Assessment of the relationship between Google Trends search data and national suicide rates in Türkiye

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Abstract

Aim: The present study aimed to examine possible relationships between suicide-related terms obtained from Google Trends and actual suicide data and whether these relationships differ according to sex.

Materials and Methods: The study period was from 2009 to 2019. In this study, suicide data were collected from the suicide statistics of the Turkish Statistical Institute (TUIK) for this timeframe. Google Trends was used to examine the search trends of suicide-related terms in Turkey. Pearson correlation analysis was used to find associations between the data obtained from TUIK and Google Trends. Finally, linear regression analysis was performed to identify predictors of monthly completed suicide rates in the general population.

Results: In our study, 105 search terms obtained from Google Trends were examined to find associations with suicide rates in a specific timeframe. Among them, 31 terms had positive correlations, and nine had significant negative correlations. The terms "allergy" and "pain" were the most closely related to the overall suicide rates. Other significantly correlated terms were "how to commit suicide", "to commit suicide", "depression," and "hallucination". In addition, significantly different results were found for men and women.

Conclusion: The present study showed that suicide-related terms obtained from Google Trends may predict actual suicide rates and may be an easy way to monitor suicide trends in Turkey. Future studies should use a more comprehensive internet network, including social media and other search engines, and consider other variables related to suicide to better understand this relationship.

Introduction

Suicide is death caused by injuring oneself with the intent to die. Approximately one million people die by suicide yearly [1, 2]. In our country, the Turkish Institute of Statistics (TUIK) reported that the suicide rate in 2019 was 0.62 per 100,000 people aged under 15 years and 4.95 for those aged 15 to 19 years [3]. Suicide is a multidimensional behavioral outcome associated with various biological, psychological, and social factors. Therefore, understanding suicide risk factors that can be recognized and modified is crucial for suicide prevention. Although there is no way to predict suicide with certainty, there are some risk factors and determinants. These include mental illness, social causes, biological and genetic predispositions, and physical illness. Among these risk factors, psychiatric disorders have the greatest impact on suicide rates [4-6].

Given that Google is increasingly incorporated into research in the field of health, as in all areas of life, it is becoming a beneficial instrument for studying mental health and human behavior [7, 8]. Google Trends, a Google Labs device, is a free, simple-to-use tool for accessing search data from a sizable population and gaining insightful knowledge about how people generally behave and how their behavior relates to health and health care. This potential is particularly apparent when the data of an actual epidemiological event in a certain location show an essential link with an abnormal increase in the search frequency of a word describing an epidemiological event (for example, an influenza epidemic) in a specific timeframe [9].

People frequently look for mental health information online because they believe it is less stigmatizing than receiving professional care [10]. On the other hand, there is increasing concern that as the frequency of searching for

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health-related information online rises, people at risk of suicide are using the internet more regularly to look up information about suicide. Users may find content that both encourages suicide and attempts to prevent suicide and information that addresses people searching for information about suicide online who need aid [11, 12]. In the presuicidal period, people may intensify their research on terms related to their mental state and confusion, psychiatric symptoms and disorders, and the social, relational, and economic difficulties they experience. They may also intensify their searches for terms that reflect the need for help. Even worse, search phrases will take individuals at risk of suicide directly to websites that provide suicide techniques, tools, and plans without providing medical help [13]. Numerous researchers have investigated the connection between the volume of searches using suicide-related search terms and suicidal behavior due to the possibility that these search results could aid in the prediction of suicide as well as alter an information seeker's behavior by influencing their suicide-related thoughts and plans [14, 15].

The relationship between the volume of Google Trends searches using terms and the suicide rate has been the subject of various studies in the literature. Although some studies have claimed that Google Trends data can help predict suicide [16-18], Tran et al. [19] suggested that this was not the case in their multicenter study conducted between 2004 and 2012. They stated that Google Trends did not appear to be a reliable tool for the prediction of suicidal acts and had limited validity in estimating national suicide rates. Despite these studies, to our knowledge, no research has been conducted on the correlation between the actual rate of suicide and the volume of Google searches using these terms in our country. In this study, we aimed to ascertain whether there are possible relationships between the volume of searches for suicide-related terms obtained from Google Trends and actual suicide data, as well as whether there are sex differences in these relationships. The main hypothesis was that there would be significant correlations between the volume of Google Trends searches using some suicide-related terms and the actual suicide rates. We also hypothesized that these relationships would be different for men and women.

Materials and Methods

Monthly suicide data from January 2009 to December 2019 were obtained from the online database of the Turkish Statistical Institute (TUIK), which is open to the public. TUIK is the only official institution that publishes suicide statistics in Turkey. No further permissions or ethical approvals were required to use this publicly available data posted on the internet [3]. In addition, our study did not involve human subjects, animals, TUIK, and Google Trends data are publicly published, there was no requirement for ethics committee approval, as in similar studies [5, 17, 19, 20]. Google Trends was used to examine the search trends for Turkey. Google Trends is an online search tool launched by Google in May 2006. Google Trends allows for a search of trends in Google searches over time and region. It analyzes the popularity of search queries in Google Search, providing information on the frequency

of specific keywords, subjects, and phrases across regions and languages over a specified period. In addition, the data, presented in a graphical format, can be downloaded as CSV files [8]. Google Trends normalizes search data by dividing each data point by the total number of searches for the region and period it represents. After that, the figures are scaled from 0 to 100 based on the percentage of searches for each topic across all issues. The total number of searches for a term may differ across regions with similar search interests. Low-volume search terms are represented by "0," high-volume search terms are represented by "100," and others are in the middle. It is important to remember that Google Trends excludes searches that a specific user repeatedly submits in a short period. Google Trends does not display the total number of searches. Regardless, the relative query rate for a search phrase is calculated. This means that Google divides the total number of searches conducted in each location at any given time by the total number of searches conducted for a specific term. The results are then standardized using a Google Trends Relative Search Volume (RSV) index ranging from 0 to 100, with a value of 100 denoting the period when the volume of searches for that phrase is at its peak. To clarify, the RSV index adjusts the query percentage of search terms (from 0 to 100), which is the ratio of the total volume of queries in each geographic location to the total number of searches in that region. As an RSV value, the maximum search percentage in the specified time is adjusted to 100, and all subsequent measurements for that period are calculated using that value [8].

The study initially utilized search terms from previous studies to generate a list of candidate search terms related to suicide [16, 17, 20]. These terms were translated into Turkish to search on Google Trends. Search statistics for these terms are obtained monthly from Google and only reflect searches made in Turkey. Afterward, we expanded the list of queries by discussing the authors and considering the characteristics of Turkish people. The study aimed to encompass a broad range of commonly used, non-medical terms in its analysis. Terms such as "baby blues," less frequently used, did not generate enough search volume to be analyzed and were therefore excluded. We collected the search terms between 01/01/2009 and 31/12/2019 in Turkey, a specific period to match the official figures provided by TUIK. The data is provided from Google Trends and lack gender differentiation, unlike the suicide data from TUIK. In addition, search terms were categorized as follows: variables related to suicide, variables related to mood and anxiety symptoms, stressor- and trauma-related variables, variables related to alcohol and substance use, sleep-related variables, variables related to psychopathology and treatment, and others. Lastly, the correlation between TUIK monthly suicide numbers and Google trends data in the timeframe was investigated and analyzed.

Statistical analysis

The data were analyzed using IBM SPSS Statistics version 21 (IBM Corporation). The distributions of the continuous variables were checked by using the Kolmogorov-Smirnov test. All continuous variables were normally distributed. The relationship between the monthly Google trend val-

Table 1. Number of positive and negative correlations among 50 Google search terms according to Evan's scale.

Correlation Strength	Evan's scale	General population
Very weak or none	0.00-0.19	7+ / 3-
Weak	0.20-0.39	28+ / 8-
Moderate	0.40-0.59	3+ / 1-
Strong	0.60-0.79	0
Very Strong	0.80-1.0	0

ues of the terms related to suicide and the number of completed suicide numbers per month was examined by Pearson correlation analysis. Weak, moderate, or strong relationship according to correlation values was made using the classification reported in Evans' study [21]. Linear regression analyses were performed to find predictors of monthly completed suicides in the general population. All variables that showed a statistically significant (p<0.05) relationship with the number of completed suicides in the Pearson correlation analysis were included as possible predictors. All the represented p values were two-sided, and statistical significance was determined as p<0.05.

Results

According to the TUİK suicide data between January 2009 and December 2019, the number of reported cases for men and women are 25,555 and 9,016, respectively, adding up to 34.571 in total. The Pearson correlation of the Google trends data between 2009 and 2019 for 105 search terms is calculated and categorized into five classes according to Evan's scale, as shown in Table 1. 40 terms have a weak to moderate correlation. Among them, 31 terms have a positive, and nine have a negative correlation (Table 1). Accordingly, the number of completed suicides per month in the general population was found to be weakly correlated with the search terms "is suicide a sin?", "suicide plan", "attempted suicide", "teen suicide", "killing oneself", "shooting oneself", "postpartum depression", "abandonment", "insomnia", and "psychosis". On the other hand, it has a moderate relationship with the terms "how to commit suicide", "to commit suicide", "separation", and "allergy". The Google trend value for none of the search terms had a solid or robust association with monthly suicide data (Table 2).

When the relationship between the number of monthly completed female suicides obtained from TUIK and the Google trend values was examined, it was found that Google trend values of no search terms did not have a moderate, strong, or powerful relationship with the number of suicides. On the other hand, the rate of male suicides was weakly correlated with Google trend values of the terms "allergy", "headache", "pain", "psychologist", "psychiatrist", "I cannot sleep", "drugs", "alcohol", "litigation", "unemployment", "loneliness". At the same time, it has a moderately significant correlation with the search terms "breakup", "distress", "anxiety","bipolar", "anxiety disorder", "I want to die", "suicide", "how to commit suicide", and "suicide". However, we found that the Google trend value of none of the search terms had a strong or

very strong relationship with monthly suicide data for men (Table 2).

Linear regression analysis was performed to find predictors of monthly completed suicides in the general population. All variables (search terms) that showed a statistically significant (p<0.05) relationship with the number of completed suicides in the Pearson correlation analysis were included as possible predictors in the analysis. The model explained a significant percentage of the variance (adjusted R^2 = 0.494, F=5.444, df=120, and p=0.021). According to the analysis, Google trend values for the search terms "antidepressants", "pain", "how to commit suicide","headache", "allergy", "depression", "hallucination", and "to commit suicide" were found to be significant predictors of the number of completed suicides per month in the general population (ß=0.19 C.I: 0.07-0.87, p=0.021; ß=-0.847, P= 0.007, C.I= -2.318- 0.366; ß=0.33, P=0.001, C.I.= 0.244- 0.930; ß=1.385, P<0.001, CI: 1.275- 2.719; ß=-0.950, P<0.001, CI=-2.037-0.638; ß=0.221, P=.005, CI: 0.196-1.086; ß=-0.159, P=.018, CI: -0.907-0.087 and ß=-.163, P=0.023, CI: -0.605- 0.047).

To find the determinants of the number of completed suicides in men and women, linear regression analysis was performed, which included all variables that had a statistically significant (p<0.05) relationship with suicide rates in the previous correlation analysis. Both models for determinants of monthly suicide rates for men and women explained a significant percentage of the variance (adjusted R^2= 0.32 and 0.43, respectively). Significant determinants of female monthly completed suicides were found to be Google trend values of search terms "relationship problem", "suicide methods", "anxiety disorder", "being sacked", "harassment", "sleep problem", and "chronic illness" (Table 3). The predictors of male monthly suicides were determined as Google trend values of the search terms "separation", "how to commit suicide", "insomnia", "to commit suicide", and "to be abandoned" (Table 4).

Discussion

To our knowledge, this is the first study that evaluates the relationship between actual suicide rates and Google trends data in our country. As we hypothesized, this study mainly indicated that google trends values of some search terms related to suicide were significantly correlated to actual monthly suicide rates in Turkey. In addition, the fact that different search terms were found to be associated with monthly suicide numbers in women and men indicated that this relationship differs between genders. Moreover, the terms "antidepressants", "pain", "how to commit suicide", "headache", "allergy", "depression", "hallucination", and "commit suicide" were statistically significant predictors of the monthly suicide rates in the general population in the present study.

An important finding of our study is that Google trend values of two medical terms, "allergy" and "pain," were significantly correlated with the overall suicide rates in our study, which is consistent with other works [17]. A research study about depression in people suffering from allergies shows that physiological imbalances due to the hypo-responsiveness in the cholinergic and beta-adrenergic pathways of the autonomic nervous system are associated

Table 2. The correlations between monthly suicide rates and the volume of Google search terms related to suicide examined in Turkey between the years 2009-2019.

Google search terms (Original in Turkish)	English translation	Monthly correlations between google trends RSV values and TUIK suicide rates (2009-2019)		
İntiharla ilgili değişkenler	**Variables related to suicide**	Total	Men	Women
İntihar günah mı	*Is suicide a sin?*	0.198*	0.264**	-0.012
İntihar	*Suicide*	0.371**	0.509**	-0.160
İntihar düşüncesi	*suicidal ideation*	0.013	0.089	-0.049
İntihar planı	*suicide plan*	0.193*	0.154	0.122
İntihar girişimi	*suicide attempt*	0.199*	0.292**	-0.165
Genç intiharı	*teen suicide*	0.176*	0.202*	0.012
Çocuk intiharı	*child suicide*	-0.080	-0.091	-0.045
Ölmek istemek	*wanting to die*	0.272**	0.366**	-0.083
Kendini öldürmek	*kill yourself*	0.188*	0.240**	-0.037
Kendini öldürme	*don't kill yourself*	0.000	0.063	-0.162
İntihar konuşması	*suicide talk*	-0.258**	-0.242**	-0.122
Nasıl intihar edilir	*how to commit suicide*	0.410**	0.537**	-0.125
İntihar yolu	*way of suicide*	0.007	-0.035	0.072
Acısız intihar	*painless suicide*	0.229**	0.299**	-0.070
Kendini vurmak	*shoot yourself*	-0.179*	-0.153	-0.088
Atlayarak intihar	*suicide by jumping*	0.095	0.118	-0.022
Asarak intihar	*suicide by hanging*	0.054	-0.025	0.165
İntihar notu	*suicide note*	0.008	0.022	-0.043
İntihar tedavisi	*Suicide treatment*	-0.033	-0.097	0.091
İntihar ilacı	*suicide medicine*	0.087	0.068	0.094
İntihar düşünceleri	*suicidal thoughts*	-0.104	-0.079	-0.057
İntihar etmek	*Commit suicide*	0.424**	0.507**	0.017
İntihar girişimi	*suicide attempt*	0.113	0.196*	-0.214*
İntihar planı	*suicide plan*	0.075	0.034	0.080
İntihar yardım	*suicide help*	-0.025	-0.033	-0.032
İntihar yöntemleri	*Suicide methods*	0.110	0.041	0.179*
Kendini asmak	*hang yourself*	0.202*	0.215*	-0.024
Yüksekten atlamak	*jump high*	0.225**	0.336**	-0.170
Ölmek istiyorum	*I want to die*	-0.320**	-0.457**	0.117
Duygudurum ve anksiyete belirtileri ile ilgili değişkenler	**Variables related to mood and anxiety symptoms**	Total	Men	Women
Depresyon belirtileri	*depression symptoms*	-0.238**	-0.378**	0.123
Depresyondayım	*I'm depressed*	-0.224**	-0.300**	0.054
Doğum sonrası depresyon	*postpartum depression*	-0.177*	-0.193*	-0.019
Antidepresanlar	*antidepressants*	0.305**	0.378**	-0.039
Umutsuzluk	*Despair*	-0.081	0.061	-0.257**
Bipolar bozukluk	*Bipolar disorder*	0.208*	0.306**	-0.172*
Anksiyete bozukluğu	*anxiety disorder*	0.313**	0.448**	-0.173*
Gevşeme	*Relaxation*	-0.058	0.030	-0.183*
Bilişsel davranışçı terapi	*cognitive behavioral therapy*	0.264**	0.396**	-0.159
Rahatlama	*Relaxation*	0.249**	0.376**	-0.160
Bipolar	*bipolar*	0.293**	0.442**	-0.217*
Mani	*mania*	-0.243**	-0.182*	-0.196*
Hipomani	*hypomania*	0.138	0.131	-0.006
Bipolar depresyon	*bipolar depression*	-0.022	-0.056	0.060
Depresyon	*Depression*	-0.213*	-0.162	-0.201*
Anksiyete	*Anxiety*	0.307**	0.446**	-0.180*
Yaygın anksiyete bozukluğu	*generalized anxiety disorder*	0.146	0.167	-0.053
Panik atak	*Panic attack*	0.225**	0.340**	-0.198*
Fobi	*Phobia*	-0.123	-0.087	-0.163
Ajitasyon	*Agitation*	0.051	0.033	0.091
Bitkinlik	*Fatigue*	0.100	0.217*	-0.144
Sıkıntı	*Trouble*	0.369**	0.495**	-0.106
Ağır depresyon	*severe depression*	0.245**	0.296**	0.000
Majör depresyon	*major depression*	-0.033	0.033	-0.174*
Manik depresyon	*Manic depression*	-0.041	-0.060	0.049
Moral bozukluğu	*Despondency*	-0.275**	-0.360**	0.069
Mutsuzluk	*Unhappiness*	0.084	0.225**	-0.142
Hayat anlamsız	*life is meaningless*	-0.001	-0.087	0.165
Hayattan zevk alamamak	*not enjoying life*	-0.033	-0.070	0.045
Stresör ve Travma ile ilişkili değişkenler	**Stressor and Trauma-related variables**	Total	Men	Women
Ayrılık	*Separation*	-0.419**	-0.551**	0.097
Ayrılmak	*To leave*	0.283**	0.400**	-0.147
Sosyal izolasyon	*Social Isolation*	0.026	0.055	-0.093
Sosyal destek	*Social support*	0.050	0.169	-0.283**
İlişki sorunu	*relationship problem*	-0.124	-0.036	-0.223*
Travma	*Trauma*	0.144	0.292**	-0.207*
Posttravmatik stres bozukluğu	*posttraumatic stress disorder*	-0.080	-0.090	-0.033
Taciz	*Abuse*	0.061	-0.102	0.311**
Cinsel istismar	*sexual abuse*	0.127	0.256**	-0.150
Sözlü taciz	*verbal abuse*	0.028	0.028	0.018
İşten çıkarılmak	*To be fired*	0.097	0.237**	-0.234**
Yalnızlık	*Loneliness*	-0.295**	-0.403**	0.072
Terkedilmek	*To be abandoned*	0.199*	0.365**	-0.181*
Boşanmak	*Divorce*	0.265**	0.381**	-0.135
Stres	*Stress*	0.048	0.148	-0.124
Kanser	*Cancer*	0.129	0.316**	-0.338**
İşsizlik	*Unemployment*	0.203*	0.400**	-0.301**
İşten kovulmak	*To be fired*	0.233**	0.243**	0.120
Evlilik	*Marriage*	-0.159	-0.158	0.000
Dava	*Case*	0.295**	0.435**	-0.189*
İlişki ayrılık	*relationship breakup*	-0.010	-0.094	0.132
Sosyal refah	*Social welfare*	-0.079	0.010	-0.191*
Alkol ve Madde kullanımı ile ilgili değişkenler	**Variables related to alcohol and substance use**	Total	Men	Women
Alkol	*Alcohol*	0.325**	0.459**	-0.169
Alkol bağımlılığı	*Alcohol addiction*	-0.115	0.029	-0.268**
Alkol yoksunluğu	*alcohol withdrawal*	-0.050	-0.014	-0.151
Madde bağımlılığı	*substance abuse*	-0.052	0.127	-0.284**
Sarhoşluk	*Inebriation*	-0.132	-0.113	-0.052
Uyuşturucu	*Drugs*	0.313**	0.442**	-0.156
Uyku İle ilişkili değişkenler	**Sleep - related variables**	Total	Men	Women
Uyku bozukluğu	*Sleeping disorder*	-0.005	0.145	-0.273**
Uyku sorunu	*Sleep problem*	0.100	0.244**	-0.179*
Uyuyamıyorum	*I can't sleep*	0.368**	0.442**	-0.023
Uykuya dalamıyorum	*I can't fall asleep*	0.021	0.032	0.021
İnsomnia	*insomnia*	-0.190*	-0.285**	0.022
Uykusuzluk	*Insomnia*	0.044	0.194*	-0.274**
Psikopatoloji ve tedavi ile ilgili değişkenler	**Variables related to psychopathology and treatment**	Total	Men	Women
Şizofreni	*Schizophrenia*	0.010	0.006	-0.006
Psikiyatrist	*Psychiatrist*	0.303**	0.439**	-0.200*
Psikolog	*Psychologist*	0.335**	0.482**	-0.192*
Psikoterapi	*Psychotherapy*	0.150	0.319**	-0.286**
Akıl sağlığı	*Sanity*	0.075	0.238**	-0.176*
Şizoafektif	*schizoaffective*	-0.006	-0.040	0.096
Psikoz	*Psychosis*	0.173*	0.274**	-0.116
Delüzyon	*delusion*	0.001	0.044	-0.126
Halüsinasyon	*hallucination*	0.356**	0.382**	0.067
Diğer	**Other**			
Ağrı	*Pain*	0.316**	0.483**	-0.208*
Baş ağrısı	*Headache*	0.280**	0.452**	-0.245**
Alerji	*Allergy*	0.404**	0.543**	-0.132
Astım	*Asthma*	0.079	0.072	-0.305**
Kronik hastalık	*chronic disease*	-0.095	0.040	-0.289**

*P<0.05, ** p<0.001

Table 3. Google search terms as predictors of women completed suicide rates in Turkey collected by the TUIK in the 2009-2019 period.

Google search terms	B	SE	Beta	t	p	95.0% CI for B		VIF
						Lower Bound	Upper Bound	
Cancer	-0.384	0.102	-0.496	-3.772	0.000	-0.585	-0.182	3.328
Relationship problem	-0.134	0.047	-0.214	-2.841	0.005	-0.227	-0.041	1.092
Suicide methods	0.105	0.052	0.149	1.993	0.048	0.001	0.208	1.082
Anxiety disorders	0.409	0.091	0.665	4.508	0.000	0.229	0.589	4.188
To be fired	-0.127	0.046	-0.264	-2.786	0.006	-0.218 1	-0.037	1.73
Abuse	0.218	0.072	0.271	3.020	0.003	0.075	0.361	1.556
Sleep problem	-0.155	0.063	-0.212	-2.469	0.015	-0.279	-0.031	1.419
Chronic disease	-0.126	0.057	-0.174	-2.220	0.028	-0.239	-0.014	1.189

VIF: Variance Inflation Factor CI: Confidence Interval.

Table 4. Google search terms as predictors of men completed suicide rates in Turkey collected by the TUIK in the 2009-2019 period.

Google search terms	B	SE	Beta	t	p	95.0% CI for B		VIF
						Lower Bound	Upper Bound	
Seperation	-0.521	0.165	-0.328	-3.148	0.002	-0.848	-0.193	2.489
How to commit suicide	0.419	0.144	0.280	2.909	0.004	0.134	0.704	2.130
Insomnia	-0.778	0.184	-0.377	-4.223	0.000	-10.143	-0.413	1.831
To commit suicide	0.336	0.130	0.266	2.594	0.011	0.080	0.593	2.414
To be abandoned	0.182	0.089	0.158	2.058	0.042	0.007	0.357	1.349

VIF: Variance Inflation Factor CI: Confidence Interval.

with depressive behaviors. The author further postulated that allergic reactions might worsen these imbalances and increase the risk of suicide [22]. On the other hand, previous research suggests that pain is an independent risk factor for suicide, and poorly managing pain has been identified as a risk for suicidal behavior [23]. Therefore, we argue that people who frequently search for "pain" online may be patients whose pain has not been adequately controlled and who seek help online.

Another interesting finding is that although the search term "major depression" does not correlate with suicide rates in our study, "depression" does. This phenomenon might be due to Turkish people's common usage of colloquial terms while searching. The correlation of a given search term can differ between countries. Also, terms that are similar in meaning can have different correlations due to cultural differences and semantic issues. For example, the term "divorce" was found to be positively correlated with suicide rates both in our study and in a Taiwanese study [24] but not in a Spanish study [17]. Interestingly "relationship breakup", like "divorce", is correlated with suicide in the Spanish study but not in our study. Notably, some terms like "depression," a well-known risk factor for suicide, as opposed to expected, are negatively correlated with suicide. This unexpected finding may be a sign that people who frequently search for such terms are seeking help with their mental state, and therefore these terms may have a protective effect on suicidal behavior. In addition, we argue that these searches could have been made by the depressed person's relatives, social circle, and healthcare professionals to learn about the condition and seek

help. While it is also possible that the depressed person did the searches to seek help, this is less likely because depression often causes low energy and loss of interest. On the other hand, this is the first study to suggest that the Google trends value of the term "hallucination" is a significant predictor of the general population's monthly suicide rate. In a review article on suicide risk factors in schizophrenia patients, the authors identified several illness-related risk factors associated with suicidal behaviors. They showed that psychotic symptoms such as hallucinations could be used to predict suicide in patients with schizophrenia [25]. In another article, the authors claimed that even subthreshold auditory hallucinations could be a valuable hint for predicting suicides [26].

In the present study, "how to commit suicide" and "to commit suicide" were significant predictors of the monthly suicide rates, as expected. However, the term "suicide" is not a significant predictor, despite being correlated. One explanation may be that almost anyone can search "suicide," whereas only individuals with serious suicidal intentions would search the other two terms. Notably, the terms "suicide", "depression", and other well-known risk factors of suicide are not correlated with suicide rates in the Spanish study. They believe that improved awareness and understanding of the risks can prevent suicidal thoughts from realization [17]. However, in the Taiwanese study, the term "suicide death" and other suicide-related terms, such as "major depression", "violent suicide", and "adult suicide" are significantly associated with suicide rates, as opposed to the Spanish study [17, 24]. Our interpretation of these disparities is that internet searches can affect individuals

differently. The results of the Google search of the term "suicide" can affect the mental state of a suicidal person. For instance, in some countries, finding out about a suicide help center through a Google search could be more accessible due to the higher availability of such centers in the country, whereas in other countries, websites containing internet bullies can be present in the search results, increasing the risk of committing suicide. On the other hand, one of the reasons for such unexpected findings may be the deficiencies in the study methodology and the current widespread use of Google Trends in this area.

We found that the Google search terms "insomnia, abandonment, and methods of suicide" were shared by men and women and significantly associated with actual suicide rates. Our findings also indicated that the Google trend values of the search terms "insomnia", "separation", and "to be abandoned", were determinants of the monthly suicide rate for males, consistent with other studies [27-29]. Suicidality and suicide risk factors for men have been linked to relationship breakdowns, economic problems, and work-related stress [30]. A recent meta-analysis also indicated that insomnia in adults may be a risk factor for suicidal ideation, suicidal behavior, and attempted suicide [27]. Other than common phrases, we found that the Google trend values of the search terms "being sacked" and "harassment" were significant predictors of the suicide rate for women in the present study. In a recent article, it was suggested that sexual harassment is prospectively associated with suicidal behavior [31]. In addition, a recent study found that the effect of unemployment on the suicide rate was much more prominent in women than in males [32]. Nonetheless, the fact that the suicide rates in men and women were associated with different search terms may be due to the differences in the use of the internet between the sexes, as well as the differences in the quality of suicidal behavior and coping behaviors for psychiatric problems and seeking help.

As with many studies, it cannot be ignored that our study has certain limitations. A limitation of the current study and much of the literature is that the research team generated the search terms, which may not represent the search terms used by suicidal individuals. On the other hand, the generalizability of our results is limited, as all Google searches analyzed in this study were conducted only in the Turkish language. Another limitation of the study is that it only examined the relationship between the total number of completed suicides per month and entire groups as a whole, rather than the relationship between a particular individual's suicidal behavior and internet search behavior; that is, individual characteristics were not examined. In addition, all search activities were not limited to potential suicidal events; these search queries, especially those related to the term "depression," could also be performed by people at risk of suicide, their friends and family, and physicians. Finally, a significant limitation was that we did not calculate time-lagged correlations between the volume of Google searches and suicide rates.

Conclusion

In conclusion, our study supports the link between suicide and internet search activity and suggests that inter-

net searches for suicide-related terms may predict the actual frequency of suicidal behavior. Similar to methods used for infectious diseases, the volume of internet searches may be a reasonable way to monitor suicidal tendencies. In addition, in this context, it is crucial to direct users to websites where they can get help rather than websites providing pro-suicidal information. Google may change its algorithm to place suicide prevention websites on the first page after searches for suicide-related terms because websites on the first page are the most frequently viewed by internet users. Last, future studies should use a more comprehensive internet network, including social media and other search engines, and consider other variables related to suicide to better understand the relationship between suicidal behavior and internet search data.

Ethical approval
Because our study did not involve human subjects and animals, and TUIK and Google Trends data are publicly published, there was no requirement for ethics committee approval, as in similar studies [5, 17, 19, 20].

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