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Research article

Investigating the relationship among seasonality, socioeconomic risk factors and suicides in Greece

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ABSTRACT

Globally, there has been growing evidence pointing to a relationship between suicides, seasonality, and socioeconomic factors. This study aims at investigating the seasonal suicide patterns, the effect of gender on these patterns, the trend of these patterns, and whether the suicides are associated with economic and social risk factors. The objects of the current study have been the seasonal suicide patterns in Greece during 1980–2018 (39 years), as well as their interrelation with a variety of socioeconomic risk factors, however for a shorter period (21 years) due to the unavailability of aggregated data provided by the Hellenic Statistical Authority (ELSTAT). The Walter-Elwood test was applied in order to investigate seasonality. Poisson regression models were applied to investigate the relationship between seasonality, socioeconomic risk factors, and monthly suicides. The best variable subset was selected according to the leaps and bounds algorithm. A total of 15,692 suicides were recorded. In the total sample and men, a peak was documented in May – June, whereas females mostly peaked in July. Among the risk factors under investigation, an increase in marriage rates appeared to have significantly lowered the number of suicides, while a rise in unemployment rates exhibited a statistically non-significant increase in suicides. The findings of the study suggest distinct sex-oriented seasonal patterns and a protective effect of marriage.

KEYWORDS: Seasonality, suicide, marriage, unemployment, consumer price index.

Introduction

Suicide is one of the major public health concerns, constituting the 17th leading cause of death worldwide, making its underlying pathophysiological pathways and social triggering mechanisms a critical point as far as the preventive interventions of mental health professionals and State policies are concerned.[1] Since the 19th century and Durkheim's study on circannual suicide patterns,[2] seasonality of suicides has been thoroughly documented, with an increasing number of studies showing a peak in spring/summer and a trough in winter, depending on the region under investigation.[3] A small number of studies reported a bimodal annual distribution.[3–5] Despite accumulating evidence, seasonal patterns have not always been consistent; contradicting historical evidence for the seasonal trend has been reported, pointing to either a flattened seasonality and a diminishing trend towards today or the opposite.[6,7] Beyond seasonal patterns, as suicide is commonly seen as a multi-factorial phenomenon, several possible socioeconomic risks factors such as age,[8] marital status,[9–11] gross domestic product (GDP) per capita,[8] urbanicity,[8] religion,[12] unemployment rates, and psychiatric disorders,[13–15] national days and festive periods,[16–18] have been extensively studied, often with contradicting findings.[19–21] Particularly in Greece, it has

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been argued that the unemployment rate, as well as the GDP per capita, are both associated with an increase in suicide rates, although the effect of these factors concerns specific groups including the working age (20–59 years old) men.[21] In another study, these findings were not replicated and the suicides were associated with meteorological parameters.[19]

Due to the contradicting evidence regarding the factors associated with suicide rates, the present study aimed to clarify the existence of seasonal suicide patterns, the effect of gender on seasonality, the trend of these patterns, and whether the suicides are associated with economic and social risk factors for the longest available duration, as a recent study in Greece has pointed out.[16]

Material and Method

Study design

Monthly data on suicide, marriages, and the Consumer Price Index (CPI) were obtained from the Hellenic Statistical Authority (ELSTAT) regarding the period 1980-2018 (468 months).[22] The aim of the CPI is to measure the level of the prices of goods and services purchased by the average Greek household each month and, in general, it depicts the inflation in the economy. Unemployment monthly rates were accessible from April 1998 to the end of 2018. The estimated population of the country, for the 1st of January and 30th of June of every year, was included in the study. Subsequently, the population of the 1st of January was assigned to the months of the 1st semester (January until June) and the population of the 30th of June to the remaining months (July up to December), except for 1980 from which only the population of 30th of June was available. Monthly marriage rates were calculated by dividing marriages by the underlying population and then multiplied by 100.000 to obtain rates per 100.000 persons.

Statistical analysis

Initially, the seasonality was investigated by applying the Walter-Elwood test using the average monthly suicide counts for the total period under study (1980–2018) and by applying Poisson regression with dummy variables for each month (1–12) having the month with the lowest suicide rate as a reference month.[23,24] Negative binomial regression was used for over-dispersed data according to the likelihood ratio test. The trend of seasonal patterns across the study period was investigated by dividing the study sample into 5-years subgroups (except for the last subgroup which contained 4 years; 2015–2018) and reapplying Poisson regression as described above. Sex - stratified analysis was also applied.

Consequently, the relationship between socioeconomic factors (CPI, marriages, unemployment rates) and suicides was investigated. Firstly, individually for each factor, the underlying relationship between outcome (suicides) and exposure variables was assessed by using natural cubic splines with 3 degrees of freedom (df) in order to explore possible nonlinear associations for the longest period available for each exposure variable. Based on the Akaike Information Criterion (AIC), the linear models were selected, as the best fit (suppl. table 1).[25] AIC was used to evaluate the goodness of fit for models; the lower the AIC, the better the model fits the real-world data. Furthermore, considering the limitation of taking into account data only from April 1998 to 2018 (249 months), the best variable subset was selected using the user-written select command,[26] which implements the leaps and bounds algorithm.[27] The selected subset was further applied in the sex-stratified analysis. All models were adjusted for seasonality and time trends with indicator variables.

The logarithm of the population (total and by sex) assigned to each month was used as an offset in every regression model.

Analysis was conducted in Stata MP (version 13, Stata inc.). Statistical significance was set at 5%.

No ethical approval or consent was needed, as the data were aggregated and publicly available.

Results

In total, 15,692 suicides (12,331 males and 3,361 females) were included in the study (suppl. figure 1-2). Total suicides ranged from 11 to 74 every month with a mean (standard deviation (SD)] of 33.52 (9.8). The average unemployment rate was 15.24% (6.7%). Descriptive characteristics are presented in table 1. In addition, the monthly and yearly averages of the variables under investigation are presented in suppl. table 2–3.

Seasonality

Seasonal patterns were both evident in the total sample (figure 1), as well as across all 5-year subgroups (suppl. figure 3). The Walter-Elwood test indicated a maximum angle rate at 160.4 degrees, which corresponded to June, while Poisson regression results pointed to May as the peak month. Across subgroups, May was also found to be the most prevalent peak month. In males, the peak month was consistently May after 1995 (suppl. figure 4-5), while in former intervals it differed greatly (from March to July). On the contrary, female suicides

Table 1. Descriptive statistics of suicides per month in Greece during the period 1980–2018. Unemployment rates were available from April 1998 to the end of 2018.

		Mean	SD	Min	Max
Suicides	Male	26.34	8.37	9.00	60.00
	Female	7.18	3.42	0.00	20.00
Unemployment rates	Male	11.88	6.86	4.70	25.40
	Female	19.91	6.40	11.00	31.9
Marriage rates		45.54	19.06	5.94	105.67
Consumer Price Index		65.04	36.15	4.99	111.34

Table 2. Percentage changes (and corresponding 95% confidence intervals (CI)) in monthly suicides per outcome for the period April 1998 – December 2018 in Greece. Results from Poisson models are adjusted for time trends and seasonality.

	Total			Men			Female		
	% Change	95% CI	p	% Change	95% CI	p	% Change	95% CI	p
Consumer Price Index	–	–	–	–	–	–	–	–	–
Marriage rates	–0.5	–0.8 – –0.1	0.025	–0.5	–0.9 – –0.1	0.024	–0.3	–1.1 – 0.6	0.618
Unemployment rates	2.4	–0.5 – 5.5	0.099	1.6	–1.6 – 4.8	0.313	4.1	–2.6 – 11.3	0.226

peaked mostly in July (suppl. figure 6–7), while peaks were also found in April and May at different intervals. The monthly distribution appeared to be unimodal, however, a small, and in most cases statistically significant, peak was evident in January, probably due to an increase in male suicides (figure 1–2, suppl. figure 4–5). Females' patterns appeared to be also unimodal (suppl. figure 6–7). When the incidence rate ratio (IRR) of the peak month from the 5-year intervals was plotted separately, a downward trend from 1980 to 2018 was observed, although upward fluctuations were evident in 1995–1999 and after 2010 (suppl. figure 8).

In relation to socioeconomic factors

Unemployment rates and marriage rates were selected as the best subset variables, excluding CPI due to the higher AIC of the most complex model (suppl. table 4). Unemployment rates appeared to increase suicides by 2.4%, although the increase was not statistically significant (p=0.099). The same statistically non-significant effect was documented in both males and females (p=0.313 & p=0.226, respectively), as sex-specific unemployment rates were associated with a 1.6% and 4.1% increase in suicides, respectively. Marriage played a protective role as it decreased suicides by 0.5% with a 95% confidence interval of 0.1 % - 0.8 %. In the male subgroup, marriage rates were associated with a 0.5% reduction in suicides (p=0.024), while the 0.3% reduction in females was statistically not significant (p=0.618). For exploratory-only purposes, univariate models are also presented in suppl. table 5.

Discussion

The current study demonstrates the existence of seasonal suicide patterns in Greece during the four decades under study. Seasonality was evident in all subgroups, including sex-stratified analysis, as others have previously been documented.[16] As it was demonstrated in Spain,[3] another Mediterranean country, women appeared to follow a unimodal pattern with a peak in July, while in the men's subgroup, a small second peak was shown to exist in January, apart from the main one in May. These results replicate international findings which indicate a peak month between the spring and summer months.[3,28,29] However, contradicting evidence to our results does exist, pointing to a more intense seasonal pattern in women than men circannual or a bimodal seasonality in women and two seasonal cycles in men.[5,29] In the total sample, June appeared to be the peak month regarding the Walter-Elwood test while the Poisson model showed May as the riskiest month. This inconsistency probably depicts the Walter-Elwood test underlying an assumption of a unimodal pattern. Regarding the seasonal trend across the whole period under study, seasonality appeared to decrease over the decades, although upward fluctuations were also documented (suppl. figure 8). This finding is also consistent with the international evidence documenting a smoothing of seasonal patterns towards the 21st century,[6] although that was not evident in neighboring Italy or in the USA, where an increase was observed.[29,30] This could be attributed to the increasing prevalence of depression and subsequently, the increasing use of anti-depressant medications in Greece, which

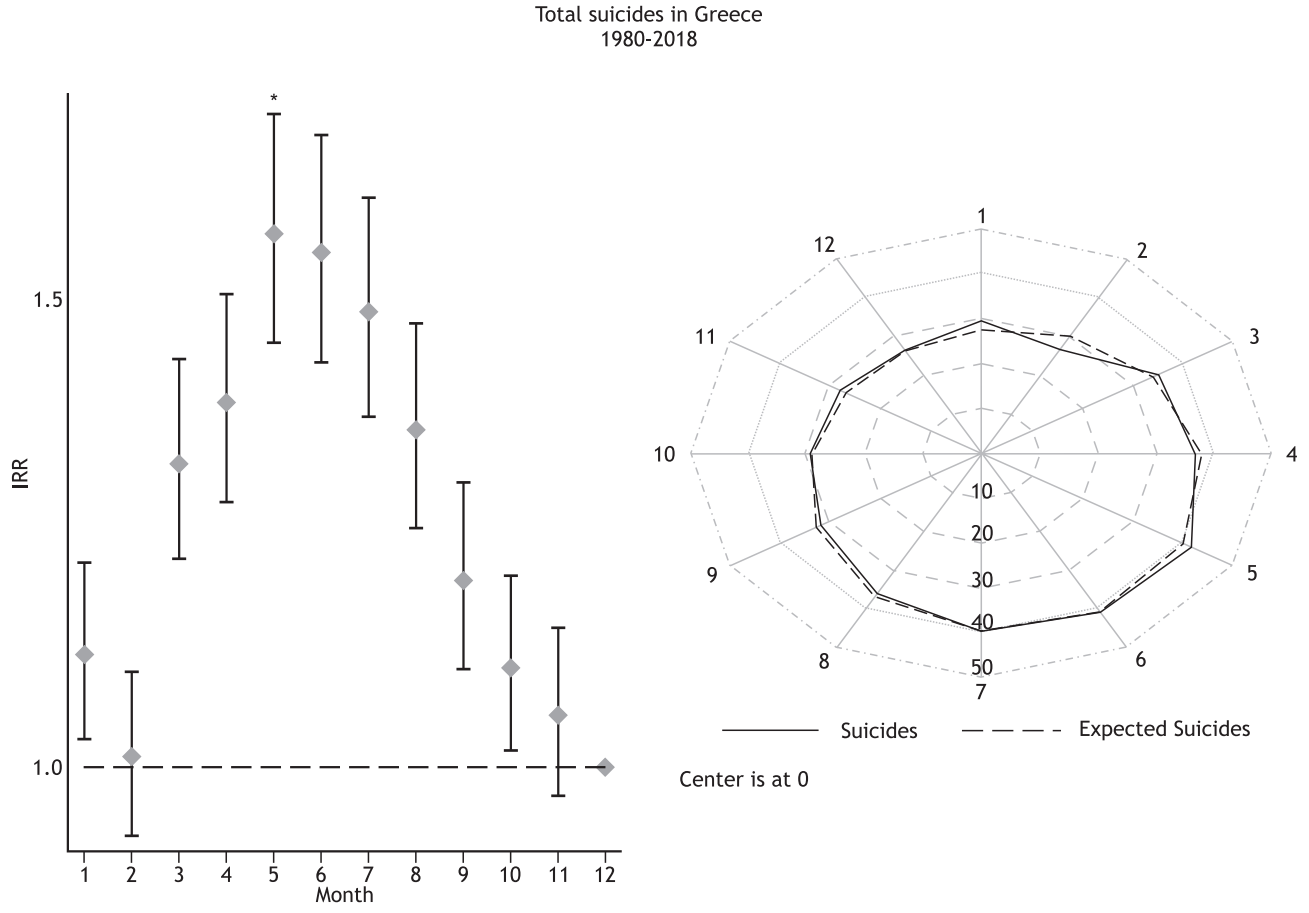

Figure 1. Seasonal pattern of suicides in Greece for the period 1980–2018. IRR stands for incidence rate ratio. Peak month is denoted with an asterisk (*).

tend to flatten the circannual suicide pattern, as it has been previously supported.[31,32] Nevertheless, genetic mechanisms may also play a crucial role, as heritability of suicidal behavior contributes up to 30–55% and suicide cases meet criteria for psychiatric disorders up to 60–98%.[33,34] Subsequently, it can be hypothesized that certain neurotransmitters such as serotonin or its metabolites, which follow a distinct seasonality,[35] mediate suicidality.[36,37] In turn, this could infer that either the depletion of the specific neurotransmitter increases the risk of suicide, especially in winter,[35] or on the other hand, the sudden increase in spring, possibly due to the higher levels of sunlight,[38] contributes to increased suicidality, similar to the one caused by antidepressants in a short-term period, as other studies have supported.[39,40]

Across the three socioeconomic factors that were investigated, marriage rates were consistently found to protect against suicide in the total population as well as in men but not in females, as literature has also previously supported.[9–11] On the other hand, unemployment seemed to have no significant effect on suicides, which consists of a contradicting finding, if previous reports concerning the connection between unemployment rates and suicide rates in Greece,[41] or in other countries, such as Taiwan,[42] are taken into account. Nonetheless, evidence similar to this study's recently emerged in neighboring Italy, pointing to a non-significant relationship between suicide and unemployment.[20] Mixed findings were also documented in England with either positive, negative, or no relationship at all.[43] As far as Greece is concerned, the mixed findings could result from different methodologies, such as forensic studies or ecological studies, using aggregated data yearly.[21,44] On the other hand, it is possible that the current study could not identify more specific associations such as the exaggeration of suicides in certain age groups (i.e. working-age males) due to high unemployment rates, as other studies have pointed out in the past.[21,41] Furthermore, CPI was excluded in the final model (table 2), although it exhibited a statistically significant protective role (supp. table 5). This discrepancy probably appeared because CPI has had small fluctuations since April 1998, which was considered as the starting year in the final model, in order to also include unemployment rates, and due

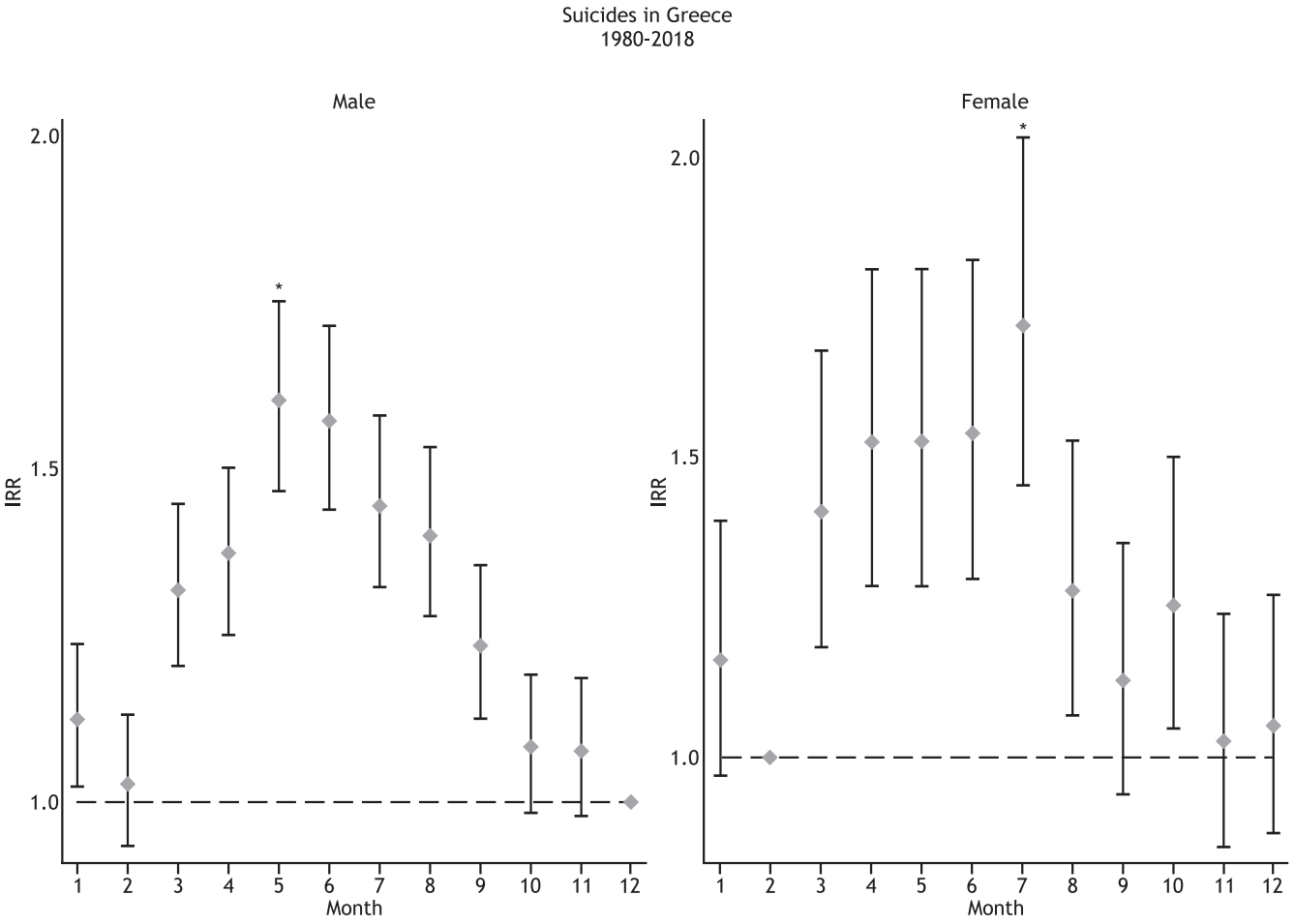

Figure 2. Seasonal male and female suicide patterns in Greece for the period 1980–2018. Peak months are denoted with an asterisk (*).

to this, it failed to decrease AIC as an explanatory factor. Macroeconomic conditions, such as the consumption trend, have historically appeared to explain the suicide rates adequately.[45] On the contrary, unemployment rates alone could not explain the change in suicides unless unemployment protection was also taken into account.[46] Regarding our findings, strong family bonds may explain the protective role of marriages, as Greek families could offer extensive social support against economic hardship,[44] similar to the one that is perceived in Muslim community in China.[47] Besides social support due to family ties in Greece,[48] we could hypothesize, generalizing the suggestions made by Basta et al for suicides on the island of Crete,[44] that families and subsequently marriage may also offer economic support, especially in small communities (for example, the Greek villages/towns), alleviating the pressure towards the person at risk of committing suicide due to lack of employment or adequate purchasing power.

It is worth noting that absolute suicide counts appeared to increase abruptly in 2011 (suppl. figure 1–2), a year after the economic crisis started and the 1st bailout was implemented. Economou et al. found that the 1-month prevalence of major depression steadily increased from 2008 to 2013,[31] while suicidality also followed this trend up to 2011, with a decline afterward. It appeared that economic hardship could contribute to the decline in mental health via the dismantling of health services.[31,49]

The main limitation of the study is its ecological design and its inherent inability to establish a causal relationship between suicide counts and the risk factors under investigation. The quality of the suicide data is another issue, as under-reporting cannot be excluded. Furthermore, the availability of unemployment rates after April 1998 restricted our investigation in the final model and probably this resulted in the exclusion of CPI from the analysis although data from 1980 regarding suicide, CPI, and marriage rates were available. Furthermore, the lack of daily suicide data does not allow us to investigate more specific patterns such as the ones around National or Holy days, as recently Tsouvelas

et al have found.[16] On the other hand, the main advantage of the current study is the investigation of suicide seasonal patterns of both sexes during almost 4 decades, as well as the trend of these patterns.

In conclusion, our findings suggest a distinct suicide seasonality with a peak mostly in May or June, depending on the statistical method, and a negative association between suicide rates and marriage, which is an important social parameter. A better understanding of suicide circannual patterns and their relationship to certain social and economic drivers could help better preventive strategies be designed and implemented.

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Ερευνητική εργασία

Διερεύνηση της σχέσης των αυτοκτονιών, της εποχικότητας και κοινωνικοοικονομικών παραγόντων στην Ελλάδα

Λάμπρος-Ωρίων Ασημακόπουλος

Εργαστήριο Νευροφυσιολογίας, Τμήμα Ιατρικής, Σχολή Επιστημών Υγείας, Δημοκρίτειο Πανεπιστήμιο Θράκης, Αλεξανδρούπολη

ΙΣΤΟΡΙΚΟ ΑΡΘΡΟΥ: Παραλήφθηκε 8 Απριλίου 2022/Αναθεωρήθηκε 30 Οκτωβρίου 2022/Δημοσιεύθηκε Διαδικτυακά 15 Δεκεμβρίου 2022

ΠΕΡΙΛΗΨΗ

Παγκοσμίως, υπάρχει ολοένα και μεγαλύτερος όγκος ενδείξεων περί ύπαρξης σχέσης μεταξύ των αυτοκτονιών, της εποχικότητας και κοινωνικοοικονομικών παραγόντων. Σκοπός της παρούσας μελέτης είναι να εξετάσει τα εποχικά μοτίβα των αυτοκτονιών, την επίδραση του φύλου σε αυτά, την τάση τους και τη σχέση των αυτοκτονιών με οικονομικούς και κοινωνικούς παράγοντες κινδύνου. Διερευνήθηκε η εποχικότητα των αυτοκτονιών στην Ελλάδα για το διάστημα 1980–2018 (39 έτη), όπως επίσης και η σχέση των αυτοκτονιών με κοινωνικοοικονομικούς παράγοντες για μικρότερη όμως περίοδο (21 έτη) λόγω μη διαθεσιμότητας των δεδομένων, τα οποία ελήφθησαν από την Ελληνική Στατιστική Αρχή. Για τη διερεύνηση της εποχικότητας χρησιμοποιήθηκε το Walter-Elwood test, ενώ η παλινδρόμηση Poisson χρησιμοποιήθηκε για να εξεταστεί η σχέση μεταξύ εποχής, κοινωνικοοικονομικών παραγόντων και μηνιαίων αυτοκτονιών. Συνολικά, 15.692 αυτοκτονίες συμπεριελήφθησαν. Στο ολικό δείγμα, καθώς και στους άνδρες, η κορύφωση των μηνιαίων αυτοκτονιών καταγράφηκε κατά τον Μάιο-Ιούνιο, ενώ στις γυναίκες κυρίως τον Ιούλιο. Από τους παράγοντες κινδύνου, η αύξηση των γάμων φάνηκε να μειώνει στατιστικώς σημαντικά τις αυτοκτονίες ενώ η αύξηση των ποσοστών ανεργίας, ναι μεν να τις αυξάνει, αλλά στατιστικώς μη σημαντικά. Τα ευρήματα της μελέτης δείχνουν την ύπαρξη διακριτών ανάμεσα στα δύο φύλα εποχικών μοτίβων και την προστατευτική επίδραση των γάμων έναντι των αυτοκτονιών.

ΛΕΞΕΙΣ ΕΥΡΕΤΗΡΙΟΥ: Εποχικότητα, αυτοκτονίες, γάμοι, ανεργία, δείκτης τιμών καταναλωτή.

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