)
Variables	**RR (95% CI)**			
	Mean humidity (%)			
	Mean humidity	**Lag 0-1 day**	**Lag 0-6 days**	**Lag 0-13 days**
Population	1.003 (1 – 1.01)	1.006 (0.99 – 1.02)	1.01 (0.99 – 1.03)	1 (0.98 – 1.02)
F 31 among age 18-70	1.007 (0.99 – 1.02)	1.01 (1 – 1.02)	1.02 (1 – 1.04)	1.008 (0.98 – 1.03)
F 32 among age 18-70	1 (0.98 – 1.02)	1.002 (0.98 – 1.02)	1.007 (0.98 – 1.04)	0.98 (0.95 – 1.02)
Female	1.002 (0.99 – 1.01)	1.005 (0.99 – 1.02)	1.02 (1 – 1.04)	1.006 (0.98 – 1.03)
Male	1.004 (0.99 – 1.02)	1.006 (0.99 – 1.02)	1.003 (0.98 – 1.03)	0.98 (0.96 – 1.01)
Urban	1.003 (0.99 – 1.02)	1.005 (0.99 – 1.02)	1.02* (1.006 – 1.05)	1.01 (0.98 – 1.04)
Rural	1.002 (0.99 – 1.02)	1.006 (0.99 – 1.02)	1.0002 (0.98 – 1.02)	0.98 (0.95 – 1.01)
Age 18-40	1.001 (0.99 – 1.01)	1.004 (0.99 – 1.02)	1.01 (0.99 – 1.04)	0.99 (0.96 – 1.02)
Age 41-70	1.008 (0.99 – 1.02)	1.01 (1 – 1.03)	1.02 (0.99 – 1.05)	1.01 (0.98 – 1.04)
Variables	**RR (95% CI)**			
	Hours of sunshine (h) per day			
	Mean sun-hour	**Lag 0-1 day**	**Lag 0-6 days**	**Lag 0-13 days**
Population	1.04* (1.007 – 1.07)	1.05* (1.01 – 1.09)	1.03 (0.98 – 1.09)	1.03 (0.95 – 1.11)
F 31 among age 18-70	1.02 (0.98 – 1.06)	1.04 (1 – 1.08)	1.04 (0.97 – 1.12)	1.06 (0.96 – 1.16)
F 32 among age 18-70	1.08* (1.03 – 1.14)	1.08* (1.02 – 1.15)	1.02 (0.93 – 1.13)	1.007 (0.88 – 1.15)
Female	1.02 (0.98 – 1.06)	1.03 (0.99 – 1.08)	1.04 (0.97 – 1.11)	0.98 (0.88 – 1.07)
Male	1.06* (1.02 – 1.11)	1.07* (1.02 – 1.13)	1.03 (0.95 – 1.12)	1.1 (0.99 – 1.23)
Urban	1.04 (1 – 1.08)	1.06* (1.02 – 1.11)	1.06 (0.99 – 1.14)	1.04 (0.94 – 1.15)
Rural	1.04 (1 – 1.08)	1.04 (0.99 – 1.09)	1.004 (0.93 – 1.08)	1.02 (0.92 – 1.13)
Age 18-40	1.04 (1 – 1.08)	1.04 (1 – 1.09)	1.03 (0.95 – 1.1)	1.07 (0.96 – 1.18)
Age 41-70	1.05* (1.008 – 1.1)	1.07* (1.02 – 1.13)	1.05 (0.97 – 1.14)	1 (0.89 – 1.12)

(*p < 0.05)

urban. This disagrees with findings instudies from New Zealand and Australia [9,11].

The result of this study showed a significant difference in the frequency of yearly cases, especially when comparing the years 2008–2009 and 2010–2012. According to doctors in the Hanoi Mental Hospital, the reason for this might be an increasingly positive perception from the community about mental health careanda significantly improved quality of treatment in the hospital. This study showeda rising trend in mental health problems in Vietnam that need to be addressed by Vietnamese health managers working to prevent and control chronic diseases.

Table 5: The averages of mean temperature and maximum temperature by years.

Year	Temperature	Mean values (°C)	Min – Max (°C)
2008	Mean-temp	23.7	7.4 – 32.3
	Max-temp	27.6	8 – 37.8
	90-95-99% percentiles of max-temp	34.4 – 35.7 – 37.1	
2009	Mean-temp	24.9	11.1 – 33.5
	Max-temp	28.8	12.6 – 38.8
	90-95-99% percentiles of max-temp	35.2 – 35.9 - 38	
2010	Mean-temp	*25*	*12.6 – 34.5*
	Max-temp	*28.9*	*14.3 – 40.4*
	90-95-99% percentiles of max-temp	*35.6 – 37.4 – 39.7*	
2011	Mean-temp	23.4	9.8 – 33.3
	Max-temp	26.9	11.2 - 39
	90-95-99% percentiles of max-temp	34.9 – 35.9 - 37	
2012	Mean-temp	24.4	9.7 – 33.4
	Max-temp	27.9	11.3 – 39.6
	90-95-99% percentiles of max-temp	35 – 36.2 – 38.5	

Mean-temp: Mean temperature Max-temp: Maximum temperature

However, a limitation of this study is the lack of adjustment for populations at risk and demographic changes that could influence the time trend estimates in the study.

In the present study, there was an increase in 4% of daily hospital admissions for depressive disorders including bipolar affective disorder and depressive episode whensunshine-hours increased a unit. Furthermore, admissions for F32 among patients 18-70 years old were impacted by hours of sunshine. When sunshine-hours increased a unit, admissions rose 8%, similarly at a time lag 0-1 day with RR=1.08 (1.02 – 1.15). Different results have been foundin other countries in regions with temperate climates because hospital cases for depressive disorders elevated for lack of sunshine-hours [2,6,11]. The risk of hospital admission appears quite high at a lag time of 0–13 days (RRs = 1.02–1.1) when the daily hours of sunshine increased. This could be due to heat-related mechanisms and interactions with heat exposure.

An increase in cases was associated with a mean temperature at time lags of0–1 day, 0–6 days, and 0–13 days. When ambient temperature increased, admissions for F31 among patients 18-70 years of age had high risks with RRs of 1.07 (1.02 – 1.12), 1.07 (1.006 – 1.13), and 1.07 (1.001 – 1.15) respectively. A study in Israel similarly concluded that increased environmental temperature may be a risk factor for patients with bipolar disorder [20]. Moreover, the risks of admissions for F31 among the group 18-70 years of age and men were elevated at a lag time of 0–13 days with RR of 1.07 (1.001 – 1.15) and 1.08 (1 – 1.18) respectively. In addition, the peak of cases among men was in August with a RR of 2.03 (1.03 – 4.03) compared to January. Increasing temperatures, as occur in the transition from winter to spring, might therefore be seen as an indicator for hospital admissions for depressive disorders in men. Future studies, however, need to be carried out to confirm this conclusion and to disentangle the mechanisms related to health-seeking behavior and physiological responses and interactions of medical treatments. There was a large increase in admitted cases when the mean temperature increased at a time lag of 0–13 days in the whole male group, residents in urban areas, and the age group 18– 40 years of age. This has been explained in terms of biological mechanisms in which the symptoms of depression occur two weeks after exposure to risk factors [5]. Moreover, men spend more time outside for occupational activities compared to women [21]. This may explain the high relative risks associated with high temperature and sunshine. Although researchers often select temperature as a main variable in the statistical methods used to explore the relation between seasonality and affective disorders, there have been no consistent neurobiological explanations for this finding [4,12,13]. Moreover, a climatic variable like geomagnetic storm had a relation with depressive disorder [22]. Further studies need to be carried out in the future to explore the effect of weather variation in depressive disorders.

The outcome of the study revealed that hospital visits for depressive disorders areindependent of relative humidity changes. This is in contrastto a study from the UK [23].However, a limitation of the study is that relative humidity is related to temperature and it can be hard to separate their independent contributions as well as to compare results from temperate and tropical regions.

Findings from previous studies on seasonality of manic episodes and bipolar affective disorder in tropical and subtropical regions indicated similar results to this study regarding thepeak in the warm periods [12,13]. There was a significant correlation in admissions to the Hanoi Mental Hospital, and the preponderance of admissions was in the warm period of late spring and early summer, and winter. A study on monthly variations of emergency psychiatric visits for mania registered in a mental hospital in Brazil's tropical climate concluded that the number of hospital records had a peak in August and February [3,12,13]. In addition, a study from Egypt reported the highest rate of hospital cases for mania in June and in December, while admissions for depression had a peak in December [12]. In India, almost all cases for mania occurred in the monsoon and winter months [3]. In contrast, European nations, with their temperate climates,have reported a preponderance of admissions for mania in summer and spring/summer [1,2,19,24]. Many studies from New Zealand and Australia also show the highest rates of admissions for mania in summer and spring [9,11,25,26]. Moreover, studies on the effects of weather variations on depressive disorders in different countries in both hemispheres revealed similar results [7]. The main findings of the study from Israel on admission rates to psychiatric hospitals indicated that during the hottest seasons of spring and summer there was an increased trend in bipolar depression. This might be evidence of a correlation between weather factors and bipolar depression [27]. In addition, Korean research indicated an association between hospital admissions and hours of sunshine and sunlight radiation but not temperature, humidity, atmospheric pressure, or rainfall [14,16]. A Brazilian study in Belo Horizonte showed that the rate of admissions for mania were associated with the hotter and more luminous times of the year [13]. Similarly, studies from New Zealand have reported significant correlations between hospital admissionsand luminosity but not humidity [9,11,25].

More recently, there has been a concern linking the periodicity of depression and hospital admissions to time-pattern variations in neurotransmitters. Serotonin plays a key role in triggering depressive disorders [5,28,29], and serotoninergic neurons projecting the suprachiasmatic nucleus of the anterior hypothalamus assist in regulating circadian rhythms such as sleep-wake cycles, body temperature, and the functions of the hypothalamic–pituitary–adrenocortical axis [5]. In animal models of depression, symptoms of weight loss, decreased sleep, and reduced exploratory behavior occur. Available evidence from research using receptor imaging techniques demonstrates that depression is clearly associated with dysfunction of the $5HT_{1A}$ receptors [17]. Considerable evidence suggests that the level of serotonin changes in a seasonal manner, and these fluctuations have been shown in levels of 5HT-associated activity in platelets [28]. Furthermore, it has been shown that low serotonin levels in humans are associated with reduced inhibition and increased activity and impulsiveness [5,27]. In addition, serotonin might be a mediator between environmental variables and depression symptoms because both light and humidity have been shown to be related to central 5HT function [26,28,29].

Our research indicated that hours of sunshine did not play a role as a protective factoragainst depression even though it is related to underlying mechanisms of serotonin activity [5,28,29]. In countries with temperate weather, sunshine has been shown to play a key role in mood disorders such as depression, but this has been less of a concern in tropical countries [2,14,25]. The absence of the relationship in this study population might be due to the tropical location of the study areas with less seasonal variability in sunshine hours compared to countries with temperate climates.

CONCLUSION

This study has demonstrated contrasting seasonality of depressive disorders between population subgroups, and there was an especially large gender difference with significantly more womenbeing admitted for depressive disorders, but with more men visiting hospital for depressive disorder in periods of hot weather. This study has also identified significant associations between weather variability and depressive disorders supporting increased rates of admission in particularly lag 0-1 following elevated temperatures. It also demonstrated bi-annual seasonal peaks of the disease occurring in summer and autumn. The research results are formative and could pave way for future studies in the entire nation aimed at exploring the effects of climate and weather on psychopathological disorders among patients.

LIMITATIONS OF THE STUDY

The study used hospital registry data from one psychiatric hospital in northern Vietnam. It is not possible to generalize the results nationwide because Vietnam has different areas with distinctly specific weather patterns. Moreover, a questionnaire specific to seasonal affective disorder (the criteria defined by the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV)) was not used to diagnose cases and instead all admissions were diagnosed by ICD 10 criteria. It is essential to carry out more studies in the future using sufficient information to set up a model including environment, personal traits, and socioeconomics together with admissions for mental health disorders. A further limitation of the study was the small number of observations that reduced the power of the statistical tests.

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