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Research

(Summer) Time for murder: Is there a link between increased temperature and homicides?

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Abstract

A number of studies investigating the link between weather and homicides indicate that weather has an effect on the occurrence of murder. These studies argue that the weather and its changes can act as stressors, especially for individuals who are highly sensitive to stress and thus the weather can have both physiological and psychological effects on human behaviour. The aim of the present study is to examine the relationship between temperature (daily Tmean and Tmax) and the incidents of homicides in Central and Northern Greece. A total of 137 homicides were registered in the investigated area between 1995 and 2004. The results revealed that more than 30% of the registered homicides occurred on a day with a Tmean> 25° C and that about 45% of the registered homicides occurred on a day with a Tmax> 25° C while half of them were committed with a Tmax> 30° C. The results showed a higher correlation of the number of homicides with Tmax than with Tmin. Our findings are in accordance with other studies, which showed an association between crime and increased temperature, as well as with theories of criminality, according to which negative affect and violent acts increase as temperature rise.

Keywords: Homicides, temperature, summer, environment, mental health

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Introduction

A comparison between Greece and other European countries, as well as the US, revealed similar decreasing trends in the number of homicides **[1].** According to the statistics of the Greek Police (www.astynomia.gr), in 2015 there was a 18% decrease of the reported homicides compared to 2014. More precisely, 86 homicide cases were recorded, out of which 16 were motivated by robbery. In addition, there were 169 homicide attempts, compared to 155 recorded in 2014 (increase of 9.03% in attempts). In 2016, further decrease in homicide cases was recorded by the Greek police (www.astynomia.gr) compared to 2015. There were 81 cases of homicides, out of which 9 were motivated by robbery and 132 homicide attempts were recorded (21,9% less than in 2015). The statistical data may not be entirely accurate and despite the technological progress (use of new statistical programs, full computerization in the work of authorities, electronic interconnection between authorities), there is still insufficient evidence with respect to crimes and perpetrators. Crime trends depend on the coverage and reports of authorities, measurement rules, redrafting of criminal provisions and criminalization and decriminalization of behaviour**.** Besides, the overall downward trend in the number of crimes against life in recent years in Greece is only one aspect of the criminality phenomenon, compared to intentional manslaughter, where the is a general trend upward trend **[2]**.

Among the factors that affect the incidence of homicides, weather is of particular interest, due to the observed association between crime and temperature. Most homicides take place between 30° North to 30° South latitudes, and therefore in the warmest regions of the world **[3].** Crime maps in the US presenting the amount of violent crime per capita by state confirm that in general the South is particularly violent with regards to murder, aggravated assault and property crimes, in contrast to the North **[4].** A number of studies investigating the link between weather and homicides indicate that weather has an effect on the occurrence of murder. These studies argue that the weather and its changes can act as stressors, especially for individuals highly sensitive to stress. Thus, the weather can have both physiological and psychological effects on human behaviour **[3]**. According to Gary Becker's **[5]** ***Canonical Model of Crime***, individuals act in a rational way even when committing criminal acts, since they calculate costs and benefits. The benefits of their actions have to outweigh the costs, in order to be carried out. Therefore, the weather can be a predictor of crime, since it has an impact on its successful completion, as well as on the probability of being sanctioned afterwards **[6].** According to the S***ocial Interaction Theory of Crime***, the commitment of a deviant act is influenced by social interactions taking place on a daily basis **[7, 8].** Taken a step further, the conditions under which social interactions take place (e.g. weather) could lead to an increased crime rate. Anderson et al. (1995) **[9]** postulate in their ***General Affective Aggression Model*** that a person's arousal, state of affect and cognitions are determined by various personal and situational variables. In this model, temperature predicts violence in a steady and linear relationship **[4].** The **Routine Activity Theory** of Cohen and Felson (1979) **[10]** states that a crime occurs if a suitable target is available, there is no guardian to prevent the crime and there is a motivated offender. According to this theory, during the warmer months people leave their homes to travel to public places. Within these places, the interactions with many others often lead to victimizations. This theory also considers the increase in violence as a linear function of increases in temperature **[4].** Another theory relating temperature to violent acts is the ***Negative Affect Escape Model*** **[11, 12].** According to this model, negative affect (feelings of irritation, annoyance, or discomfort) and violent acts increase as temperature rises, but this happens up to a certain inflection point. After reaching this point, there will be a decrease in violence as temperature increases because it will be more important for a person to escape the heat and engage in activities that reduce discomfort, instead of pursuing aggressive motives **[13]**. Therefore, this model hypothesizes a curvilinear relationship. The same holds true for the **Social Escape / Avoidance Theory** of Cohn et al. (2004) **[14],** which is closely related to the Negative Affect Escape Model. It argues that people will try to avoid conditions that could have negative affect as a consequence. Therefore, on days with extreme temperatures (both hot and cold) people will have less social interaction, which in turn leads to decreased opportunities for the occurrence of violent crime **[13].**

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Moreover, theories on external conditions argue that these can impact human judgment in a way that increases aggression and loss of control **[15, 16]**. In addition, the literature indicates that climatic conditions affect mental health conditions **[17], 18].** A number of studies which have explored this link have not found a significant correlation between homicide rates and meteorological variables. The findings of Michael and Zumpe (1983) **[19]** did not indicate clear links between temperature and monthly number of homicides in different geographic locations of the US and neither did Maes et al (1993) **[20],** when they assessed the effect of weather variables on homicides levels. In a study conducted in Belgium for the period 1979-1987, Maes (1993) **[21]** reported significant seasonality in suicide but not in homicide **[22]**. Cheatwood (1995) **[23]** accessed the effect of the number of previous days (i.e. before a homicide) in a row in which the discomfort index (a combined measure of temperature and humidity used to analyze the relationship of heat and violence) has been over the physiologically relevant level over an 8-year span of time. He concluded that in all cases the variance explained was quite small **[13].** The same insignificance for homicides was shown by the findings of Yan (2000) **[24]** on seasonality of suicides in Hong Kong. Rotton and Cohn (2003) **[25]** used cross-sectional and time series analyses and showed that temperature is associated to various violent crimes, such as assault or rape but the effect of temperature was not verified for cases of homicide. Nakaji et al (2004) **[26]** evaluated the seasonal changes in mortality rates from main causes of death in Japan (for the time period 1970–1999) and found that homicides were "*little or not at all influenced by seasonality*". Similarly, Butke and Sheridan (2010) **[13]** analysed data between 1999 and 2004 for the city of Cleveland, Ohio and found that while higher temperatures are related to higher amounts of aggressive crime they do not have an effect on homicides. In addition, Talaei et al. (2014) **[27]** examined various meteorological elements (daily mean air temperature, minimum & maximum relative humidity, minimum & maximum daily air pressure) in the city of Mashhad, in the northeast of Iran, between March 2009 to February 2010 and their findings indicate that homicide and suicide rates do not correlate with any meteorological variables.

In contrast, other empirical results suggest that high temperature is related to increases in homicides, as well as the hit-and-run deaths in Tokyo **[13].** Various studies support a linear relationship between temperature and violent crime **[9]**. DeFronzo (1984) **[28]** also found a significant relationship between homicide data and the number of 'Hot Days' in his study. According to the results of Harries and Standler (1988) **[29]** there is no curvilinear effect between temperature and aggression, even under conditions of extreme heat **[3]**. Anderson (1987) **[9]** showed that on hotter quarters of the year there was an increase in violent crimes. However, a number of studies suggest that there exists a curvilinear, inverted-U shaped relationship between temperature and crime **[4]**. It is therefore possible that after temperature reaches a threshold the behaviour changes and becomes less aggressive **[22]**. The findings of Cohn and Rotton (1997) **[8]** considering assaults and domestic violence in Minneapolis and assaults in Dallas indicate the existence of an inverted-U relationship **[4]**. The results of Jacob et al., (2007) **[6]** show an impact of short term weather changes on weekly or daily rates of criminal activity, however it was indicated that in the long run this correlation is not linear. A series of experiments conducted by Baron and Bell **[12] i**n the 70s which examined the influence of high ambient temperature on aggressive behaviour showed a curvilinear relationship between aggression and heat. In their experiments they used two temperature conditions (34°C for heat and 23°C for ‹cool›) and two arousal conditions. The findings indicated that aggressive behaviour increases until the temperature reaches the threshold of 29°C, and then decreases. It was concluded that high ambient temperatures, particularly when other sources of irritation or discomfort coexist, may become so annoying that aggression is no longer being enhanced and can well be reduced. These results led to the conceptualization of the negative affect escape model. Anderson and Anderson et al (2000) **[30]** draw the attention to the fact that the indicated curvilinear effect could be an experimental artefact, since the temperature manipulations were extremely obvious to the subjects **[3]**. Similarly to Baron and Bell **[12]**, a study by Gamble and Hess (2012) **[4]** examining the effects of temperature on violent crime in Dallas from 1993 to 1999 found a curvilinear relationship between daily mean temperature and daily rates

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of violent crime. Beyond the threshold of 26.6°C increases in temperature lead in rises in crime. Upon this threshold and for temperatures up to 32.2°C the relationship becomes negative. While the relationship between climatic conditions and homicides is of great interest, it has not been examined sufficiently. Having in mind the above data, the aim of the current study is to examine the association between temperature (daily T_{mean} and daily T_{max}) and homicide incidents (attempted and accomplished) in Central and Northern Greece. In Greece there is no previous study exploring results by region and/or frequency per time period (e.g. months or seasons).

Method

Temperature determines weather conditions and most studies which examine the relationship between weather and crime are based on the variability pattern of temperature. The temperature data (daily T_{mean} and daily T_{max} in Celsius degrees) were obtained from the European Climate Assessment & Dataset (ECA & D) **[31]** which "*consists of daily station series obtained from climatological divisions of the National Meteorological and Hydrological Services and stations series maintained by observatories and research centres throughout Europe and the Mediterranean*". Table 1 presents the data used for the purpose of this study and in Figure 1 the location of the meteorological stations is displayed.

Table 1: Temperature data for the time period 1995-2004

Region – Prefecture	T_{mean}	T_{max}
Epirus	Ioannina (1998-2004) Corfu (1995-1998)	Ioannina (1998-2004) Corfu (1995-1998)
Western Macedonia	Kozani (1998-2004) Hellinikon (1995-1998)	Kozani (1998-2004) Lamia (1995-1998)
Central Greece	Tanagra (2001-2004) Agrinio (1998-2001) Hellinikon (1995-1998)	Tanagra (1995-2004)
North Aegean	Samos (1995-2004)	Samos (1995-2004)
Larissa	Larissa (1995-2004)	Larissa (1995-2004)
Trikala	Larissa (1995-2004)	Larissa (1995-2004)

Figure 1: presents the location of the meteorological stations which are included in the ECA dataset.

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Not all meteorological stations in the investigated area could provide the required time period data and therefore some stations had to be combined. Although Lamia is located in the northern part of Central Greece it was included in the region of Western Macedonia. In addition, the area of Hellinicon which is not located within the investigated area was included in the Periphery of Central Greece and Western Macedonia. Since data from different stations were used, in some cases T_{mean} equals T_{max} (see Fig. 3).

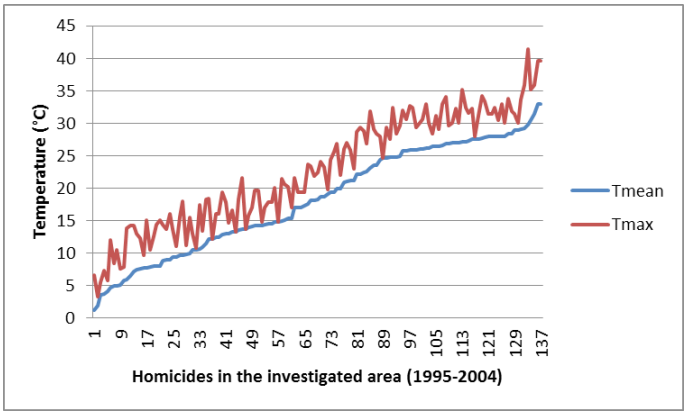
Figure 2: Geographical coverage of available data

Data for homicides in the years between 1995 and 2004 were collected by the regional and local police departments and include both attempted and accomplished homicides. In the present study data from the regions of Epirus, Western Macedonia, Central Greece (Continental Greek Region) and North Aegean were analysed. In addition, data from the Prefectures of Larissa and Trikala (region of Thessaly) have been evaluated. The mentioned areas represent in total 16.5% of the Greek population (investigated area: 1.789.538 - total: 10.815.197) and 35.5% of the Greek geographical area (investigated area: 46.804 km^2 – total: 131.957 km^2). Figure 2 presents the geographical coverage of the available data.

Results

A total of 137 homicides were registered in the investigated area between 1995 and 2004 (M = 14, SD = 3). The minimum number of homicides per year was 9 (in 1998) and the maximum was 17 (in the years 1999 and 2002). A monthly and a seasonal analysis were conducted. Linear and exponential regression analyses for the number of homicides within the selected temperature ranges were performed (intervals of 5°C or above a certain temperature value). The results show that 43 (31.4%) of the registered homicides occurred on a day when T_{mean} > 25 °C and that 61 (44.5%) were conducted on a day when T_{max} > 25 °C (31 of which when T_{max} > 30 °C).

Figure 3: Homicides in the investigated area and daily values of T_{mean} and T_{max}



According to the monthly analysis, in the time period 1995 to 2004 only 3 homicides occurred in April (see Fig. 4), whereas 20 occurred in July (M = 11 per month, SD = 5). Although the highest number of homicides occurred in July, November and December follow as months with the highest number of homicides (16 and 15 respectively). The number of homicides for June and August (a month in which temperature reaches 35°C to 40°C) are close to the average with 11 and 12 homicides respectively. Spring is the only season during which the number of homicides per month is lower than the monthly average.

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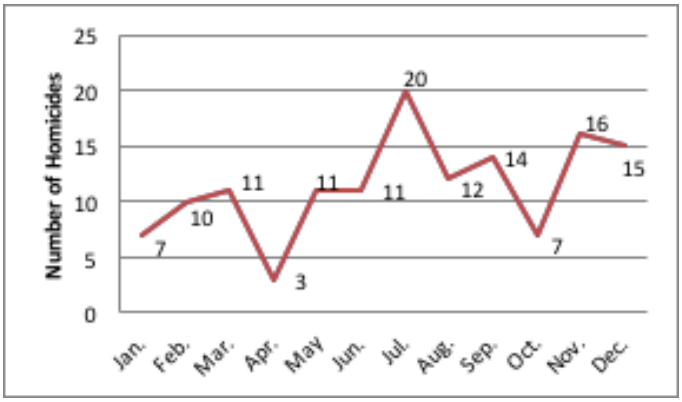
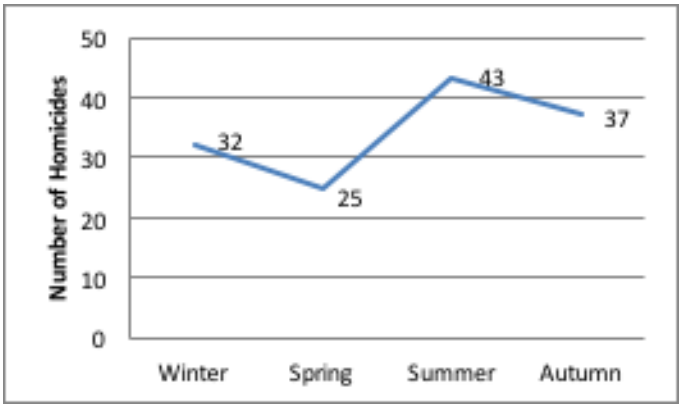
Figure 4: Monthly analysis for homicides and temperature data (1995 – 2004)



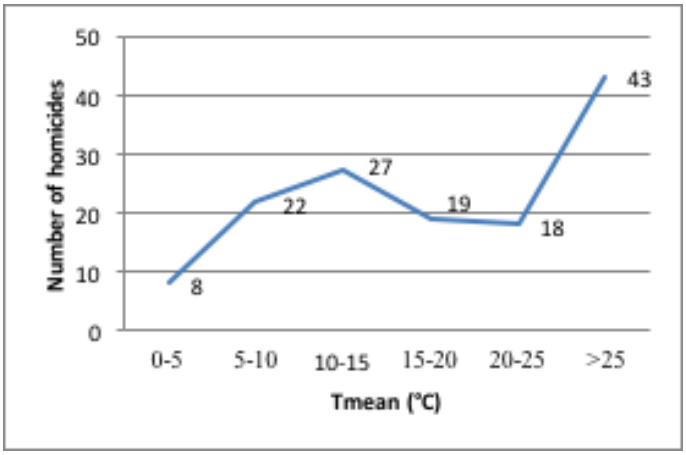
The seasonal analysis (see Fig. 5) shows that most homicides occurred during summer (31%), followed by autumn (27%), winter (23%) and spring (18%). The number of homicides in the summer period is 72% higher than in the spring.

Figure 5: Seasonal analysis for homicides and temperature data (1995 – 2004)



Daily T_{mean} values for registered homicides ranged from 1.2 to 33.0°C. This range of daily mean temperature was divided into the six following groups: Group 1: 0 to < 5°C, Group 2: 5 to < 10°C, Group 3: 10 to < 20°C, Group 4: 15 to < 20°C, Group 5: 20 to < 25°C, Group 6: > 25°C. The number of homicides per temperature group for T_{mean} is presented in Figure 6. The lowest number of homicides (5.8%) occurred when the daily T_{mean} was lower than 5°C, while the highest number of homicides (31.4%) occurred when the daily T_{mean} was higher than 25°C. The number of homicides per temperature group for T_{mean} is rising between groups 1 and 3, is decreasing in the next two groups and is increasing again in the last group.

Figure 6: Number of homicides per temperature group (T_{mean})



Daily T_{max} values for registered homicides ranged from 3.2 to 41.4 °C. This spectrum of daily maximum temperature was divided into the seven following groups: Group 1: 0 to < 5°C, Group 2: 5 to < 10°C, Group 3: 10 to < 20°C, Group 4: 15 to < 20°C, Group 5: 20 to < 25°C, Group 6: 25 to < 30°C, Group 7: > 30°C. The number of homicides per temperature group for T_{max} is presented in Figure 7. The lowest number of homicides (0.01%) occurred when the daily T_{max} was lower than 5°C, while the highest number of homicides (22.6%) occurred when the daily T_{max} was higher than 30°C. The number of homicides per temperature group for T_{max} is rising between groups 1 and 4, decreasing in group 5 and finally increasing again in the last two groups.

Figure 7: Number of homicides per temperature range (T_{max})

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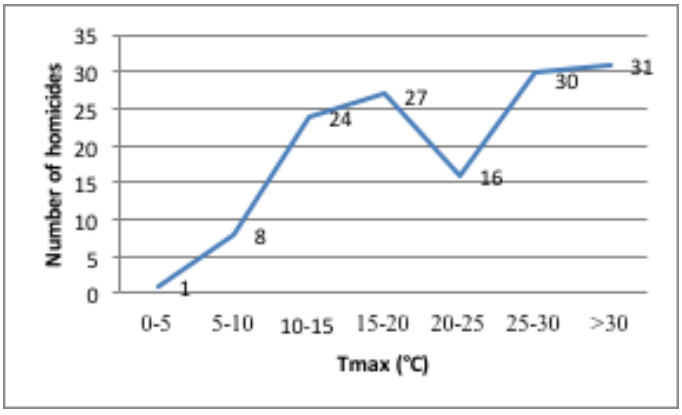

The results of the linear and exponential regression analysis that were performed for the number of homicides per temperature group are presented in Table 2.

Table 2: Regression analyses of temperature range of reported homicides for years 1995–2004

Element	Analysis	b	R	R^2	$R^2_{adj.}$
T_{mean}	Linear	4.429	0.709	0.503	0.379
	Exponential	0.213	0.719	0.517	0.396
T_{max}	Linear	4.500	0.839	0.704	0.645
	Exponential	0.448	0.780	0.609	0.531

For T_{mean} in the linear regression R^2 = .503 and in the exponential regression R^2 = .517 and for T_{max} R^2 = .704 in the linear regression and R^2 = .609 in the exponential regression. In the linear regression analysis the value of b was similar for T_{mean} (b = 4.42) and T_{max} (b = 4.50). In contrast, in the exponential regression analysis for T_{mean} the value of b was much lower (b = .21) than the one for T_{max} (b = .44). The results indicate a stronger correlation of homicides with T_{max} than with T_{mean}.

Discussion

The present study indicates a stronger correlation of homicides with T_{max}, than with T_{mean}. This finding is in accordance with the *Negative Affect Escape Model* **[11, 12],** according to which negative affect, such as feelings of irritation or discomfort, and violent acts increase as temperature rises. However, the findings of the monthly analysis, according to which most homicides occur in July, even though the warmest days usually include the first week of August, could indicate that there is a threshold of temperature beyond which aggression decreases. In our study only 2 homicides were reported at T_{mean} > 32°C. On the other hand, it could be possible that after the second week of August the temperatures begin to decrease. The different results of the studies indicating a linear or curvilinear relationship between weather and crime can be partly traced back to the different measurements. While a number of studies focuss on the measurement of the short-term relationship between these variables using hourly, daily, or weekly microdata, other studies concentrate on the measurement of the same relationship by using aggregate annual data.

We found that most homicides occurred when T_{mean} was higher than 25°C and T_{max} was higher than 30°C and in addition most murders occurred in summer followed by autumn and therefore the results support *Routine Activity Theory* **[10]**. It is therefore likely that homicides in Central and Northern Greece occur mostly during vacations (i.e. summer / early autumn). If this explanation holds true, it would mean that the increased number of homicides in the summer and autumn is more strongly related to variations in people's activity patterns and the greater risk of victimization when being outside, than to changes in weather conditions. The findings of a study conducted by Copus and Laqueur **[32]** in 2014 showed that during large scale sporting events there was a decrease in crime rates in Chicago. According to the authors this drop can be traced back to the fact that people watch the games at home and that there are therefore less people in public spaces. The decrease in crimes of 25% in Chicago during the Super Bowl supported this view **[32].** As the climate becomes warmer worldwide it is essential to conduct further studies on the relationship be-

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tween temperature and homicides, as well as on the question if this relationship is linear or curvilinear. In particular if the relationship is linear, substantial increases in homicides may be a consequence. This could impact law enforcement and its resources. In addition, the examination of this relationship could enable prediction and prevention activities **[4]**. There is an annual increase in temperature of about 0.4°C to 0.6°C since the 1990 in Greece. According to the Ministry of Environment, Energy and Climate Change (2014) this increase is mostly due to a steady rise of temperature during the summer period.

A limitation of our study is that we have not used microdata, as in the study by Jacob et al (2007) **[6],** which showed that crime rates are increasing during hot weeks. Moreover, we can suggest that the positive serial correlation in crime commonly reported is not an endogenous process driven by the optimization of offenders, but probably reflects persistence of unobserved factors that influence of criminal activity **[6, 33].** The link between poverty, unemployment and economic downturns and increases in crime rates has long been the subject of social science study. For example, in our previous studies we examined if the recent financial crisis in Greece has coincided with an increase in crime, analyzing crime rates since the start of the financial crisis and over an extensive time period (7 years). Our results are in agreement with the results of previous broader studies as well as with criminological theories, according to which in times of economic stress an increase in both property crimes and violent crimes is expected **[34, 35].**

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References

1. La Free G., Curtis K., McDowell D. How effective are our 'better angels? Assessing country-level declines in homicide since 1950. *Eur J Criminol 2015, 12*:482-504, *doi/10.1177/1477370815584261*

2. Panousis G. *Exaggerations, Uses and Abuses*. Legal Library, Athens, 2008:

3. Mishra A. Does Temperature Affect Homicide Rate? *J Climatol Weather Forecasting 2015, 3*:1-6, doi:10.4172/2332-2594.1000132

4. Gamble JL, Hess JJ. Temperature and Violent Crime in Dallas, Texas: Relationships and Implications of Climate Change. *West J. Emerg. Med 2012, 13*:239-246, doi: 10.5811/westjem.2012.3.11746

5. Becker G. *Crime and Punishment: An Economic Approach.* National Bureau of Economic Research, 1974

6. Jacob B, Lefgren L, Moretti E. The dynamics of criminal behaviour: evidence from weather shocks. *J Hum Resour 2007*, *42*:489-527, doi: 10.3386/w10739

7. Glaeser, E.L., Sacerdote, B., Scheinkman, J.A. Crime and Social Interactions. *QuarterlyJournal of Economics 1996,*111:507-548, doi.org/10.2307/2946686

8. Cohn EG, Rotton J. Even criminals take a holiday: Instrumental and expressive crimes on major and minor holidays. *J Crim Justice* 2003, 31:351-360, doi:10.1016/S0047-2352(03)00029-1

9. Anderson CA. Temperature and aggression: Effects on quarterly, yearly, and city rates of violent and nonviolent crime. *J Pers Soc Psychol* 1987, 52:1161-1173, PMID: 3598860

10. *Cohen LE, Felson M. Social Change and Crime Rate Trends: A Routine Activity Approach. Am Sociol Rev 44:588–608, doi:10.2307/2094589*

11. Baron RA. Aggression as a function of ambient temperature and prior anger arousal. *J Pers Soc Psychol* 1972, 21:183-189, doi: 10.1037/h0032892

DOI: 10.26386/obrela.v1i4.100 ISSN 2585-2795

12. Baron RA., Bell PA. Aggression and heat: the influence of ambient temperature, negative affect, and a cooling drink on physical aggression. *J Pers Soc Psychol* 1976, 33:245-255, PMID: 1271212

13. Butke P, Sheridan SC. An analysis of the relationship between weather and aggressive crime in Cleveland, Ohio. *Weather, Climate and Society* 2010, 2:127-139.

14. Cohn EG, Peterson AG, Tarr DB. Temperature, city size, and the southern subculture of violence: Support for Social Escape/Avoidance (SEA) theory. *J Appl Soc Psychol* 2004, 34:1652-1674, doi: 10.1175/2010WCAS1043.1

15. Card D, Dahl GB. Family violence and football: The effect of unexpected emotional cues on violent behavior. *Quarterly Journal of Economics* 2011, 126:103-143, PMCID: PMC3712874

16. Baumeister RF, Heatherton TF. Self-Regulation Failure: An Overview. *Psychol Inq* 1996, 7:1-15, doi.org/10.1207/s15327965pli0701_1

17. Petridou E, Papadopoulos FC, Frangakis CE, Skalkidou A, Trichopoulos D. A role of sunshine in triggering of suicide. *Epidemiology* 2002, 13:106-109, PMID: 11805594

18. Turecki G, Sequeira A, Gingras Y, Seguin M, Lesage A, Tousignant, M., et al. Suicide and serotonin: study of variation at seven serotonin receptor genes in suicide completers. *Am J Med Genet B Neuropsychiatr Genet* 2003, 118: 36-40,

19. Michael RP, Zumpe D. Sexual violence in the United States and the role of season. *Am J Psychiatry* 1993, 140:883-886, doi.org/10.1176/appi.ajp.157.10.1674

20. Maes M, Meltzer HY, Suy E, De Meyer F. Seasonality in severity of depression: relationships to suicide and homicide occurrence. *Acta Psychiatr Scand* 1993, 88:156-161, doi.org/10.1111/j.1600-0447.1993.tb03431.x

21. Maes M. Seasonality in violent suicide but not in nonviolent suicide or homicide. *Am J Psychiatry* 1993, 150:1380-1385, doi.org/10.1176/ajp.150.9.1380

22. Ceccato V. Homicide in Sao Paulo, Brazil: Assessing spatial-temporal and weather variations. *J Environ Psychol* 2005, 25:307-321, doi: 10.1016/j.jenvp.2005.07.002

23. Cheatwood D. The effects of weather on homicide. *J Quant Criminol* 1995, 11:51-70, doi: 10.1007/BF02221300

24. Yan YY. Weather and homicide in Hong Kong. *Percept Mot Skills* 2000, 90:451-452, doi: 10.2466/PMS.90.2.451-452

25. Rotton J, Frey J. Air pollution, weather, and violent crimes: Concomitant time-series analysis of archival data. *J Pers Soc Psychol* 1985, 49:1207-1220, doi: 10.1037/0022-3514.49.5.1207

26. Nakaji S, Parodi S, Fontana V, Umeda T, Suzuki K, Sakamoto J, et al. Seasonal changes in mortality rates from main causes of death in Japan (1970–1999). *Eur J Epidemiol* 2004, 19:905-913, PMID: 15575348

27. Talaei A, Hedjazi A, Rezaei AA, Fayyazi Bordbar MR, Talaei A. The relationship between meteorological conditions and homicide, suicide, rage, and psychiatric hospitalization. *J Forensic Sc* 2014, 59:1397-1402, doi: 10.1111/1556-4029.12471

28. DeFronzo J. Climate and crime: Tests of an FBI assumption. *Environment and Behavior* 1984, 16:185-210, *doi: 10.1177/0013916584162003*

29. Harries KD, Stadler SJ. Heat and violence: New findings from Dallas field data,1980 –1981. *J Appl Soc Psychol* 1988, 18:129-138, doi: 10.1111/j.1559-1816.1988.tb00010.x

30. Anderson CA, Anderson KB, Dorr N, DeNeve KM, Flanagan M. Temperature and aggression. *Chapter in Advances in Experimental Social Psychology* 2000, 32:63-133, doi: 10.1016/S0065-2601(00)80004-0

31. Klein Tank AMG, Wijngaard JB, Können GP,Böhm R, Demarée G, Gocheva A, et al. Daily dataset of 20th-century surface air temperature and precipitation series for the European Climate Assessment. *Int J Climatol* 2002, 22:1441-1453, doi: 10.1002/joc.773

32. Copus R, Laqueur H. *Entertainment as crime prevention: Evidence from Chicago Sports Games.* University of California,

DOI: 10.26386/obrela.v1i4.100 ISSN 2585-2795

Berkeley, 2014

33. Giotakos O., Aggressive behavior: theoretical and biological aspects, *Psychiatriki* 2013, 24:117 – 131, PMID: 24200542

34. Tsouvelas G, Kontaxakis V, Giotakos O, Konstantakopoulos G, Kontaxaki MI, Papaslanis T. Financial crisis and criminality in Greece: 2008 vs 2011. *Psychiatriki* 2016, 27:54-57, PMID: 27110884

35. Tsouvelas G, Konstantakopoulos G, Vakirtzis A, Giotakos O, Papaslanis T, Kontaxakis V. Criminality in Greece during the years of financial crisis: 2008–2014. *Psychiatriki* 2018, 29:19–24, doi: 10.22365/jpsych.2018.291.19