ORIGINAL RESEARCH

A Google Trends-based approach for monitoring NSSI

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Abstract: Non-suicidal self-injury (NSSI) is an intentional, direct, and socially unacceptable behavior resulting in the destruction of one's own body tissues with no intention of dying or committing suicide, even though it is associated with a higher risk of attempted, planned, or just considered suicide. In this preliminary report, we introduce the concept of "NSSI 2.0"; that is to say, the study of the Internet usage by subjects with NSSI, and we introduce a Google Trends-based approach for monitoring NSSI, called NSSI infodemiology and infoveillance. Despite some limitations, Google Trends has already proven to be reliable for infectious diseases monitoring, and here we extend its application and potentiality in the field of suicidology. Ad hoc web portals and surveys could be designed in light of the reported results for helping people with NSSI.

Keywords: infodemiology, infoveillance, Internet, non-suicidal self-injury

Introduction
NSSI 2.0

Non-suicidal self-injury (NSSI) is a deliberate and direct behavior, not conforming to social, cultural, and religious norms, and resulting in the destruction of one's own body tissues. It is direct since indirect forms of procuring self-harm like substance use, eating disorders, and heavy drinking are not considered as NSSI. It is deliberate since it is intentional, voluntary, and consists of an action or a series of actions carried out with no intention of death or committing suicide,[1] even though NSSI is associated with a higher risk of considered or attempted suicide.[2] Some studies have shown that NSSI is able to predict suicidal behaviors, and that subjects engaged in NSSI are seven times more likely to report making at least one suicidal gesture; ten times more likely to report making at least one suicide attempt; three times more likely to report having thought of suicide; and six times more likely to report having planned it.[3] Other studies have replicated this association between NSSI and suicidal tendencies, such as in the prospective survey performed by Guan et al[4] or in the study conducted by Nock et al[5] who found that over 70% of adolescent self-injurers reported at least one lifetime suicide attempt and 55% of them multiple attempts. Moreover, they discovered that this particular subgroup of NSSI injurers was characterized by a longer history of NSSI, no experience and/or feelings of pain during the injurious episodes, and a higher heterogeneity in practicing it. For these reasons, Joiner speculated that NSSI injurers were initially frightened by the idea of suicide and only after multiple attempts would they become more competent and confident with it.[6] A longer history of NSSI could be

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considered a good predictor of suicide attempts. On the other hand, NSSI could function as a strategy for avoiding suicide, such as a "replacement action" or a substitute for suicide.[7] However, the precise nature of the relationship between NSSI and suicidality remains speculative and unclear.

Even though NSSI is not defined on the basis of its frequency, reiterated and repeated episodes of NSSI are more likely to follow the first episode (reinforcing theory).[7] Common examples and modalities of NSSI behaviors include self-cutting (generally on the inside part of the arms), scratching, scraping, burning, bruising, biting, pinching, breaking bones, skin picking, hair pulling/ripping, interfering with wound healing, embedding objects, carving words and/or symbols, needlesticking, hitting walls, and banging/punching themselves and objects.[7–11] More than half of self-injurers make use of multiple methods[10] and, as already mentioned, this heterogeneity in practicing NSSI is related with a higher risk of long-term NSSI.

NSSI is a highly prevalent disorder, having an estimated lifetime prevalence among adolescents varying from 5.5% to 30.7%, while the 12-month prevalence rates vary from 7.5% to 37.2%, and the 6-month prevalence rates vary from 13.9% to 16.3%,[12] while among adults, lifetime prevalence is computed to be 5.9% with a 12-month prevalence rate of 0.9%.[10]

NSSI has, therefore, an important impact on society and represents a huge burden in terms of epidemiology, clinical relevance, and economic costs. NSSI is thus an important public health concern. Costs can be direct and include costs for health care delivery (such as psychopharmacological treatment; psychotherapy; and management of wounds, cuts, burns, or bruises); and indirect such as those due to morbidity, decreased productivity at work, school absence, impairment in social life because of damaged or lost relationships, and self-conscious negative feelings and emotions such as guilt, shame, and embarrassment.[13,14]

Even if there is a lack of an unambiguous and consistent terminology (many synonyms exist such as deliberate self-injury, deliberate self-harm, non-suicidal self-mutilation, and self-wounding, with slight differences)[7–8,11] and NSSI remains an "umbrella term" rather than a precise self-defined nosological entity,[15] and despite many efforts of providing a systematic and comprehensive consensus (it is worth mentioning the "Classification of Self-Injurious thoughts and behaviors"),[16] interest in exploring NSSI is increasing in the scientific community, a growing body of evidence is accumulating, and proposals for including NSSI in the forthcoming Diagnostic Statistic Manual (DSM) V version have been put forward,[17–20] even though in the version released it has not

been included. However, NSSI has been at least partially incorporated in the third section of the DSM-V entitled "Emerging measures and models" for diagnoses warranting attention and further research or higher clinical exposure and validation.[21–23] Besides NSSI, the newly included diagnoses are attenuated psychosis syndrome, depressive episodes with short-duration hypomania, persistent complex bereavement disorder, caffeine use disorder, Internet gaming disorder, neurobehavioral disorder due to prenatal alcohol exposure, and suicidal behavior disorder. Currently, according to the DSM-IV TR and ICD-10, a description of NSSI-like behaviors constitutes one of the items of borderline personality disorder, and NSSI-like symptoms can be found in people with anxiety and mood disorders. However, NSSI has peculiar characteristics that enable it to be distinguished from other mental diseases, since the definition of NSSI as a cluster of symptoms characterizing another psychiatric nosological entity is rather limiting, both from a clinical and a research point of view. Pervasive developmental disorders, as well as other pervasive pathologies should be indeed ruled out in the diagnosis of NSSI.[1] These peculiar forms and modalities of procuring self-harm in the context of an already extant psychiatric pathology should be termed self-injurious behaviors and should be kept distinct from NSSI.

The precise etiology of NSSI is unknown, but a genetic predisposition and biological impairments, such as alterations of brain morphology, of lipid plasma levels, or of neurotransmitters (in particular, serotoninergic, dopaminergic, and opioid systems),[24–26] as well as a history of child trauma and exposure to violence,[27] parent loss, neglect, and sexual abuse/assault, have been reported.[28] In childhood trauma survivors, NSSI would have four functions: to re-experience the original trauma and to convey feelings and emotions about it ("sorting out reality" function);[29] to try to establish a communication with the outer world and to share the need of being heard and understood; to organize the "Self"; and to fight against dissociative processes and trends. However, not all the individuals with a history of traumatic experiences will engage in NSSI behaviors, and it has been suggested that psychiatric traumatic symptoms could provide this missing link.[27] As far as sexual abuse is concerned, the evidence is mixed and not quite robust, as other scholars have failed to replicate this association and the overall effect could be weak as proven by a meta-analysis that found a mean weighted aggregate *phi* =0.23.[30]

NSSI 2.0 is the variety of online activities carried out virtually by NSSI injurers, ranging from the mere consultation of NSSI-related websites to the creation of dedicated portals

enabling video uploading, chatting and commenting, and the establishment of virtual communities. NSSI 2.0 is the flow of NSSI-related information and materials among the users.

In this research article, we intend to investigate a part of this virtual reality; that is to say, the NSSI queries trends and patterns.

Infodemiology and infoveillance

Traditional epidemiological surveys suffer from many drawbacks, such as the long term of data retrieval, collection, processing, and elaboration. Moreover, the design of a large multicentric study is complex and time-demanding/time-consuming. To overcome these hurdles, "infodemiology" and "infoveillance" are new emerging concepts introduced by Gunther Eysenbach when elaborating a promising approach for public health and epidemiological research,[31,32] based on large-scale monitoring and data-mining, within the conceptual framework of e-health and health Web 2.0. These last terms indicate new modalities, strategies, and practices of health care delivery that exploit, and are supported by, electronic processes and communication, and by a more and more dynamic and interactive information reality (which is the meaning of Web 2.0) in which the user is at the same time a consumer and a producer (that is to say, a prosumer) of the Web content. Within e-health, the patient is at the center of the health care processes, as they are more involved and informed of the many steps of medical decision making.

Infodemiology and infoveillance study all the virtual activities carried out by lay people while surfing health-related sites and communicating and sharing their health status. The main advantage of these new approaches is real time tracking, monitoring, and data collection and analysis.

Both survey-based and experimental studies have shown how people engaging in NSSI behaviors are likely to use more online sites as a preferential platform for conveying their feelings and emotions, and, moreover, the onset age of NSSI coincides with the peak of Internet use and accessing.[33]

Self-injury is fairly prevalent in the general adult population (up to a rate of 4%–5.9%, according to Briere and Gil)[9] and is particularly common in adolescent (up to 46%).[34] The observed mean age of onset is in the range of 13–16 years.[11]

It is, therefore, of vital clinical importance and relevance that the psychiatrists become aware of the NSSI-related online material and check its reliability in order to be able to react to it and discuss it with their patients.[35–39] The new media can have a dangerous epidemic and "viral" contagious effect on vulnerable subjects,[39–46] and some scholars talk about a so-called "virtual cutting edge" (the ways adolescents use the Internet for conveying their feelings and NSSI-related experiences),[37] a "Werther effect" (that is to say, the effect of improper and inappropriate media reporting of suicide, especially among celebrities and stars, on the lay population),[44] or a "cyber-suicide phenomenon" (that is to say, a suicide attempt first announced on Internet websites, such as forums, blogs, or chats, which is later followed by the fatality).[45] NSSI 2.0, being interactive, dynamic, and increasingly expanding, is a complex reality where websites could have a negative effect of reinforcement,[38,39,44,45] or, on the contrary, could be used for healthier purposes, such as health education and self-managing and coping strategy. Therefore, monitoring the hit searches could act as an efficient real time surveillance system.[47,48]

Google Trends (Google Inc., Menlo Park, CA, USA) is an online tracking system that enables a visualization of hit-search volumes throughout the years, from 2004 on, and a Google-based approach is particularly useful to monitor especially infectious diseases epidemics.[49] However, its enormous potentiality and applications in other fields of medicine, such as the field of neurology[50] or suicidology, have been noticed only recently. Sueki[51] found that the "suicide" search volumes did not correlate with the suicide statistics, but, after introducing a time lag of 1–3 months, "depression" hit-search could be used as a proxy in alerting the monitoring authorities, the surveillance institutions, and the public health officials. Hagihara et al[52] interestingly found that searching for "hydrogen sulfide" was associated with the suicide rate in Japan. Other searched terms correlated with "suicide" or "attempted suicide" and the scholars were even able to find age correlations, despite the anonymous nature of the users. Yang et al[53] confirmed these findings in the People's Republic of China, while Page et al[54] failed to replicate the results in Australia. Gunn and Lester[55] surveyed suicides using search engines and found that suicide rates in the 50 US states positively correlated with the "suicide" hit search. So far, to our knowledge, no one apart from Sueki[56] has explored the possibility of monitoring NSSI via Google.

Materials and methods

Google Trends, an online tracking system of Internet hit-search volumes that recently merged with its sister project Google Insights for Search (Google Inc.), was searched for the years 2004 to 2012 (as data before 2004 were not available) for "autolesionismo" (Italian for NSSI). Autocorrelation is the correlation of a parameter with itself

over time. Autocorrelation functions of this series of data, both crude and adjusted partial, were computed using R environment (freely available at http://www.r-project.org/).[57] A list of NSSI-related terms was searched in Italian and their flux volumes were correlated with the NSSI hit-search data. Pearson's coefficient was calculated with SPSS software V21.0.0 package (IBM Corporation, Armonk, NY, USA) and using R environment.[58] *P*-value was computed with SPSS and values ≤0.05 were considered statistically significant.
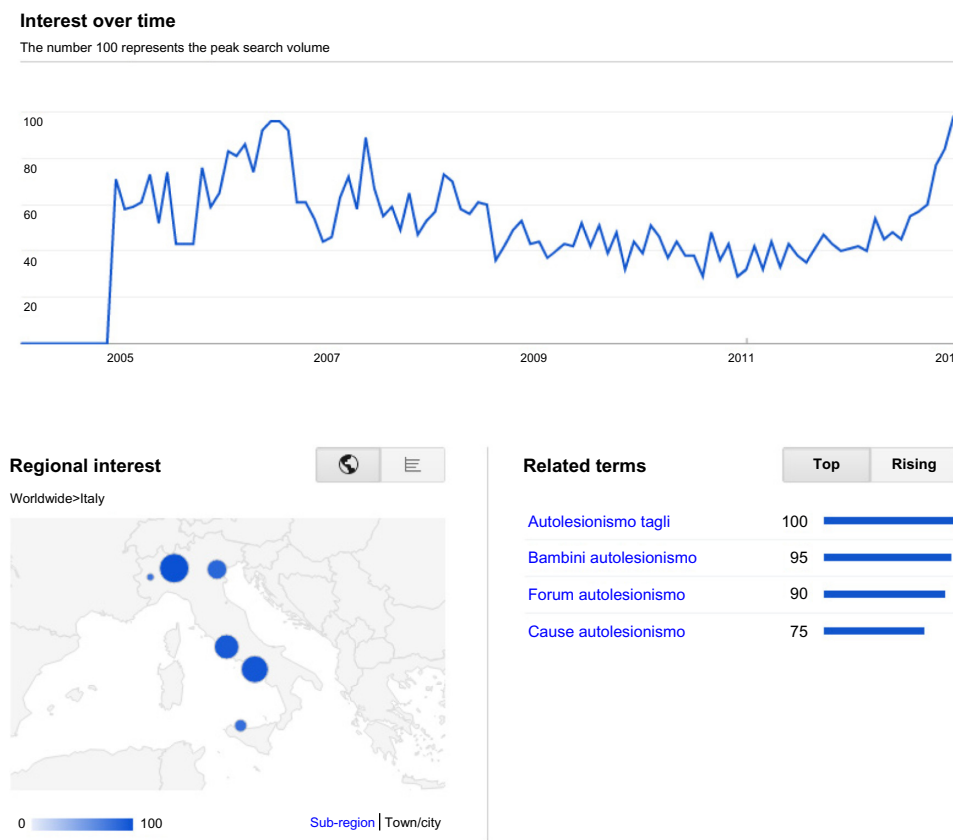
Results

The pattern of Internet search volume interestingly revealed a cyclic trend and a regular pattern (as can be seen from Figures 1 and 2). The autocorrelation reported statistically significant scores (Figure 2). The most NSSI-related search terms were NSSI and cutting, NSSI and children, NSSI and forums, and causes and reasons of NSSI (Figure 1).

The Italian towns with the higher searching fluxes and volumes were Naples, Milan, Padua, Bari, Bologna, Rome, Palermo, Turin, and Florence; that is to say, we did

not observe any geographical gradient between North and South (Figure 1 and Table 1). The queries volumes shown in Figure 1 are normalized values (rather than being the crude absolute values). This finding only appears to be in disagreement with data obtained from surveys, as we monitored the overall aggregate data, without taking into account sex or socioeconomic variables, which undoubtedly contribute to the North–South divide. The Pearson's correlation coefficients (reported in Table 2 and plotted in Figure 3) were all statistically significant.

Discussion

It is difficult to say whether NSSI is an increasing phenomenon or not because of the inconsistency of terminology and the heterogeneity of used methods and approaches, together with the lack of vast and rigorous epidemiological data. However, there is the suspicion that it is increasing, and this is probably due also to the reinforcement provided by the same digital technologies. Traditional epidemiological surveys and techniques are expensive and time consuming,

Interest over time

The number 100 represents the peak search volume

Regional interest

Worldwide>Italy

0 ▬▬▬ 100   Sub-region | Town/city

Related terms   Top | Rising

Autolesionismo tagli — 100

Bambini autolesionismo — 95

Forum autolesionismo — 90

Cause autolesionismo — 75

Figure 1 Google Trends-based NSSI hit-search volume over the years (from 2004 to 2012).
Notes: NSSI hit-search volume over the years 2004–2012 (top), a map of Italian towns with higher flux volumes (bottom, left), and a list of the most searched NSSI-related terms (bottom, right).
Abbreviation: NSSI, non-suicidal self-injury.

Autocorrelation

Partial autocorrelation
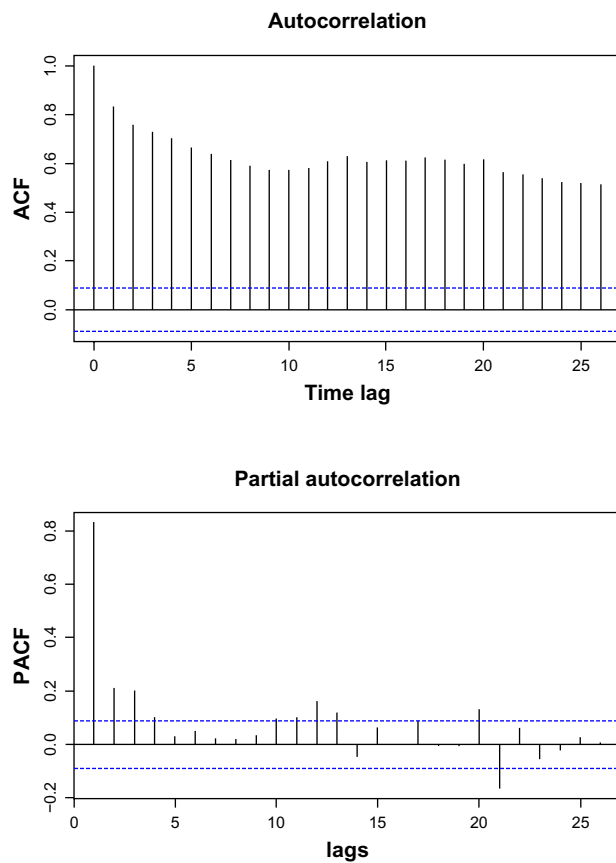
Figure 2 Autocorrelation plot for the NSSI hit-search and partial autocorrelation plot, showing a regular cyclical pattern.
Abbreviations: ACF, autocorrelation function; NSSI, non-suicidal self-injury; PACF, Partial autocorrelation function.

while in this preliminary report we show the feasibility of a Google Trends-based approach, which has been statistically validated.

However, this study has several limitations. Complete epidemiological data for NSSI are not available or are largely incomplete and, for this reason, a Pearson's correlation between NSSI online hit-search volume and NSSI rate could not be performed. Larger multicentric surveys should

Table 1 A list of the towns with higher normalized NSSI hit-search flux volumes

Towns with high hit search volumes	Normalized hit search volume (%)
Milan	100
Naples	96
Rome	94
Padua	86
Palermo	80
Turin	78

Abbreviation: NSSI, non-suicidal self-injury.

Table 2 Pearson's correlation coefficients for different hit search volumes related to NSSI and their statistical significance according to their two-tailed *P*-value

NSSI-related hit search	Pearson's correlation coefficient	*P*-value (two tails)
NSSI and suicide	r =0.26	P=0.00**
NSSI and blood	r =0.33	P=0.00**
NSSI and cutting	r =0.48	P=0.00**
NSSI and razor	r =0.52	P=0.00**
NSSI and depression	r =−0.60	P=0.00**
NSSI and anxiety	r =0.18	P=0.00**
NSSI and bullying	r =0.12	P=0.01*
NSSI and anorexia	r =−0.23	P=0.00**
NSSI and bulimia	r =−0.56	P=0.00**

Notes: *Statistically significant, with *P*-value <0.05; **statistically significant, with *P*-value<0.01.
Abbreviation: NSSI, non-suicidal self-injury.

be carried out in order to provide the researcher with more robust data and correlations.

A second limitation is due to the ambiguity of the search keywords, as also pointed out by other researchers.[33] Moreover, Google Trends monitors only the queries carried out using Google as a search engine, while other engines do exist (such as Yahoo, MSN, Bing, and so on). On the other hand, Google is the most used search engine worldwide.

A third limitation of this study is that it explores only a part of the multitude of the online NSSI-related activities (such as video uploading and sharing, chatting, and blogging) and, in particular, it investigates the NSSI-related queries patterns and trends documented in the literature. For these reasons, the approach we introduced should be complemented (rather than replaced or substituted) by further studies concerning, for example, the content of Internet websites.

Caution should therefore be taken when interpreting our findings, which are limited to a particular sector of the Internet and should not be generalized to other Internet NSSI-related activities. Furthermore, the relationship between online and offline activities could, of course, not be addressed or envisaged by such approaches.

Moreover, using search term trends is not intended as a proxy for self-injury prevalence, as individuals could come to search for self-injury for all sorts of reasons, and not simply because they self-injure. Parents, professionals, academics, journalists, and those that are just interested in or curious about NSSI search for NSSI-related terms. The use of Google Trends is intended to stimulate and foster research in the field; not to replace the need for real individual level research.

Google Trends may provide interesting geographic-level data, as found here in various Italian provinces, and this may
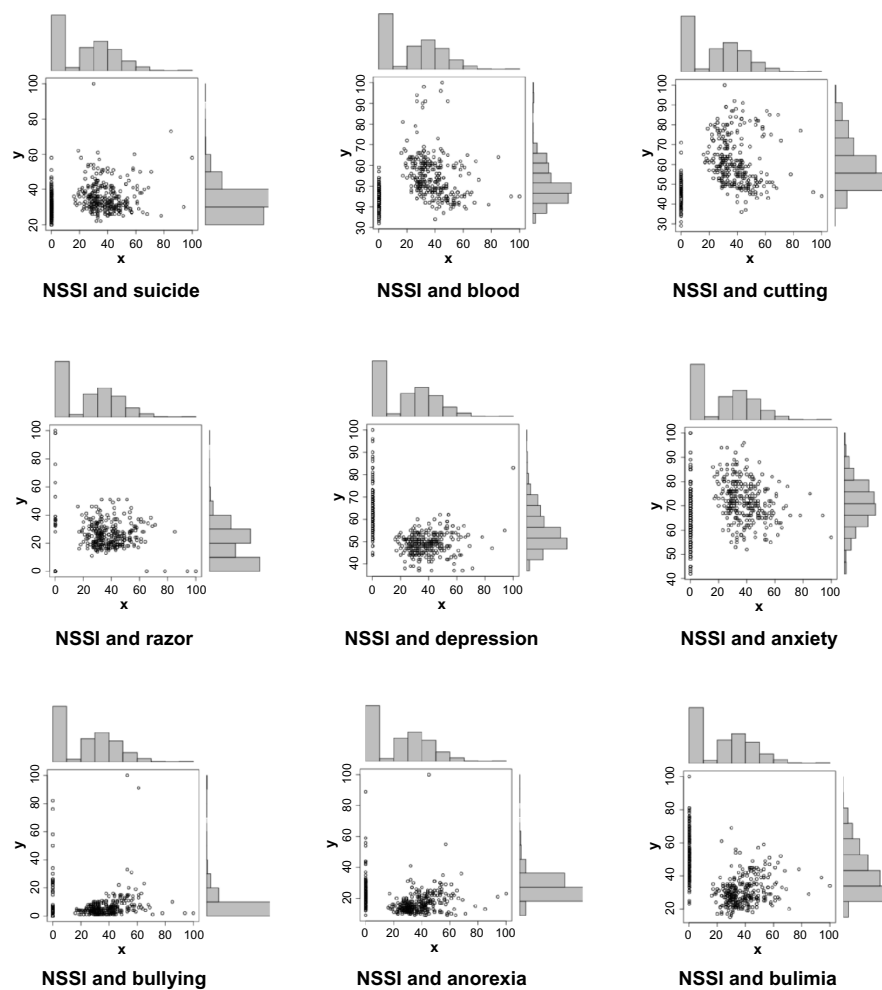
Figure 3 Pearson's correlation plots for some of the most important NSSI-related hit search terms.
Abbreviation: NSSI, non-suicidal self-injury.

provide some insight as to where NSSI is of particular interest due to increased awareness, an actual surge in cases, or a particularly high-profile case that generated local interest. For these reasons, it should be complemented and validated using traditional surveillance measures.

However, this study was one of the first surveys to explore the feasibility of an infoveillance-based approach for detecting the proxies of NSSI behaviors. This could foster further research – also replicating the findings in other regions, and other languages/cultures – and help epidemiologists to design ad hoc surveys and, above all, to help public health officials to implement dedicated web portals in order to meet with patients needs and doubts.

Conclusion

Despite its limitations, this preliminary exploration showed that a web-based approach for monitoring NSSI is feasible, and that the advantages of this type of approach are varied. Classical statistics

are delivered and processed with a delay of some months or, in the worst cases, years, while an infoveillance approach could be able to capture real time online data. Also, ad hoc web portals and surveys could be designed in light of the reported results, also with the aim of developing and implementing specific treatment plans and interventions for adolescent NSSI injurers. Moreover, since scholars have already established a clinical link between NSSI and suicidality, research about the relationship between NSSI and suicide queries should be conducted on Google Trends.

Disclosure

The author reports no conflicts of interest in this work.

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