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RESEARCH ARTICLE

The impact of meteorological factors on involuntary admission in Attica, Greece

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---------- **ABSTRACT** ----------

Few studies in the literature have examined the effect of meteorological factors, especially temperature, on psychiatric hospitalization and even less on their association with involuntary admission. This study aimed to investigate the potential association of meteorological factors with the involuntary psychiatric hospitalization in the region of Attica, Greece. The research was conducted at the Psychiatric Hospital of Attica "Dafni". This was a retrospective time series study of 8 consecutive years of data (2010 to 2017) and included 6887 involuntarily hospitalized patients. Data on daily meteorological parameters were provided from the National Observatory of Athens. Statistical analysis was based on Poisson or negative binomial regression models with adjusted standard errors. Analyses were initially based on univariable models for each meteorological factor separately. All meteorological factors were taken into account through factor analysis and then, through cluster analysis, an objective grouping of days with similar weather type was performed. The resulting types of days were examined for their effect on the daily number of involuntary hospitalizations. Increases in maximum temperature, in average wind speed and in minimum atmospheric pressure values were associated with an increase in the average number of involuntary hospitalizations per day. Increase of the maximum temperature above 23 °C at lag 6 days before admission did not affect significantly the frequency of involuntary hospitalizations. Low temperature and average relative humidity above 60% levels had a protective effect. The predominant day type at lag 1 to 5 days before admission showed the strongest correlation with the daily number of involuntary hospitalizations. The cold season day type, with lower temperatures and a small diurnal temperature range, northerly winds of moderate speed, high atmospheric pressure and almost no precipitation, was associated with the lowest frequency of involuntary hospitalizations, whereas the warm season day type, with low daily temperature and small daily temperature range during the warm season, high values of relative humidity and daily precipitation, moderate wind speed/gust and atmospheric pressure, was associated with the

highest. As climate change increases the frequency of extreme weather events, it is necessary to develop a different organizational and administrative culture of mental health services.

KEYWORDS: Meteorological factors, weather variables, mental health, mental illness, psychiatric admissions, involuntary admissions.

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Introduction

Hippocrates at his treatise "About Wind, Water and Places", mentions that whoever would study medicine aright must learn of two important subjects. One of these is the warm and the cold winds, both of which are common to every country and peculiar to a particular locality.[1] More recently, the terms "meteoropathy" and "meteorosensitivity" are being increasingly used: meteoropathic people develop a specific disorder (group of symptoms and pathological reactions) or display worsening symptoms of an existing disease, resulting from the impact of climatic factors in a certain area; meteorosensitive persons are "biologically susceptible to feel the effect of particular atmospherical events on mind and body".[2]

The health impacts of weather exposure, particularly of temperature and humidity, have been of interest for centuries. There is a positive association between specific meteorological factors and calls to emergency services,[3] emergency department visits[4,5] and hospital admission outcomes.[6,7]

As regards the association between particular climatic factors and mental health, studies have demonstrated significant positive correlations with outpatients' visits for general psychiatric and psycho-consultation services,[8] evaluations in the psychiatric emergency department[9,10] and psychiatric hospital admissions.[11,12]

Mental health involuntary admissions in Greece are regulated by Law 2071/1992. The person is examined by two psychiatrists who are on call in a Psychiatric Emergency Department, in order to undergo a psychiatric evaluation. One of the following requirements must be met before a patient can be involuntarily admitted: i. the individual must suffer from a mental disorder, unable to judge what is best for his/her health whereas lack of hospitalization will deprive him/her of the treatment needed for his/her condition, or ii. the hospitalization of a patient suffering from mental disorder is necessary in order to prevent acts of violence against himself or others.[13] If at least one of these conditions met, psychiatrists complete the medical report which is then sent by the police to the public prosecutor's office, where the order for involuntary admission is issued.

In this study, we aimed to investigate the influences of weather exposures on involuntary mental health admissions in Attica, Greece, using administrative data of the Psychiatric Hospital of Attica "Dafni" and to enlighten which meteorological parameters, individually or in combination, seem to be involved in exacerbating the psychopathology of involuntary admitted patients.

Methods

Study area

Study was conducted in Psychiatric Hospital "Dafni" in Attica region, Greece. Attica is located in the southern mainland of Greece, between 37°39' N and 38°20' N and between 23°07' E and 24°05' E. Generally, the climate of the area is characterized by long dry and short wet periods.[14] Psychiatric Hospital of Attica "Dafni" is the largest psychiatric hospital in Greece, receiving annually the largest number of involuntary hospitalization[15] from all over the

country, as hospital's services are not sectorized.[16]

Procedure

The research proposal of the study was formally approved by the Hospital Board and the Ethics Committee of the Hospital. Patient's demographic data and diagnoses were retrieved from hospital's electronic registry. Data were anonymised before being included in the study's database and any member who took part in this procedure had no access to individuals' personal data.

Research design

This is a retrospective study of 8 years' (2922 days) time series data (from January 1st 2010 to December 31st 2017) on the daily numbers of involuntarily hospitalized patients. Data points correspond to days the hospital was on duty (882 days).

Meteorological data

Values of daily meteorological parameters were provided by eight meteorological stations of the National Observatory of Athens (NOA)[17] and included temperature (°C), precipitation (mm), relative humidity (%), dew point (°C), atmospheric pressure (hPa), chill and heat index (°C),[18] along with wind speed (Km/hr), wind gust (Km/hr) and dominant wind direction (N, S, E, W).

Meteorological data at the regional unit of residence level and during the day of hospitalization were available for 5578 (81.1%) cases whereas for the remaining 1299 (18.9%) cases, meteorological data were available only from other regional units (at least three) of the Peripheral Unit of Attica. In general, meteorological data for every day of the study period were available from meteorological stations in the regional units of East Attica (Lavrio), North Athens (Psyhiko) and Central Athens (Athens). For the remaining regional units of West Attica (Aspropyrgos), West Athens (Ano Liosia), South Athens (Nea Smyrni), Islands of Attica (Spetses) and Piraeus (Korydallos), daily meteorological data were available from 1/1/2015, 18/6/2011, 21/2/2012, 12/6/2012 and 18/12/2014, respectively, until the end of the study period (31/12/2017).

Participants

During the study period, 6877 participants, residents of the Region of Attica, were examined and involuntarily hospitalized in the Psychiatric Hospital of Attica "Dafni" with a mental disorder diagnosis. Patients aged less than 18 years old and those with insufficient information on their residence (e.g. homeless, unknown of residence, migrants and refugees) were excluded from the study (n=3302). Discharge diagnosis was assigned by the psychiatrist responsible for the care of the patient, using the ICD-10 criteria. The ICD10 codes of the diagnoses included in the study were: F00-F09, F10, F11-F19, F20-F29, F30-F39, F40-F48, F50-F59, F60-F69, F70-F79, F80-F89, G90-G99.

Statistical analysis

Categorical variables are summarized through their absolute (N) and relative (%) frequencies while for continuous ones mean and standard deviations (SD) are used unless their distribution was deviating from normality in which case medians and interquartile ranges (IQR) are used.

Associations between daily number of hospitalization and meteorological parameters were investigated using Poisson regression or negative binomial regression (in case of significant overdispersion) models. In all cases robust standard errors were used to adjust them for potential violations of models' assumptions.

Initial univariable analyses were performed using grouped data at the day and regional unit of residence level thus the logarithm of the total population of each regional unit (based on the 2011 National Census) was used as an offset term. Nonlinear effects of meteorological parameters were allowed in these models through the use of natural cubic splines with 3 knots but for some crude assessment of the strength of the associations, linear versions of the same models were also fitted. Delayed effects of meteorological parameters on the incidence of involuntary hospitalizations were also investigated by using lagged values of these parameters or averages over consecutive lagged values. Each meteorological parameter entered as current day value, lagged value (best lag model shown) or average of lagged values (±1, ±2, or ±3 days around best lag value; shown only if better than best lag model). Optimal lag values were chosen based on the Akaike Information Criterion (AIC). AIC is an estimator of the relative quality of comparable statistical models and is often used for model selection. That is, the model with the lowest AIC value is considered as having the optimal trade-off between goodness of fit and complexity.

Grouping of all days of the study period into a small number of different types with similar weather conditions included the following steps: a) averaging meteorological parameters' values across all meteorological stations b) performing a factor analysis to construct orthogonal factors and reduce the number of parameters for the analysis c) choosing the optimal number of clusters and d) performing a cluster analysis to assign each study day to a specific day type. Steps b, c and d above were performed separately for the cold (16/10 to 15/4, 1458 days) and warm (16/4 to 15/10, 1464 days) period of the year.

Factor analysis was based on the method of principal components and a varimax orthogonal rotation, after verifying the suitability of the data for such an analysis using Bartlett's test for sphericity and Kaiser-Meyer-Olkin Measure of Sampling Adequacy.[19] The minimum eigenvalue used to choose the number of factors was set to 0.75 instead of the typical value of 1 to maximize the percentage of explained variation (i.e., achieve values >90%). The choice of the optimal number of clusters was based on the results from three different methods: a) "Jump" method,[20] b) "Slopes" method[21] and c) "Gaps" method.[22] Cluster analysis was based on the "Kmeans" method which maximizes the Euclidean distance between clusters.[23]

P-values less than 0.05 were considered as indicating statistical significance. All analyses were performed using Stata version 14 and R version 4.2.1.

Results

Characteristics of study participants are summarized overall and by availability of meteorological data at the regional unit of residence level in Table 1.

As shown in Supplementary Table 1, lowest (i.e., better) AIC values were found for mean wind speed and atmospheric pressure and highest % relative changes for relative humidity and temperature. Assuming linear effects, associations of daily number of involuntary hospitalizations with temperature and atmospheric pressure were positive while those with relative humidity and wind speed were negative.

Results from selected univariable models using cubic splines for some selected meteorological parameters' effects are shown in Figure 1 for exploratory and illustrative purposes. The choice of the models included for presentation in Figure 1 is based on the optimal AIC value within each set of temperature, relative humidity, atmospheric pressure and wind speed related parameters (see also Supplementary Table 1). As shown in Figure 1a, increase of the maximum temperature from 0 °C to 23 °C is associated with a clear increase in the average number of involuntary hospitalizations per day whereas further increase of the maximum temperature does not seem to affect the frequency of involuntary hospitalizations significantly. Mean relative humidity (Figure 1b) seem to have a protective effect but only for

values over 60%. Minimum atmospheric pressure (Figure 1c) seems to have an inverted U-shaped association with the frequency of involuntary hospitalizations, with the highest values corresponding to the 1010 to 1020 hPa range. Finally, increases in mean wind speed (Figure 1d) from 0 to approximately 7 km/h seem to increase the frequency of involuntary hospitalizations but further increases seem to be associated with a strong protective effect. It is also noteworthy that the best fitting models were found for lagged values of the examined meteorological parameters ranging from 2 days before the hospitalization day (for mean relative humidity) to 12-14 days before the hospitalization day (for minimum atmospheric pressure).

In any case, the aforementioned univariable associations should be interpreted with caution as meteorological parameters are more or less correlated with each other. Meteorological data are summarized separately for the cold and hot periods of the year in Table 2. Details of the distribution of meteorological parameters by day type are given in Supplementary Table 2. Figure 2, summarizes the main meteorological characteristics of each day type in the cold and hot periods of the year.

Using the type of day as a predictor for the daily number of involuntary hospitalizations we found that the most prevalent day type during the previous 5 days was associated with the best AIC values. Modelling results suggested the presence of significant overdispersion thus a negative binomial regression model was preferred instead of a Poisson one. Results of this model (Supplementary Table 3) revealed that day type C2, in the cold period, was associated with the lowest frequency of involuntary hospitalizations. C2 is characterized by the lowest temperatures with low range between minimum and maximum, northern winds of moderate intensity, high atmospheric pressure and almost no rainfall. In the cold period, day types C4, C5 and C6 were associated with statistically significantly more involuntary hospitalizations (estimated relative increases, compared to day type C2, 19% to 21%). In the warm period, day types H2 to H6 were all associated with increased frequency of involuntary hospitalizations compared to day type C2 (estimated relative increases 19% to 39%).

The day type associated with the highest frequency of involuntary hospitalizations was H5 (Incidence Rate Ratio-IRR vs. C2: 1.39; 95% CI 1.17-1.66; $p<0.001$). It is noteworthy that the H5 day type had the 2nd lowest average daily mean temperature (21.2 °C) during the warm period but also the lowest range between minimum and maximum daily temperatures (average 5.8 °C). At the same time, H5 is associated with the highest values of relative humidity and daily rainfall and moderate wind speed/gust and atmospheric pressure.

Estimated IRRs with the corresponding 95% CIs from the final negative binomial regression model are shown graphically in Figure 3.

Discussion

This study has used an eight-year dataset of 6877 involuntary admitted patients, in order to explore the association with climatic factors in Attica, Greece.

Our results from univariable analyses indicated that increase of the maximum temperature from 0 °C to 23 °C associated with a clear increase in the average number of involuntary hospitalizations. Findings from a survey in Italy, showed that temperature (maximum and medium) significantly correlated with involuntary admission.[24] Another study from Greece, mentioned that increasing major psychiatric diseases total admissions are associated with increasing temperature.[25] Researchers from Switzerland found that the hospitalization risk increased linearly by 4.0% for every 10 °C increase in mean daily temperature.[26] Evidence from a research in USA showed that higher temperature (high, low, and average) was significantly correlated with the number of emergency psychiatric evaluations.[27]

Our study's statistical analyses showed mainly negative association of daily number of involuntary hospitalizations with relative humidity. On the opposite, research findings from Italy showed that humidex index significantly associated with involuntary admission,[24] while in a Brazilian study relative humidity did not present any risk for total mental health admissions.[28]

Study's evidence, that low temperatures might be a protective factor for involuntary admission, strength the results of previous studies from Berlin and Lisbon for total psychiatric evaluations[9] and admissions,[29] on the contrary research evidence from a study in Shanghai found no effect of cold weather on mental health hospital admissions.[30]

Although our findings from the univariable analyses showed that further increase of the maximum temperature above 23 °C at lag 6 days before admission did not seem to significantly affect the frequency of involuntary hospitalizations, other studies from Portugal (27 °C, lag 0–1 and lag 0–2),[29] China (24.6 °C, lag 0–1),[30] and Hong Kong (28 °C, lag 0–2)[31] indicated a significant positive association between high daily temperature and total psychiatric hospitalizations.

The statistical analysis showed that the minimum atmospheric pressure (lag 12-14) and the mean wind speed from 0 to approximately 7 km/h (lag 5-11) increased the frequency of involuntary hospitalizations, whereas further increase of the wind speed appeared to have a strong protective effect. This evidence is quite similar with the results from a study in Germany, indicated that low pressure and windiness predicted the number of emergency psychiatric evaluations for up to 7 days, although no protective effect of increased wind speed was reported.[9]

The predominant day type during the last five days before admission showed the strongest correlation with the daily number of involuntary hospitalization. The C2 day type of cold season, characterized by the lowest temperatures, was associated with the lowest frequency of involuntary hospitalizations. On the other hand, the H5 day type of warm season, characterized by relatively low average daily mean temperature and the lowest range between minimum and maximum daily temperatures, was associated with the highest frequency of involuntary admissions. A study from Sweden underlined that temperature associated with increase in emergency psychiatric visits during the warm (14% at lag 0–3 and 22% for lags 0–14, statistically significant) and cold (25% and 18% at lags 0–14 and 0–21 respectively, not statistically significant) season.[32]

Seasonal, biological, psychological, and social factors are implicated in the causation of mental health disorders.[33] Season may increase the risk of psychiatric patients hospitalizations,[34] especially for manic[35,36] and schizophrenia episodes.[37,38] As our study coincided with the Greek financial crisis, available researches worldwide indicated that consequences of economic crisis increased the risk of exposure to weather variations,[6] caused a negative impact on mental health[39] and might be associated with higher rates of admissions in psychiatric hospitals.[40]

As we mentioned above, one of the criteria of involuntary admission in Greece is dangerousness.[13] Involuntarily admitted patients commonly present dangerous behaviours,[41] meteorological factors are associated with increase of acts of violence and emergency psychiatric visits[42] and hospitalizations.[43] Therefore, dangerousness and acts of violence and their positive correlation with meteorological factors are likely to be an independent parameter that significantly influences the association of involuntary hospitalization with these factors.

Modern people live in closed and air-conditioned spaces, which reduce body's self-regulation mechanisms and natural adaptation ability to respond to different environmental conditions and sudden weather changes.[44] Various climatic parameters could affect biological mechanisms, which are associated to the pathophysiology of mental health, such as dysfunction of synaptic neurotransmission,[45] elevations of extracellular serotonin in the

hypothalamus,[46] changes of serotonin precursor L-tryptophan concentration in plasma[47] and platelet serotonin.[29]

Recent studies reported that extreme temperature and precipitation had a significant effect on mental health hospitalization.[48,49] As the increasing frequency of extreme events caused by global climate change has made floods, droughts, and heat waves more likely,[50] we should pay more attention to the development of a different scientific, professional and operational culture in the management of mental health services.

Strengths and limitations

The strengths of the present study include its longitudinal design, based on an eight-year retrospective time series study with a large number of involuntary admissions and meteorological parameters. To the best of our knowledge, the current study is one of the fewest worldwide investigating the relationship between meteorological factors and involuntary admissions.

One main limitation is the ecological fallacy due to the design of the study. We regarded all admissions as discrete episodes and a patient could potentially be counted more than once. All data obtained was for patients requiring involuntary hospitalization and the impact of meteorological factors may differ from those who are voluntary admitted. Factors could contribute to the onset of an acute psychiatric episode have not been taken into consideration.

Conclusions

The findings of this study underline that certain meteorological factors as well as specific types of weather affect the frequency of involuntary hospitalizations.

There are positive associations of daily number of involuntary admissions with temperature and atmospheric pressure and negative with relative humidity and wind speed are negative. Low temperatures might be a protective factor, while further increase of the maximum temperature above 23 °C (at lag 6 days) does not affect significantly the frequency of involuntary hospitalizations. Minimum atmospheric pressure (at lag 12-14 days) and mean wind speed from 0 to 7 km/h (at lag 5-11 days) increase the frequency of involuntary hospitalizations, further increases of wind speed have a strong protective effect. The lowest frequency of involuntary hospitalizations were noticed on C2 day type (low temperatures and low range between minimum and maximum temperature, northern winds of moderate intensity, high atmospheric pressure and almost no rainfall) of the cold season, whereas the highest frequency on H5 day type (lowest average and range of daily mean temperature during the warm season and the daily highest values of relative humidity, rainfall and moderate wind speed/gust and atmospheric pressure) of the warm season (both at lags 1 to 5 days).

Further studies should be carried out in the future, including diagnostic and sociodemographic characteristics, in order to clarify the impact of meteorological parameters on involuntary admitted patients and investigate the possible causative factors.

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Table 1. Demographic and clinical characteristics of study participants by availability of regional unit of residence specific meteorological data.

Variable	Unavailable	Available	Overall	p-value
	n=1299 (18.89%)	*n=5578 (81.11%)*	*N=6877 (100%)*	
Sex				0.018
– *Male*	828 (63.74%)	*3357 (60.18%)*	*4185 (60.86%)*	
– *Female*	471 (36.26%)	*2221 (39.82%)*	*2692 (39.14%)*	
Age (years) - *Median (IQR*)*	*43.8 (34.4, 53.8)*	*45.6 (35.6, 55.8)*	*45.3 (35.4, 55.3)*	<0.001
Diagnosis (ICD10)				0.130
– *F00-F09*	45 (3.46%)	264 (4.73%)	309 (4.49%)	
– *F10*	46 (3.54%)	147 (2.64%)	193 (2.81%)	
– *F11-F19*	88 (6.77%)	345 (6.19%)	433 (6.30%)	
– *F20-F29*	834 (64.20%)	*3537 (63.41%)*	*4371 (63.56%)*	
– *F30-F39*	224 (17.24%)	935 (16.76%)	*1159 (16.85%)*	
– *F40-F48*	2 (0.15%)	11 (0.20%)	13 (0.19%)	
– *F50-F59*	0 (0.00%)	4 (0.07%)	4 (0.06%)	
– *F60-F69*	23 (1.77%)	127 (2.28%)	150 (2.18%)	
– *F70-F79*	25 (1.92%)	101 (1.81%)	126 (1.83%)	
– *F80-F89*	1 (0.08%)	16 (0.29%)	17 (0.25%)	
– *G90-G99*	2 (0.15%)	14 (0.25%)	16 (0.23%)	
– *Other*	9 (0.69%)	77 (1.38%)	86 (1.25%)	
Regional unit of residence				<0.001
– *East Attica*	0 (0.00%)	619 (11.10%)	619 (9.00%)	
– *North Athens*	0 (0.00%)	691 (12.39%)	691 (10.05%)	
– *West Attica*	179 (13.78%)	145 (2.60%)	324 (4.71%)	
– *West Athens*	222 (17.09%)	902 (16.17%)	*1124 (16.34%)*	

– *Central Athens*	0 (0.00%)	2045 (36.66%)	*2045 (29.74%)*
– *South Athens*	208 (16.01%)	682 (12.23%)	*890 (12.94%)*
– *Islands*	58 (4.46%)	101 (1.81%)	159 (2.31%)
– *Piraeus*	632 (48.65%)	393 (7.05%)	*1025 (14.90%)*

*: Interquartile range

Table 2. Distribution of meteorological parameters by cold and warm period of year.

Variable	Cold	Warm
	n=433 (49.09%)	*n=449 (50.91%)*
Average temperature (°C)	13.4 (3.0, 25.2)	24.7 (13.1, 34.0)
Maximum temperature (°C)	16.4 (4.5, 28.0)	28.5 (14.4, 40.8)
Minimum temperature (°C)	10.4 (0.2, 23.1)	21.1 (9.4, 29.6)
Average heat index (°C)	29.0 (28.4, 29.5)	29.2 (27.1, 33.5)
Maximum heat index (°C)	29.6 (28.9, 30.4)	30.6 (27.1, 39.0)
Minimum heat index (°C)	28.2 (28.0, 28.5)	28.0 (27.1, 29.7)
Average wind chill factor (°C)	7.1 (0.2, 9.6)	8.1 (8.1, 8.1)
Maximum wind chill factor (°C)	8.1 (2.1, 9.7)	8.1 (8.1, 8.1)
Minimum wind chill factor (°C)	6.3 (-3.0, 9.6)	8.1 (8.1, 8.1)
Average relative humidity (%)	70.4 (36.9, 89.5)	55.0 (30.2, 88.6)
Maximum relative humidity (%)	82.1 (50.1, 93.7)	69.3 (40.0, 93.9)
Minimum relative humidity (%)	57.2 (26.6, 80.9)	41.3 (19.0, 85.4)
Average dew point (°C)	7.8 (-5.0, 19.5)	14.4 (2.3, 21.7)
Maximum dew point (°C)	9.8 (0.0, 21.2)	16.7 (4.9, 23.8)
Minimum dew point (°C)	5.7 (-8.0, 17.0)	11.9 (-2.5, 19.2)
Average atmospheric pressure (hPa)	1017 (992, 1033)	1012 (993, 1026)
Maximum atmospheric pressure (hPa)	1019 (1002, 1036)	1013 (1003, 1027)

Minimum atmospheric pressure (hPa)	1014 (985, 1032)	1011 (984, 1024)
Daily rainfall (mm)	2.2 (0.0, 68.1)	0.4 (0.0, 20.5)
Average wind speed (Km/hr)	6.5 (0.4, 19.0)	6.8 (1.6, 16.6)
Maximum Wind Gust (Km/hr)	13.1 (1.8, 28.0)	13.7 (5.8, 29.8)
Dominant wind direction		
– *N*	1 (0.23%)	3 (0.67%)
– *NNE*	32 (7.39%)	38 (8.46%)
– *NE*	6 (1.39%)	4 (0.89%)
– *ENE*	24 (5.54%)	20 (4.45%)
– *E*	36 (8.31%)	35 (7.80%)
– *ESE*	38 (8.78%)	42 (9.35%)
– *SE*	50 (11.55%)	71 (15.81%)
– *SSE*	59 (13.63%)	79 (17.59%)
– *S*	61 (14.09%)	63 (14.03%)
– *SSW*	50 (11.55%)	43 (9.58%)
– *SW*	30 (6.93%)	20 (4.45%)
– *WSW*	22 (5.08%)	13 (2.90%)
– *W*	13 (3.00%)	15 (3.34%)
– *WNW*	11 (2.54%)	3 (0.67%)

*Cold period 16/10 to 15/4, Warm period 16/4 to 15/10.

*All values are averaged over regional units. Data refer to days with at least one involuntary hospitalization. All figures are mean (min-max).

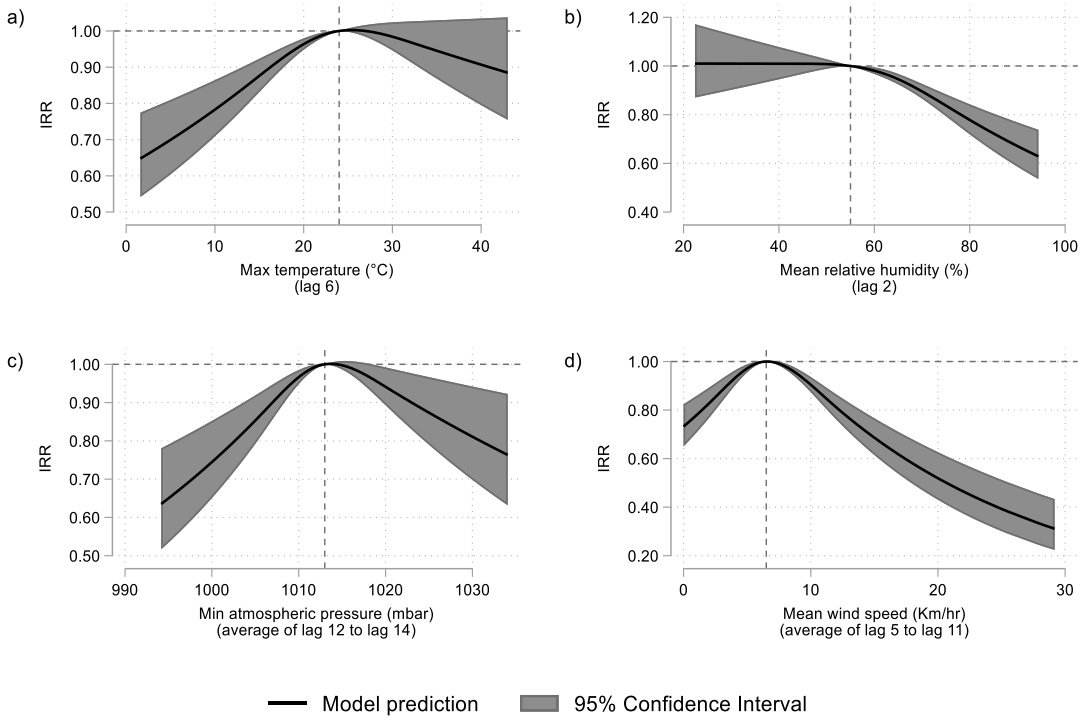

Figure 1. Estimated (95% CI) Incidence Rate Ratios (IRR) for involuntary hospitalizations by a) max temperature, b) mean relative humidity, c) min atmospheric pressure and d) mean wind speed. Reference values for IRR denoted with vertical dashed line (temperature 23°C, relative humidity 55%, atmospheric pressure 1013 hPa, mean wind speed 6.5 Km/hr). Estimates based on univariable Poisson models. Results shown for lagged values or average of lagged values associated with optimal AIC values.

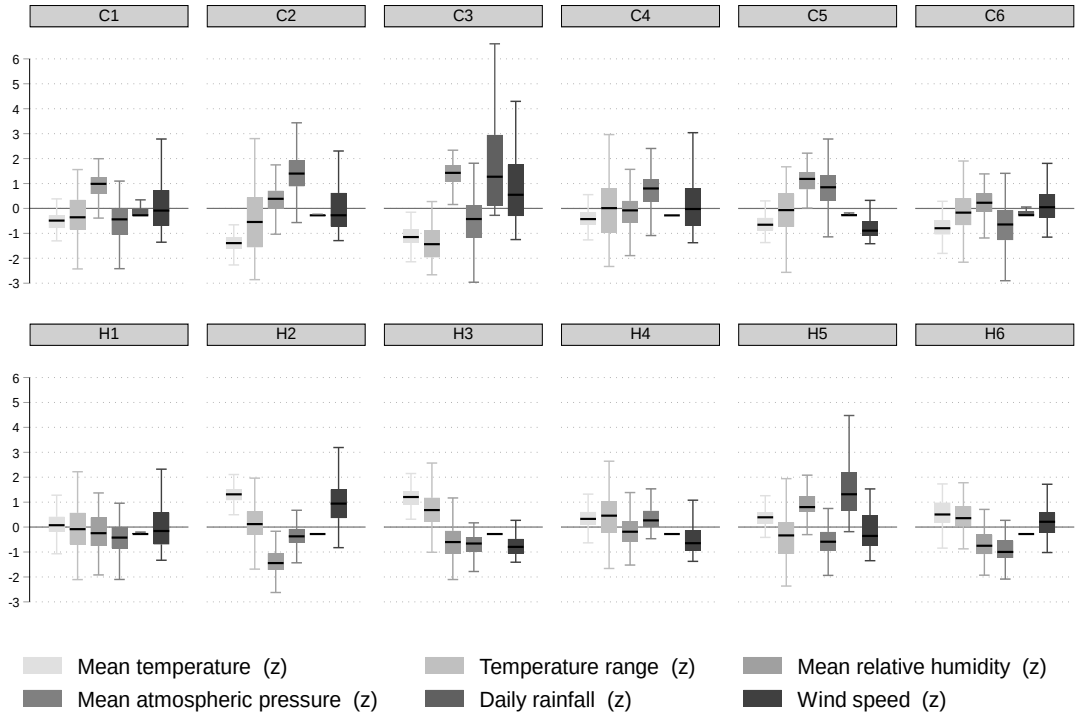

Figure 2. Distribution (box-plots) of selected meteorological parameters by day type. All values are standardized (i.e., z-values: difference with mean divided by standard deviation). Day types C1 to C6 refer to the cold period (16/10 to 15/4) and H1 to H6 to the warm period (16/4 to 15/10).

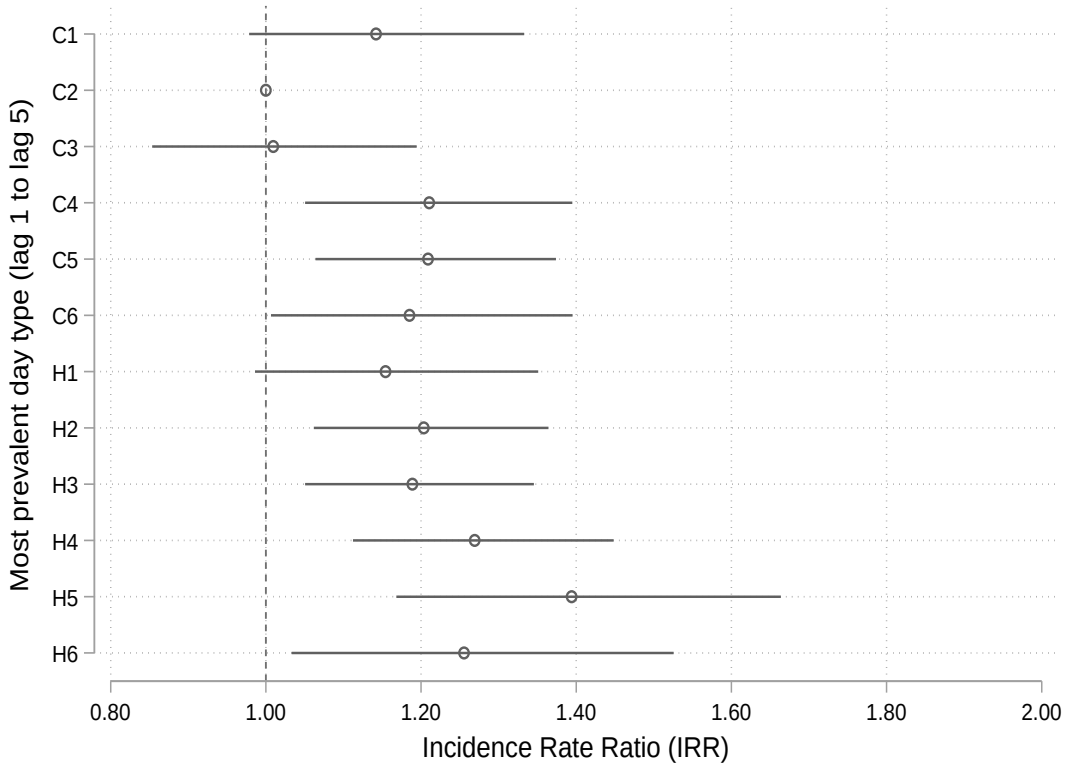

Figure 3. Results from a negative binomial regression model for the daily number of involuntary hospitalizations by type of day (most prevalent day type during the previous 5 days). Day types C1 to C6 refer to the cold period (16/10 to 15/4) and H1 to H6 to the warm period (16/4 to 15/10).

ΕΡΕΥΝΗΤΙΚΗ ΕΡΓΑΣΙΑ

Η επίδραση των μετεωρολογικών παραγόντων στην ακούσια νοσηλεία στην Αττική, Ελλάδα

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---------- **ΠΕΡΙΛΗΨΗ** ----------

Μελέτες έχουν δείξει τη συσχέτιση συγκεκριμένων μετεωρολογικών παραμέτρων με την θνησιμότητα και τις σωματικές ασθένειες, λιγότερα στοιχεία υπάρχουν για την συσχέτισή τους με τις ψυχικές διαταραχές. Σκοπός της παρούσας μελέτης είναι να διερευνήσει πιθανή συσχέτιση των μετεωρολογικών παραγόντων με την ακούσια νοσηλεία. Η έρευνα διεξήχθη στο Ψυχιατρικό Νοσοκομείο Αττικής «Δαφνί». Πρόκειται για αναδρομική μελέτη χρονοσειράς δεδομένων 8 συναπτών ετών (2010 έως 2017) και περιλαμβάνει 6887 ακουσίως νοσηλευόμενα περιστατικά. Οι τιμές των ημερήσιων μετεωρολογικών παραμέτρων προέρχονται από το Εθνικό Αστεροσκοπείο Αθηνών. Η στατιστική ανάλυση βασίστηκε σε μοντέλα Poisson ή αρνητικής διωνυμικής παλινδρόμησης με διορθωμένα τυπικά σφάλματα. Οι αναλύσεις βασίστηκαν αρχικά σε μονοπαραγοντικά μοντέλα για κάθε μετεωρολογικό παράγοντα χωριστά. Όλοι οι μετεωρολογικοί παράγοντες ελήφθησαν υπόψη μέσω παραγοντικής ανάλυσης και μέσω ανάλυσης κατά συστάδες έγινε αντικειμενική ομαδοποίηση ημερών με παραπλήσιο τύπο καιρού. Οι τύποι ημερών που προέκυψαν εξετάστηκαν ως προς την επίδραση τους στον ημερήσιο αριθμό νοσηλειών. Αύξηση της μέγιστης θερμοκρασίας από τους 0 εως 23 °C, αυξήσεις της μέσης ταχύτητας ανέμου από 0 έως 7 Km/h και τιμές της ελάχιστης ατμοσφαιρικής πίεσης μεταξύ 1010-1020 hPa, συνδέονται με αύξηση του μέσου αριθμού νοσηλειών ανά ημέρα. Αύξηση της μέγιστης θερμοκρασίας πάνω από 23 °C, με βέλτιστη περίοδο υστέρησης εμφάνισης 6 ημέρες πριν την εισαγωγή, δεν επηρεάζει σημαντικά την συχνότητα των νοσηλειών. Η χαμηλή θερμοκρασία

και η μέση σχετική υγρασία υψηλότερη από 60%, έχουν προστατευτική επίδραση. Ο επικρατέστερος τύπος ημέρας εμφάνισε την εντονότερη συσχέτιση επίδρασης με τον ημερήσιο αριθμό νοσηλειών, 1 εως 5 ημέρες πριν την νοσηλεία. Ο τύπος ημέρας της ψυχρής περιόδου, με χαμηλότερες θερμοκρασίες, μικρό ημερήσιο θερμοκρασιακό εύρος, βόρειους ανέμους μέτριας ταχύτητας, υψηλή ατμοσφαιρική πίεση και ελάχιστη βροχόπτωση, σχετίζεται με χαμηλότερη συχνότητα νοσηλειών, ενώ αντιθέτως ο τύπος ημέρας της θερμής περιόδου, με χαμηλή ημερήσια θερμοκρασία και μικρό ημερήσιο θερμοκρασιακό εύρος κατά την διάρκεια της θερμής περιόδου, υψηλές τιμές σχετικής υγρασίας και ημερήσιας βροχόπτωσης, μέτρια ταχύτητα/ριπή ανέμου και ατμοσφαιρικής πίεσης, σχετίζεται με υψηλότερη. Καθώς η κλιματική αλλαγή έχει αυξήσει την συχνότητα ακραίων μετεωρολογικών φαινομένων, είναι αναγκαία η ανάπτυξη διαφορετικής οργανωτικής και διοικητικής κουλτούρας των υπηρεσιών ψυχικής υγείας.

ΛΕΞΕΙΣ ΕΥΡΕΤΗΡΙΟΥ: Μετεωρολογικοί παράγοντες, καιρικές μεταβλητές, ψυχική υγεία, ψυχική ασθένεια, ψυχιατρικές εισαγωγές, ακούσιες νοσηλείες.

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