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THE INFLUENCE OF DAYS OF THE WEEK, SEASONALITY AND LUNAR PHASES ON THE SUICIDE RATE IN THE CITIES OF SEMEY, UST-KAMENOGORSK AND PAVLODAR REGION.

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Abstract

Introduction. Suicide is a global public health problem. More than 720,000 people die by suicide each year. Every suicide is a tragedy that affects families, communities, and entire countries, with long-term consequences for the loved ones of the deceased. The timing of suicides may also depend on external factors. Research on this topic has so far yielded somewhat contradictory results regarding the relationship between suicides and specific days or seasons of the year. Seasonal factors influence the level of suicides and the number of suicide attempts.

Objective: Analyze the impact of weekdays, months, seasonal fluctuations, and lunar phases on the suicide rate in the Pavlodar region, including the cities of Ust-Kamenogorsk and Semey.

Materials and Methods: A retrospective study. To determine seasonality in the time series of completed suicides, seasonal-trend decomposition using the Loess method was applied. Graphical methods were used to identify seasonal fluctuations, as well as the statistical criteria QS and Kruskal-Wallis. The influence of seasonality was assessed using a linear regression model that accounted for trends and seasons. Data from forensic examinations in Ust-Kamenogorsk, Semey, and the Pavlodar region were collected for the period from 2013 to 2022, including 3657 cases of suicide. Variables: days of the week, months, lunar phase.

Results. The Kruskal-Wallis test showed statistically significant differences between the quarters $\chi2(3) = 15.35$, $p = 0.00154127$. Moreover, the QS statistical criterion indicated the existence of seasonality $QS = 7.65$, $p = 0.02185496$. An increase in the average number of suicides in the second quarter. Increases and decreases in completed suicides occurred on all days of the week. Quasi-Poisson regression did not reveal an influence of lunar phases on the number of completed suicides.

Conclusions. The study found an increase in the number of suicides in the second quarter of the year (from April to June), while no significant dependence of the number of suicides on the days of the week or lunar phases was established.

Keywords: *epidemiology, suicide, mortality, seasonality, days of the week.*

Резюме

ВЛИЯНИЕ ДНЕЙ НЕДЕЛИ, СЕЗОННОСТИ И ЛУННЫХ ФАЗ НА УРОВЕНЬ САМОУБИЙСТВ В ГОРОДАХ СЕМЕЙ, УСТЬ-КАМЕНОГОРСК И ПАВЛОДАРСКОЙ ОБЛАСТИ

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Введение. Самоубийство является глобальной проблемой общественного здравоохранения. Ежегодно более 720 000 человек умирают в результате самоубийства. Каждое самоубийство – это трагедия, затрагивающая семьи, сообщества и целые страны, с долговременными последствиями для родных покойного. Время самоубийств может также зависеть от внешних факторов. Исследования по этой теме до сих пор дают отчасти противоречивые результаты, касающиеся связи самоубийств с определёнными днями или сезонами в году. Сезонные факторы влияют на уровень самоубийств и число попыток самоубийства.

Цель исследования: Просчитать анализ воздействия дней недели, месяцев, сезонных колебаний и лунных фаз на уровень самоубийств в Павлодарской области, включая города Усть-Каменогорск и Семей.

Материал и методы: Ретроспективное исследование. Для определения сезонности во временных рядах совершенных самоубийств была применена сезонно-трендовая декомпозиция с использованием метода Loess. Для выявления сезонных колебаний использовались графические методы, а также статистические критерии QS и Краскела-Уоллиса. Влияние сезонности оценивалось с помощью линейной регрессионной модели, учитывающей тренды и сезоны. Были собраны данные судебно-медицинских экспертиз г. Усть-Каменогорска, г. Семея и Павлодарской области за период с 2013 по 2022 год, включающие 3657 случаев смерти от суицида. Переменные: дни недели, месяцы, лунная фаза.

Результаты. Критерий Краскела-Уоллиса показал, что есть статистически значимые различия между кварталами $\chi^2(3) = 15,35$, $p = 0,00154127$. Более того статистический критерий QS показал о существовании сезонности $QS = 7,65$, $p = 0,02185496$. Повышение средних значений количества суицидов во втором квартале. Увеличения и снижения совершенных самоубийств приходятся на все дни недели. Квазипуассоновская регрессия не выявила влияние лунных фаз на количество совершенных самоубийств.

Выводы. В результате исследования выявлен рост числа самоубийств во втором квартале года (с апреля по июнь), в то же время не установлена значимая зависимость количества самоубийств от дней недели, как и лунных фаз.

Ключевые слова: *эпидемиология, суицид, смертности, сезонность, дни недели.*

Түйіндеме

СЕМЕЙ, ӨСКЕМЕН ҚАЛАЛАРЫНЫҢ ЖӘНЕ ПАВЛОДАР ОБЛЫСТАРЫНДАҒЫ ӨЗ-ӨЗІНЕ ҚОЛ ЖҰМСАУ ДЕҢГЕЙІНЕ АПТА КҮНДЕРІНІҢ, МАУСЫМДЫҚ ЖӘНЕ АЙ ФАЗАЛАРЫНЫҢ ӘСЕРІ

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Кіріспе. Өзін-өзіне қол жұмсау – денсаулық сақтаудың жаһандық мәселенің бірі. Жыл сайын 720 мыңнан астам адам өз-өзіне қол жұмсап өледі. Әрбір өз-өзіне қол жұмсау - бұл марқұмның жақындары үшін ұзақ мерзімді салдары бар отбасыларға, қауымдастықтарға және бүкіл елдерге әсер ететін қайғылы оқиға. Өз-өзіне қол

жұмсаудың уақыты сыртқы факторларға да байланысты болуы мүмкін. Осы тақырыптағы зерттеулер суицид пен жылдың белгілі бір күндері немесе маусымдары арасындағы байланысқа қатысты біршама қарама-қайшы нәтижелер береді. Маусымдық факторлар суицид деңгейіне және суицид әрекеттерінің санына да әсер етеді.

Мақсаты: Павлодар өңіріңде, соның ішінде Өскемен және Семей қалалары бойынша суицид деңгейіне апта күндерінің, айлардың, маусымдық ауытқулардың және ай фазаларының әсерін пайымдау.

Құралдар мен әдістер: Ретроспективті зерттеу. Жасалған суицидтердің уақыт қатарындағы маусымдылықты анықтау үшін Loess әдісін қолдану арқылы маусымдық трендтің декомпозициясы қолданылды. Маусымдық ауытқуларды анықтау үшін графикалық әдістер, сонымен қатар QS және Kruskal-Wallis статистикалық сынақтары қолданылды. Маусымдық әсер тенденциялар мен маусымдарды есепке алатын сызықтық регрессия үлгісін қолдану арқылы бағаланды. Өскемен, Семей қалалары және Павлодар облыстарында 2013-2022 жылдар аралығындағы сот-медициналық сараптамалардың деректері жинақталды, оның ішінде 3657 өз-өзіне қол жұмсау. Айнымалылар: апта күндері, айлар, ай фазасы.

Нәтижелер. Краскал-Уоллис сынағы $\chi2(3) = 15,35$, $p = 0,00154127$ тоқсандар арасында статистикалық маңызды айырмашылықтар бар екенін көрсетті. Сонымен қатар, QS статистикалық критерийі маусымдық $QS = 7,65$, $p = 0,02185496$ көрсеткіштер бар екенін көрсетті. Екінші тоқсанда суицидтің орташа көрсеткіштерінің артуы. Аяқталған суицидтердің артуы мен азаюы аптаның барлық күндерінде болады. Квази-Пуассон регрессиясы ай фазаларының өзін-өзі өлтіру санына әсер етпейтінін анықтады.

Қорытындылар. Зерттеу нәтижесінде жылдың екінші тоқсанында (сәуірден маусымға дейін) суицид санының өскені анықталды, бұл ретте суицид санының апта күндеріне немесе ай фазаларына айтарлықтай тәуелділігі анықталмаған.

Түйінді сөздер: *эпидемиология, суицид, өлім, маусымдық, апта күндері.*

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Introduction

Suicide is a global public health problem. Every year, more than 720,000 people die by suicide. Each suicide is a tragedy that affects families, communities, and entire countries, with long-term consequences for the loved ones of the deceased [25]. The timing of suicides may also depend on external factors. Research on this topic has so far yielded somewhat contradictory results regarding the association of suicides with specific days or seasons of the year [7].

Seasonal factors, such as changes in weather and social conditions, significantly influence the level of suicides and the number of suicide attempts. Changes in climatic conditions, daylight duration, and social interactions at different times of the year can have both positive and negative effects on the mental health of the population. For example, the spring months, when there is an increase in sunlight, may be associated with heightened social activity, which, as studies show, sometimes leads to an increase in suicide rates due to increased social tension [14]. Furthermore, seasonal fluctuations in social behavior may impact the number of suicides, highlighting the complexity of this issue [24]. It is important to note that the suicide rate is influenced by temporal cycles, such as days of the week, seasons, and lunar phases. Scientific studies indicate that the number of suicides varies according to these factors [20]. This suggests that the time of day and week may also affect people's emotional states and behavioral responses.

Unfortunately, the suicide rate in Kazakhstan remains one of the highest in the world, and the frequency of suicides among men significantly exceeds that among women [9, 12, 23]. This underscores the importance of a deeper understanding of suicidal behavior and the need for effective suicide prevention strategies. To achieve this, it is necessary to investigate temporal changes in suicide rates, focusing on both annual trends and seasonal fluctuations, days of the week, and times of day [10]. Comparing patterns of seasonal suicides among geographically, demographically, and socially heterogeneous populations should help shed light on the underlying factors influencing these patterns and better explain the mechanisms of this phenomenon [27]. One of the early researchers in this area was Morselli, who conducted a comparative study of the monthly distribution of suicides in 17 European countries from 1827 to 1877. He noted that the number of suicides consistently increased from the beginning of the year until June, and then gradually decreased until the end of the year [10]. In the 19th century, Durkheim studied the distribution of suicides by season and time of day. He

argued that increased social activity in spring and summer leads to heightened social tension, causing a seasonal peak in suicides in the second quarter of the year, coinciding with spring in Europe (Durkheim, 1897) [15].

Thus, studying the temporal aspects of suicides is an important step toward understanding this complex issue and developing effective measures for its prevention.

This investigation aimed to analyze the impact of the days of the week, months, seasonal fluctuations, and lunar phases on the level of suicides in the Pavlodar region, including the cities of Ust-Kamenogorsk and Semey

Materials and Methods. Design: A retrospective cohort study was conducted. Data from forensic medical examinations in Ust-Kamenogorsk, Semey, and Pavlodar region were collected for the period from 2013 to 2022, encompassing 3657 suicide deaths. Variables included: days of the week, months, lunar phase. Prior to data collection, the study received ethical approval from the Ethics Committee of Semey Medical University (protocol No. 4, November 20, 2021).

Statistical analysis. The statistical analysis was conducted using SPSS version 20.0 (IBM Ireland Product Distribution Limited, Ireland). To determine seasonality in the time series of completed suicides, seasonal-trend decomposition using the Loess method was employed. In addition, graphical methods were used to identify seasonality, as well as the QS statistical criterion and the Kruskal-Wallis test. A linear regression model was used to assess the impact of seasonality, taking into account trends and seasons. To evaluate the influence of lunar phases on the number of completed suicides, quasi-Poisson regression was used.

Results. Analysis of Quarterly Seasonality of Completed Suicides.The data breakdown indicated the presence of a trend and seasonality throughout the year. Suicide cases exhibit a decreasing trend. The figure shows that seasonality and the residual contribute significantly to changes in the time series; the seasonal component has the following structure: at the beginning of the year, there is a low number of suicide cases, followed by an increase in the second quarter and a decline towards the end of the year (Figure 1).

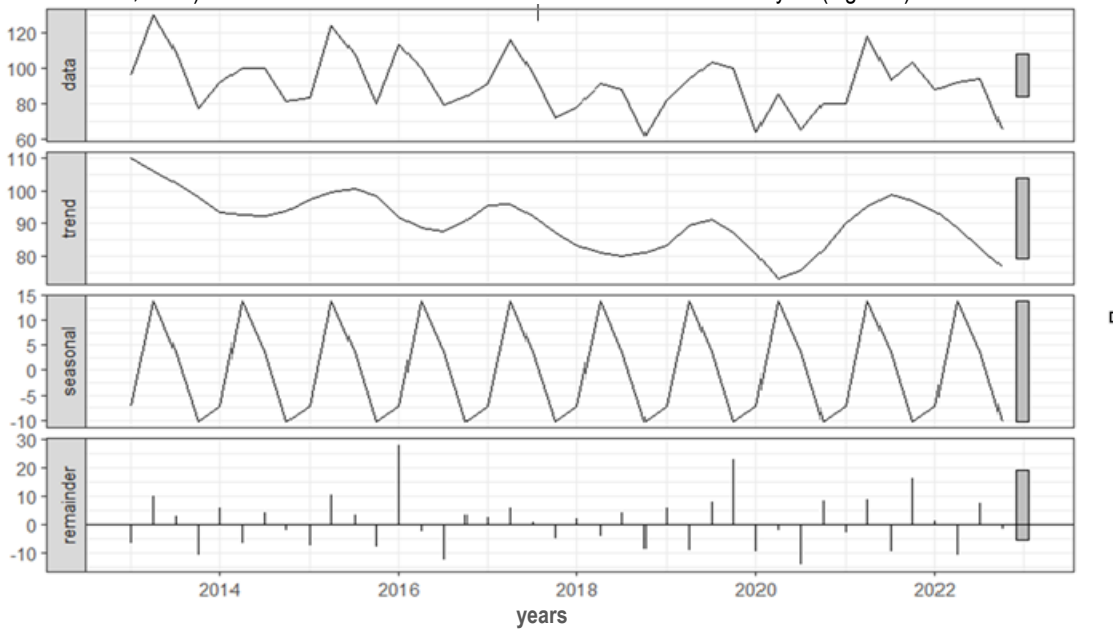

Figure 1. Analysis of quarterly seasonality of completed suicide cases.

On the seasonal graph, an increase in the number of suicides in the second quarter of the year is also observed (Figure 2).

Also, in the seasonal trend graph over all the years, there is an increase in the average number of suicides in the second quarter of the year (Figure 3).

The Kruskal-Wallis test showed that there are statistically significant differences between the quarters $\chi2(3) = 15.35$, $p = 0.00154127$. Moreover, the QS statistical criterion indicated the existence of seasonality $QS = 7.65$, $p = 0.02185496$. The linear model shows that Season 2 has a statistically significant increase in the number of suicides by 18.73 cases compared to Season 1 (Table 1). There is a trend of decreasing suicides by 0.403 cases per quarter.

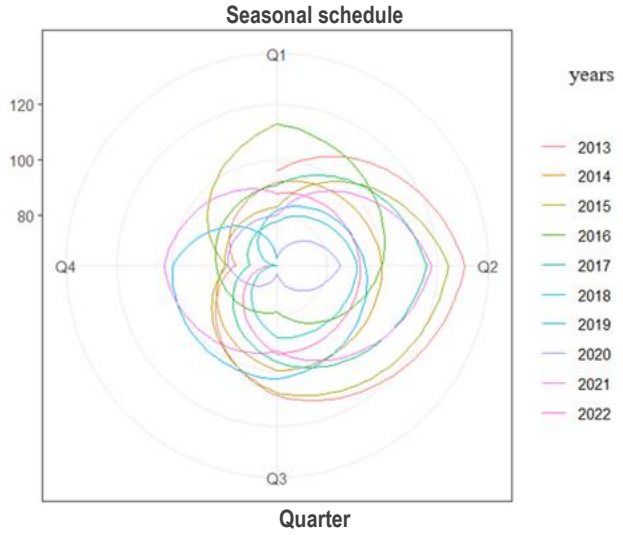

Figure 2. Seasonal chart of completed suicides from 2013 to 2022.

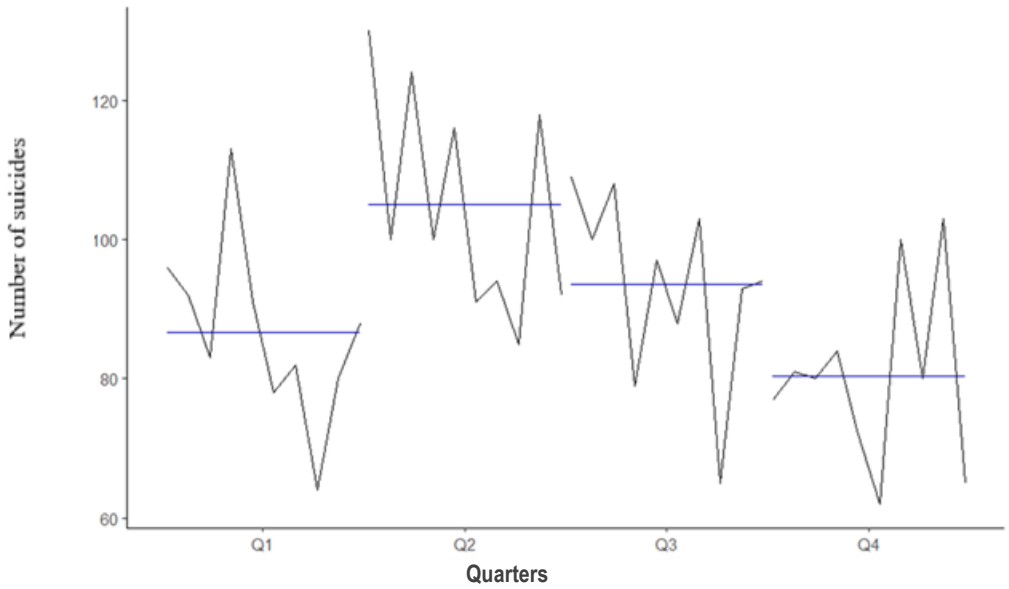

Figure 3. Seasonal chart of completed suicides from 2013 to 2022.

Table 1.

Values of the linear regression model considering seasons and trend.

Assessment	Statistical error	t value	Pr(>|t|)	**p-value**
(Intercept)	94.350	5.403	17.462	0.0000
Trend	-0.403	0.181	-2.222	0.0329
Season 2	18.703	5.892	3.174	0.0031
Season 3	7.705	5.900	1.306	0.2001
Season 4	-5.092	5.914	-0.861	0.3951

Residual standard error: 13.17 on 35 degrees of freedom
Multiple R-squared: 0.4081, Adjusted R-squared: 0.3405
F-statistic: 6.034 on 35 and 4 DF, p-value: 0.0008

Analysis of seasonality by month of completed suicides.

The data breakdown showed a slight seasonality throughout the year (Figure 4).

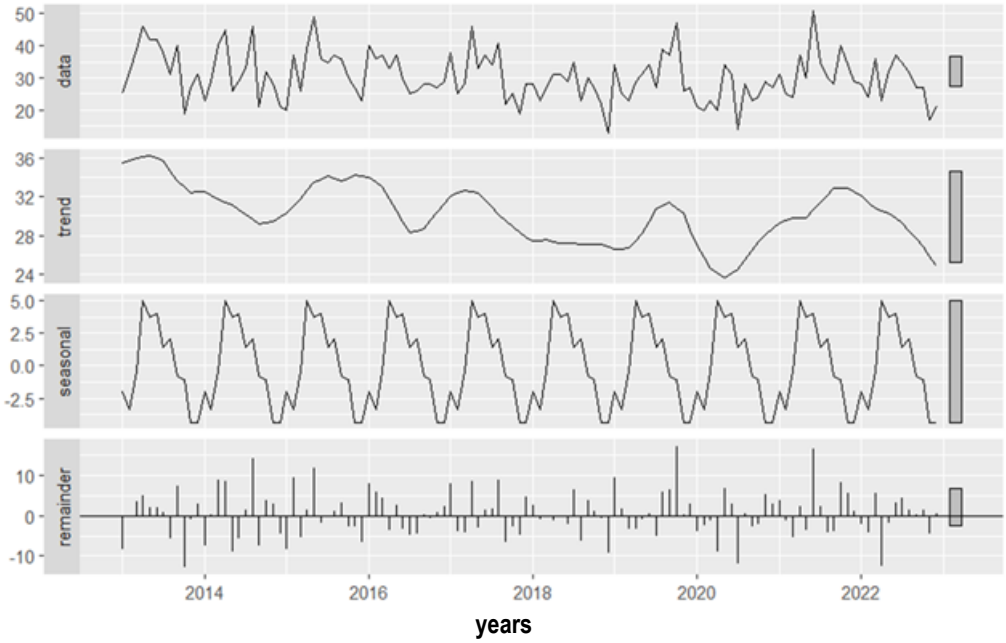

Figure 4. Analysis of seasonality by month of committed suicide cases.

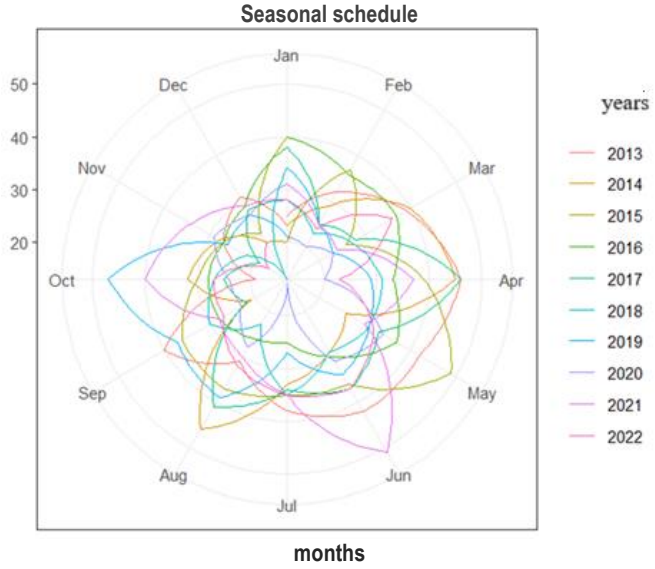

Figure 5. Analysis of seasonality by month of committed suicide cases from 2013 to 2022.

The seasonal chart did not reveal any seasonality in the months of the year (Figure 5).

The seasonal chart shows a persistent increase in the number of suicides from April to June (Figure 6), which coincides with quarterly seasonality.

The Kruskal-Wallis test showed that there were no statistically significant differences between the months $\chi2(3) = 12.94$, $p = 0.29$. The QS statistical test also did not indicate the existence of seasonality $QS = 0$, $p = 1$.

Analysis of the seasonality of completed suicides based on the days of the week.

The data breakdown revealed a slight seasonality (Figure 7).

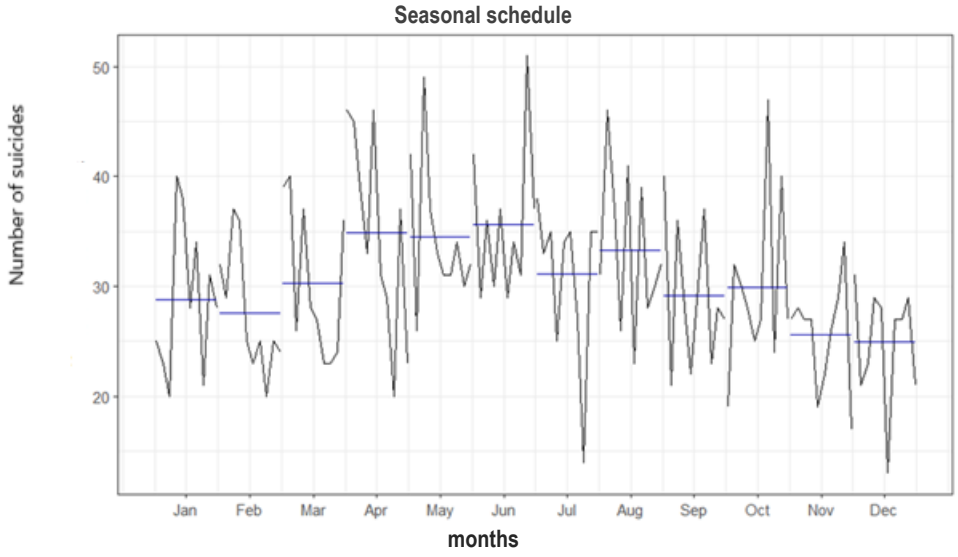

Figure 6. Analysis of seasonality by month of committed suicide cases.

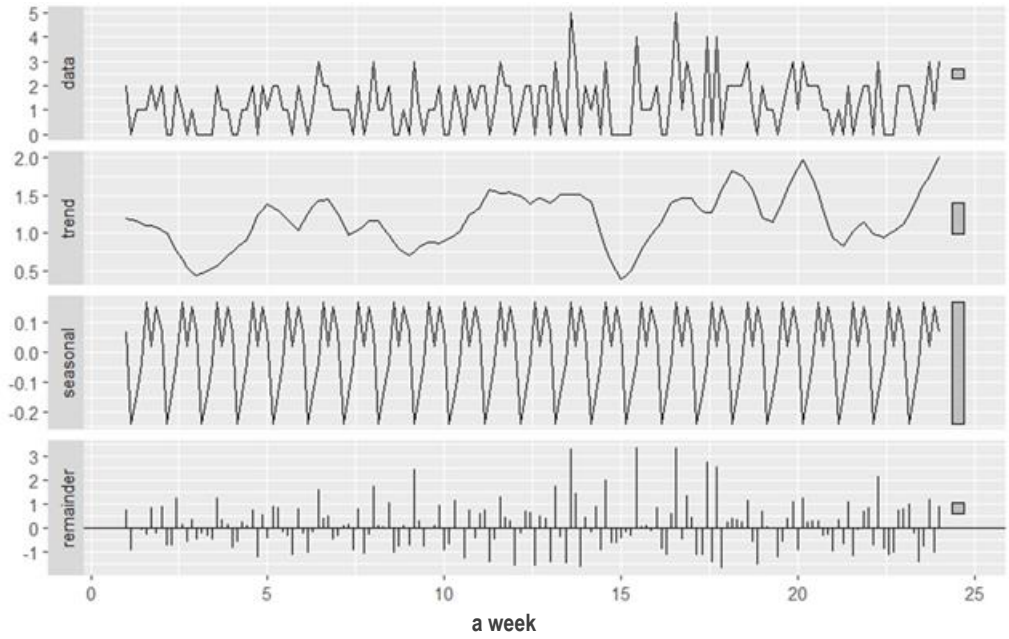

Figure 7. Analysis of the seasonality of committed suicide cases depending on the days of the week.

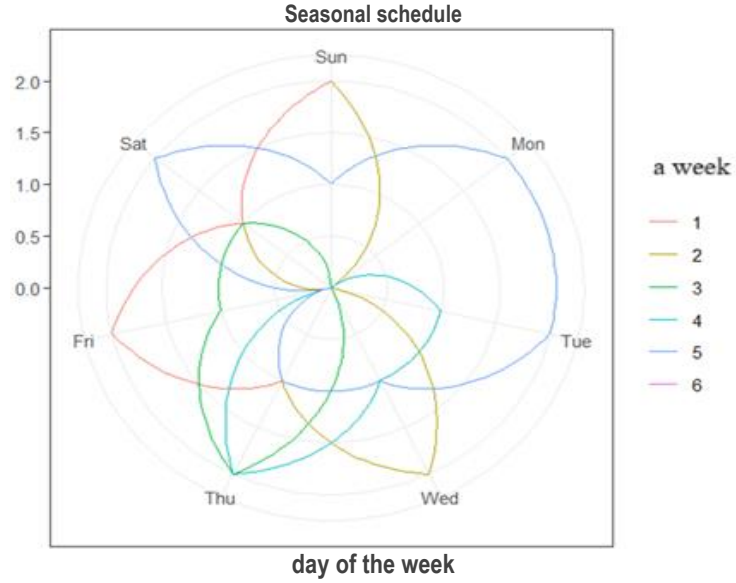

Figure 8. Analysis of the seasonality of committed suicide cases depending on the days of the week.

The seasonal graph does not show any seasonality by days of the week (Figure 8). Increases and decreases in completed suicides occur on all days of the week.

The quasi-Poisson regression did not reveal an influence of lunar phases on the number of suicides committed (Table 2).

Discussion of results

The goal of our research is to conduct a deep analysis of the influence of various temporal factors, such as days of the week, months, seasons, and lunar phases, on the level of suicides in the Pavlodar region, as well as in Ust-Kamenogorsk and Semey. Studies regarding the timing of suicide attempts are significant for several reasons.

Table 2.

Values of the Quasi-Poisson regression model.

	Assessment	Statistical error	z value	p	
(Intercept)	4.553	0.042	109.309	0.0000	***
Full moon	-0.054	0.060	-0.906	0.3708	
New moon	-0.075	0.060	-1.257	0.2168	
Waning moon	-0.021	0.059	-0.360	0.7212	

*Statistical significance: 0 <= '***' < 0.001 < '**' < 0.01 < '*' < 0.05*

(The dispersion parameter for the quasi-Poisson family is taken to be 1.646327)

The sum of squares of deviations of sample values from their mean: 59.23 with 36 degrees of freedom.

Firstly, they help us identify specific periods when individuals are most vulnerable to suicidal thoughts and actions. Understanding these temporal patterns allows for targeted intervention and support during critical moments, which can significantly reduce the level of suicide.

In our research, we observe a persistent increase in the number of suicides from April to June. This observation aligns with the results of several international studies that also recorded peaks in the number of suicides in spring and early summer [1, 4, 22]. In the studies by *Chi-Leung Kwok*, it was found that completed suicide cases peak in summer (from May to July) and reach a minimum in winter (in December) [17]. Korean researchers also identified seasonal patterns, indicating that the highest number of cases occurs in spring [27]. An analysis of data from the Australian mortality database for 2000 and subsequent years, conducted by Australian scientists, showed that the suicide rate remains stable and is not dependent on gender and age. However, seasonal fluctuations were identified: the peak occurs in January, a decrease in late summer and autumn, relatively stable rates are observed in winter and an increase in spring, followed by a decrease in November-December [5]. Brazilian scientists noted that suicide attempts most frequently occur in spring and summer [6]. Researchers observed significant and recurring seasonal patterns of suicides and suicide attempts in France, with a peak in spring [3]. Researchers observed significant and recurring seasonal patterns of suicides and suicide attempts in France, with a peak in spring [2]. Warsaw scientists identified a spring peak of suicides among men and an autumn peak among women [18].

According to the results of our research, there is a stable increase in the number of suicide cases from April to June. Researchers from Poland established that the months with the highest number of suicide attempts are June, May, and July, while the lowest rates are observed in February, January, and November [16]. Scientists from South Korea, *Chi Ting Yang*, in their studies found that a high frequency of suicides is observed during the summer period, from May to August [26].

Seasonal fluctuations in suicide mortality have been the subject of extensive research; however, patterns related to the days of the week have been studied much less thoroughly. In our study, it was established that the days of the week do not influence the suicide rate. Research by *Martin Plöderl* indicates that the suicide rate increases on Mondays and decreases on weekends throughout the week [20]. Studies by Indian researchers found that on weekdays, the highest number of suicide attempts is recorded on Fridays, followed by Mondays, while the lowest number of cases occurs on Sundays [13]. Furthermore, significant differences in the frequency of suicides were found

depending on the day of the week, with peaks on Monday and Tuesday, as well as seasonality with an increase in cases during the spring and summer months [8]. Researchers from South Korea found that the frequency and proportion of suicide deaths were highest on Mondays [19].

According to the results of our studies, quasi-Poisson regression did not reveal any influence of lunar phases on the number of completed suicides. Researchers from Northern Europe obtained similar results to those in our study. Italian researchers and scholars from Northern Europe reached comparable findings to our research. The data obtained indicate that lunar phases do not influence suicidal behavior [21]. American researchers *R. Bhagar* and *H. Le-Niculescu* found in their studies that the suicide mortality rate increased during the week of the full moon [11]. These results underscore the need for further research to better understand what factors may influence suicidal behavior and how this knowledge can be used to develop effective prevention strategies.

Conclusion. As a result of the study, an increase in the number of suicides was identified in the second quarter of the year (from April to June), while no significant dependence of the number of suicides on the days of the week or lunar phases was established.

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Author Contributions:

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Saulesh Apbassova: writing - review and editing, and funding acquisition.

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