Googling the health aspects of Gambling: An infodemiological study of worldwide Google search volumes from 2004 to 2021

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Abstract: Despite predictions that gambling prevalence would decrease over time, recent reports suggest an increasing trend that is an emerging but neglected public health problem. This study analyzed public concern regarding gambling as a health topic using aggregated Google searches. Using an infodemiological design, a search query using the keyword "Gambling (Topic)" was done in Google Trends. The region, category filters were set to "Worldwide" and "Health," with the timeframe as January 2004 to December 2021. The relative search volumes (RSV), monthly growth rate, related queries, and topics were compared and analyzed. Autoregressive integrated mean averaging (ARIMA) was also used to address seasonality, autocorrelations, and predict the RSVs in the following years, and correlation analyses determined relationships between RSVs for gambling in health and leisure categories. Results showed that after an initial decrease, there was a generally increasing trend in searches of gambling as a health topic, with a monthly growth rate of 1.36%. The RSVs for both categories are predicted to increase, with positive correlations that may be stronger in the future. Top and rising queries and topics revolved around gambling disorder-related concepts, treatment, venues, diagnosis, and online gambling, indicating an emerging public concern for the health consequences of gambling. Gambling-related online health information should therefore be updated and accurate, particularly with regard to treatment, diagnosis, and consequences.

Keywords: Gambling, Google Trends, Global, Behavioral Addictions, Problem Gambling, Mental Health, Gambling Disorder.

Introduction

Most individuals have gambled at some point in their lifetime. For most, this is not a problem, but for some this can develop into problematic and pathological gambling (Calado & Griffiths, 2016; van Schalkwyk et al., 2021). According to the World Health Organization (WHO), the prevalence rates of gambling disorders across nations ranged from 0.1% to 6.0% as of 2017 (Abbott, 2017; Calado & Griffiths, 2016)—with lower rates in Europe, intermediate in Australasia and North America, and high in Asia (Abbott, 2017; Calado & Griffiths, 2016).

It was also found at this time that the prevalence of gambling disorders tended to increase initially and then decrease over time (Abbott, 2017). These rates also tended to vary based on culture, public policy, and availability of gambling venues (Calado & Griffiths, 2016). However, gambling has been recently reported to be increasing, yet neglected as a public health problem, leading to several individual and societal harms (Atherton & Beynon, 2019; Hofmarcher et al., 2020; "Gambling: A neglected public health issue", 2021; van Schalkwyk et al., 2021). This may be due to the growth of online gambling in recent years ("Gambling: A neglected public health issue", 2021). Thus, it may be prudent to explore changes in public concern regarding the health aspect of gambling to better understand public health needs.

In a Swedish study, the direct cost of gambling-related health and social care amounted to 0.3% of the national GDP, while its estimated *indirect* cost was estimated to be about four times higher (Hofmarcher et al., 2020). Individuals with gambling disorders have a 15-fold increase in mortality (Reith et al., 2019), and are at higher risk for substance use disorders and other mental disorders (Holloway et al., 2020; Kovács et al., 2017). Public health approaches including demand, supply, and harm reduction strategies ranging from informational campaigns to machine messages have been used in recent years to address these problems (McMahon et al., 2019; van Schalkwyk et al., 2021). Given the emergence of gambling disorder as a public health problem and the use of these educational interventions, the public may have heightened interest in the health aspects of gambling.

In recent years, big data analysis and infodemiological research on internet searches have been analyzed to elucidate changes in health-related awareness, behaviour, and interest. This has been made possible due to the increasing use of the internet for health-related information (Alibudbud, 2022; Jia et al., 2021)—most prominently through Google (Arora et al., 2019; Nuti et al., 2014), due to it's dominant global market share among internet search engines (Statista, 2022). Keyword search volume data are gathered in Google's public repository, Google Trends. It has been used to monitor and assess changes in public awareness and interest in several non-communicable and communicable diseases including HIV, COVID-19, and mental health conditions (Knipe, 2020; Moalong et al., 2021; Nuti et al., 2014; Zhao et al., 2021). Previous studies have shown that Google Trends

data has a moderate to high correlation with surveillance datasets (Nuti et al., 2014). It can also categorize keywords input by users into 25 specific categories and over 300 sub-categories through natural language processing methods, enabling it to measure health-related searches from the global to the city level (Arora et al., 2019). It can also aggregate all searches for a particular keyword and its related concepts in any language by using keywords designated as "Topic" in its Explore feature (Mavragani & Ochoa, 2019). Google Trends is therefore a powerful tool for exploring changes in public concerns and interest regarding gambling as a health topic.

Objective

This study utilized search volumes and related queries and topics from Google Trends regarding Gambling as a health category from 2004 to 2021. The analyses included ranking of countries based on their search volumes for gambling, predicting search volumes for gambling in the subsequent years and correlations between search volumes for gambling as a health and leisure topic. Search volumes from different countries were also analyzed to note variations in search volume patterns, and top and rising related queries and topics were used to explore other interests related to gambling as a health topic. In doing so, the results of this study can be used to guide gambling health education and awareness programs, and be an anchor for future and country-specific infodemiological studies of gambling.

Methods

This infodemiological study measured changes in global online interest in gambling as a health topic from January 2004 to December 2021. The data gathered were relative search volume (RSV) and related topics and queries from Google Trends. The keyword "Gambling (Topic)" was utilized to aggregate searches for gambling. The data is publicly available and there was no human participant involved, therefore this study did not require local ethical approval.

Data and Measures

Relative search volume from the Google Trends system is determined by an automated algorithm that anonymizes and categorize search queries and aggregates them into single topics (Google, n.d.). Each data point is divided by the total searches in the specified geographical location and time range to compare relative popularity, thereby avoiding placing countries with the most overall search volume as the highest-ranked regions (Google, n.d., Moalong et al., 2021). The resulting number is scaled from 0 to 100 against the highest monthly search volume in the specified period and location (Google, n.d.; Moalong et al., 2021). For this study, monthly RSV was used as a measure of online public interest for gambling over time.

Top and rising search-related queries and topics are those users also searched for concerning the "Gambling (Topic)" keyword. These can be used to assess changes in other search interests related to the topic over time, which are also ranked based on their RSVs (Google, n.d.; Moalong et al., 2021). For this study, related topics and queries were used to determine other public concerns related to gambling.

Data Collection

A search query using the "Gambling (Topic)" keyword was input in the Explore feature of Google Trends (Available at: http://www.google.com/trends, accessed on 17 February 2022). Keywords with "(Topic)" can aggregate all searches regarding a particular topic and its related concepts in any language (Mavragani & Ochoa, 2019). Gambling was the topic for this study, so the "Gambling (Topic)" keyword was used.

With this keyword, Google Trends was set up using a region filter of "Worldwide" to determine global search volumes. The category filter was set to "Health" to utilize the natural language processing methods of Google Trends to limit the result to health-related searches (Arora et al., 2019). Afterward, the time range filter was set from January 2004 (the earliest available data) to December 2021. Then, monthly RSVs and search-related queries were downloaded as CSV.

The search volumes for gambling as a health topic were also compared with search volumes for gambling as a leisure topic by changing the category from Health to Hobbies & Leisure. Search volumes for the three highest and lowest-ranked countries based on RSVs were also described by setting the topic category to "Health" and changing the region filter from "Worldwide" to the respective countries (available at: http://www.google.com/trends, accessed on 29 June 2022).

Data Analysis

Initially, the ranking of countries for the "Gambling (Topic)" keyword was described and compared using their respective RSVs. Afterward, the trends and patterns of RSVs from the health and leisure categories were described and compared. Further analysis of the RSVs was done by smoothing autocorrelations and addressing seasonality using autoregressive integrated mean averaging (ARIMA), following the methodology suggested by Schaffer et al. (2021). The RSVs were initially transformed to address non-stationarity, seasonality, and changes in variance over time (Schaffer et al., 2021), then R^2 and Ljung-Box tests were analyzed for model fit. Predicted future RSV values based on the ARIMA models were determined by setting the end date to December 2025. The relationship between the RSVs of gambling in the health and leisure categories was also explored with correlation analysis.

The average monthly growth rate of RSVs for health was calculated month-over-month, subtracting the RSV of the prior month from the current month and dividing the difference by the RSV of the prior month (Jansen et

al., 2019). To compare more recent changes in month-over-month growth, the RSV were divided into two groups: one before the point with the lowest RSV, and one afterwards. .

The RSVs for gambling as a health topic in the three highest and lowest-ranked countries were also described and compared to determine the trends of RSV among these countries. Lastly, the top and rising related queries and topics were descriptively compared. All statistical analysis was done using the Statistical Package for the Social Sciences (SPSS) Version 27.

Results
Country Rankings Based on RSVs for Gambling as a Health Topic

A total of 61 countries were ranked and listed by the Google Trends system for the "Gambling (Topic)" keyword. This implies that the search volumes about Gambling as a health topic in the countries not listed in Google Trends are too low to be ranked. The top ten the highest RSV countries were from Asia, Africa, and Eastern Europe. The top country was South Korea, followed by Croatia, Bosnia & Herzegovina, Vietnam, Latvia, Indonesia, Serbia, Tunisia, Israel, and Bulgaria. The ten countries with the lowest RSV for gambling (of the 61 that were high enough to be included in the system) were Switzerland, Ukraine, Russia, Pakistan, Romania, India, Spain, France, Mexico, and Argentina. Some of these countries are also from Eastern Europe and Asia while some are from Western Europe and South America.

Comparison and Relationship of Global RSVs for Gambling as Health and Leisure Topics

The global RSV trend for the "Gambling (Topic)" keyword using Worldwide and Health filters between January 2004 and December 2021 is shown in Figure 1. RSVs during this period were normalized against the highest RSV in November 2004. The RSVs initially had a decreasing trend, reaching the lowest point in July 2013 at 33, but this subsequently changed into a continuously increasing trend between then and December 2021. The RSVs for Gambling the Hobbies and Leisure category (Figure 2) were normalized against the highest RSV in December 2021. In this case, the lowest RSV of 14 was observed in August 2011, followed by a continuously increasing trend until they peaked in December 2021.

Figure 1

Worldwide Google Search Volume for the keyword "Gambling (Topic)" as a Health Topic
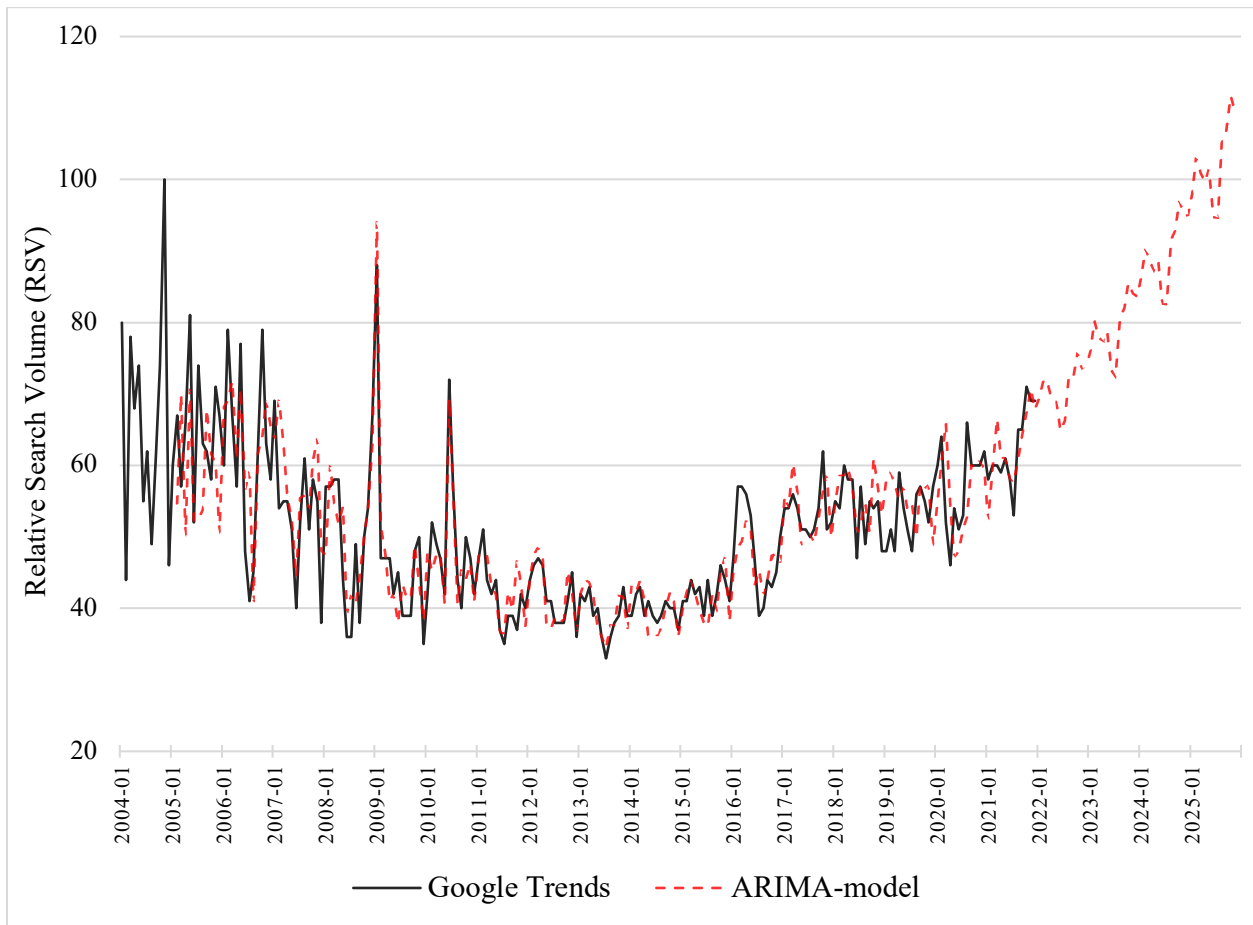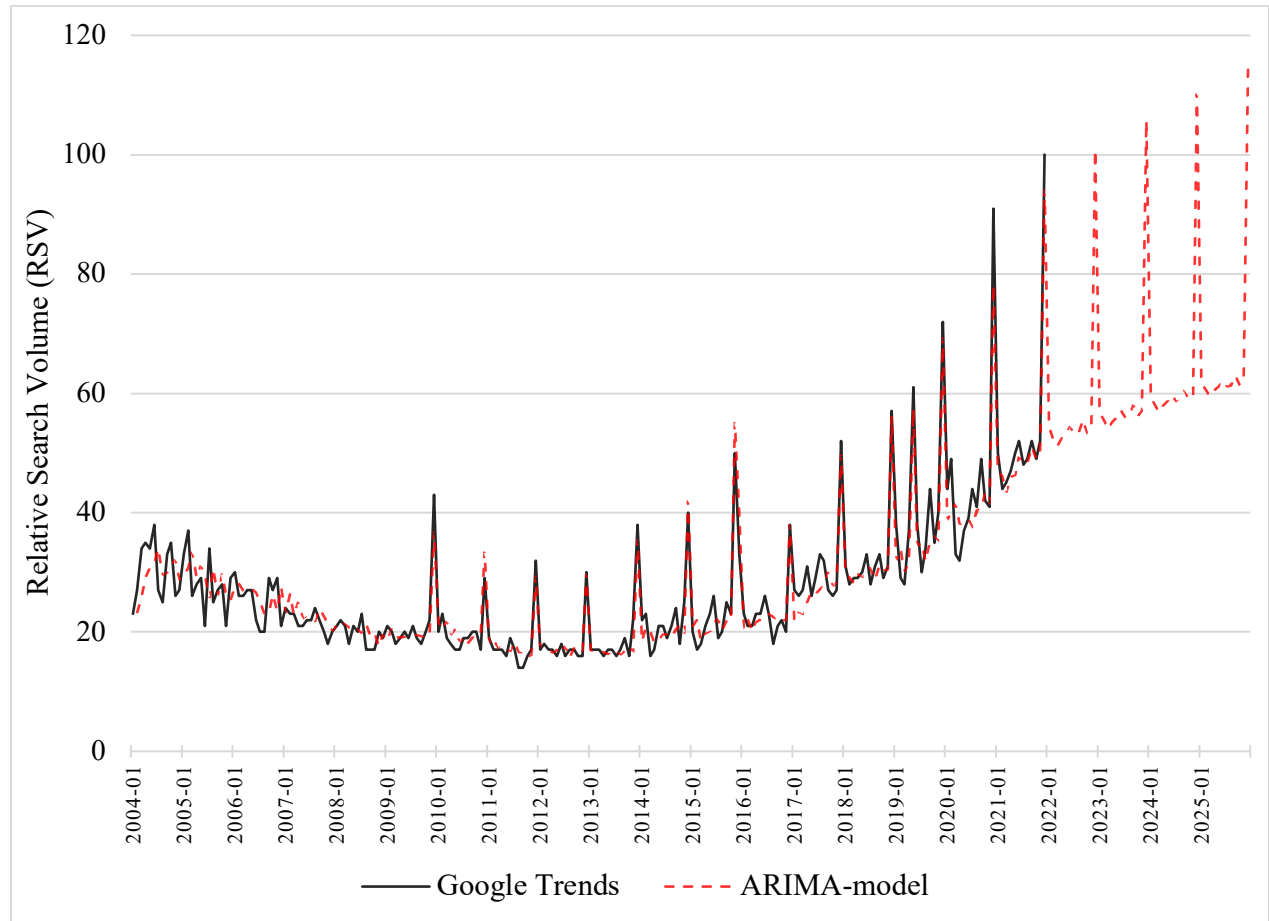
Figure 2

Worldwide Google Search Volume for the Keyword "Gambling (Topic)" as a Hobbies and

Leisure Topic

The model fit statistics of the ARIMA models are shown in Table 1. ARIMA model-based RSVs for gambling as health and leisure topics showed acceptable model fit based on their stationary *R*-square of .770 and .771. They also had Ljung Box Q values of 9.492 (*p* = .091) and 15.323 (*p* = .356), indicating that the ARIMA models have adequate predictive power for gambling RSVs.

Table 1

Fit of the ARIMA Models for the RSVs of Gambling as Health and Leisure Topics

	Model Fit statistics		Ljung-Box Q	
Model	Stationary R^2	R^2	Statistics	Sig.
Health	.770	.718	9.492	.091
Hobbies and Leisure	.771	.924	15.323	.356

As shown in Figure 1, the ARIMA model-based RSVs for health were lowest in July 2013 (34.44), and predicted to be highest in October 2025 (111.69), with a generally increasing trend since its initial decrease. This indicate that RSVs for gambling as a health topic may continue to increase in the future and exceed their initial highest value in November 2004. The ARIMA model-based RSVs for leisure (Figure 2) show a generally increasing trend with the lowest point in August 2012 and highest in December 2025, suggesting RSVs for gambling as a leisure topic might also increase in the future.

The relationship between the RSVs for gambling as health and leisure topics from January 2004 to 2021 showed a moderate positive correlation, $r = .560$, $p < .001$. When extending the timeline to 2025, the correlation became stronger, $r = .756$, $p < .001$. This suggests that public concerns regarding the health and leisure aspects of gambling might have a stronger relationship in the future.

Generally, the Google Trends RSVs for gambling as health and leisure topics showed an increasing trend, and ARIMA model-based RSVs predicted that they will further increase in succeeding years. The RSVs for both categories also showed a positive correlation that may become stronger in the future. This indicates that public interest in gambling as both health and leisure topics is increasing and may further correlate in the future.

The Growth Rate of Global RSVs for Gambling as a Health Topic

The average month-over-month growth rate of RSV for health for the total study period is 1.36% with a range of -54.00% to +77.27%. These also indicate a generally increasing trend in online interest in gambling as a health topic after an initial decrease.

To compare recent changes in gambling as a health topic, the monthly growth rate was divided into two groups based on the lowest RSV in July 2013. The average monthly RSV growth rate before July 2013 was

1.65%, while the rate from July 2013 onwards was 1.05%. This suggests the initial increasing trend in online interest in Gambling as a health topic has improved in recent years but has yet to regain its peak in November 2004.

Trends of RSVs for Gambling as a Health Topic in the Three Highest and Lowest-Ranked Countries

The three countries with the highest RSVs for gambling as a health topic from January 2004 to December 2021 were South Korea, Croatia, and Bosnia & Herzegovina. As seen in Figure 3, RSVs from South Korea showed a generally increasing trend, ending at 31 in December 2021. Similarly, Bosnia & Herzegovina has had an increasing trend ending at 10, while Croatia also arrived at 10, but with an overall decreasing trend.

Figure 3

Google Search Volume for the Keyword "Gambling (Topic)" as a Health Topic in South Korea,

Croatia, and Bosnia & Herzegovina
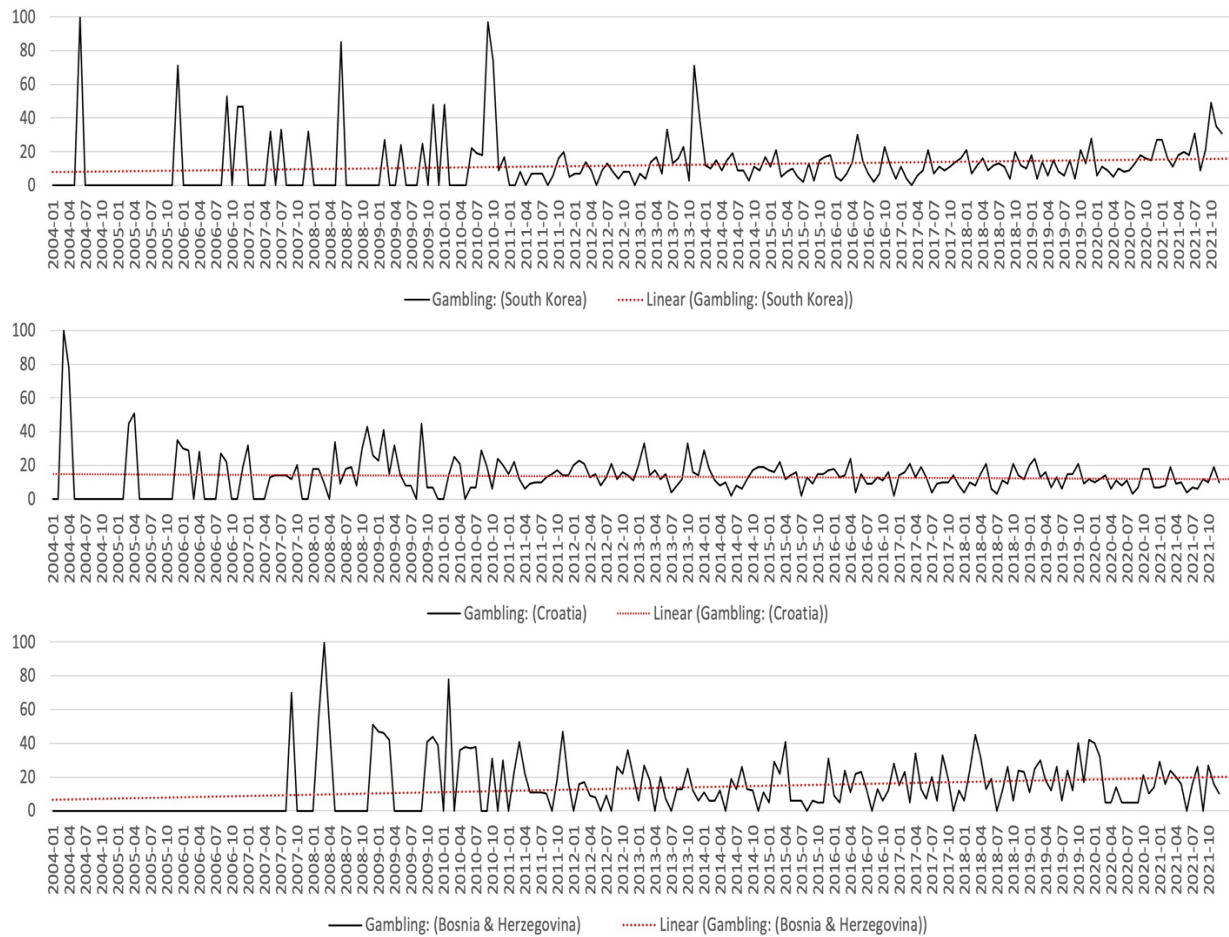
The RSVs from the three lowest-ranked countries were also analyzed (Figure 4). France has had an increasing trend, ending 34, as has Mexico, reaching 7 in December 2021. On the contrary, Argentina has had decreasing trend, ending at 4.

Figure 4

Google Search Volumes for the Keyword "Gambling (Topic)" as a Health Topic in France,

Mexico, and Argentina
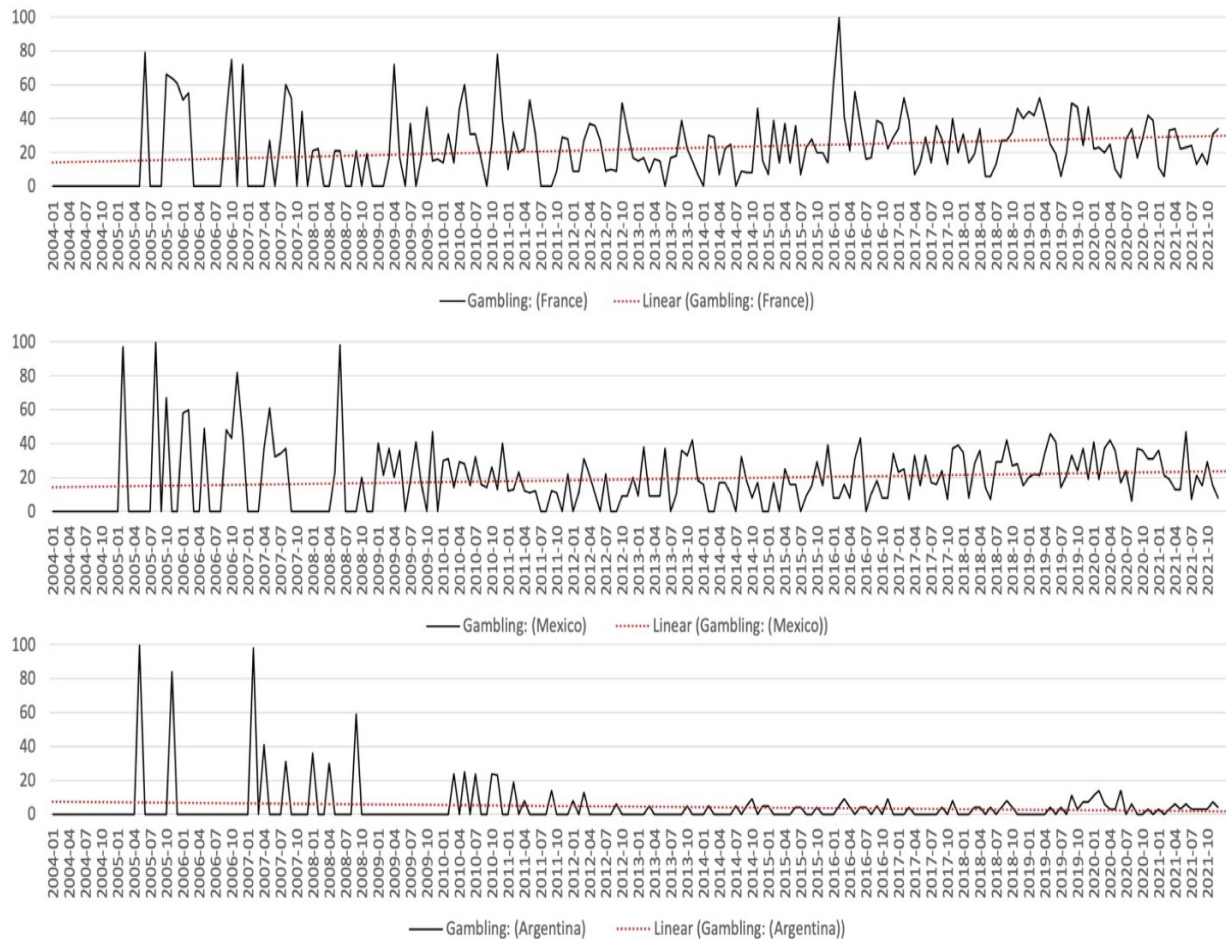
These results show that there are variations in the trends of RSVs for gambling as a health topic regardless of rank in Google Trends.

Top and Rising Search-Related Topics for Gambling as a Health Topic

Top and rising topics concerning "Gambling (Topic)" were also analyzed (see Table 2). The top topics related to gambling revolved around gambling disorder-related concepts such as "Addiction" and "Social issue," "Drug rehabilitation," "Diagnostic and Statistical Manual of Mental Disorders, 5th Edition: DSM-5,, and "Casino," substances such as "spirit", and games such as "Counter-Strike: Global Offensive," "Sports betting," and "Video game addiction."

Table 2

Related Topics Returned for "Gambling (Topic)" as a Health Topic from January 2004 to

December 2021

Top related topics	RSV	Categories	Rising related topics	% Increase	Categories
Addiction	100	concept	Spirit	>5000%	other addiction
Problem gambling	95	concept	Social issue	>5000%	concept
Game	24	game	Diagnostic and Statistical Manual of Mental Disorders, 5th Edition: DSM-5	>5000%	diagnosis
Drug rehabilitation	11	treatment	Bookmaker	>5000%	game
Online gambling	9	online	Counter-Strike: Global Offensive	>5000%	game
Compulsive behavior	7	concept	Video game addiction	>5000%	game
Spirit	5	other addiction	Drug rehabilitation	250%	treatment
Sports betting	5	game	Game	200%	game
Casino	5	venue	Sports betting	90%	game
Social issue	2	concept	Addiction	80%	concept
Diagnostic and Statistical Manual of Mental Disorders, 5th Edition: DSM-5	2	diagnosis			
Bookmaker	2	game			
Counter-Strike: Global Offensive	1	game			
Video game addiction	1	diagnosis			

Almost all rising search-related topics increased by >5000%. Similar to the top topics, these revolved around gambling disorder-related concepts, diagnostics, treatment, substances, and games. Notably, there were also rising searches for Bookmaker, an online game platform, possibly indicating increasing interest in online gambling in recent years.

Top and Rising Search-Related Queries for Gambling as a Health Topic

Top and rising related queries refer to the terms that users also searched for concerning "Gambling (Topic),". As shown in Table 3, top related queries revolved around various terminologies and languages for gambling disorder-related concepts such as "gambling addiction," "gambling rehab," and "gambling online." The languages used in these queries included English, Indonesian, Japanese, Korean, Turkish, Portuguese, Chinese, Vietnamese, Dutch, and Croatian indicating that speakers of these languages may tend to have higher interest in gambling addiction.

Table 3

Related Queries Returned for "Gambling (Topic)" as a Health Topic from January 2004 to

December 2021

Top related Queries	RSV	Categories	Rising related Queries	% Increase	Categories
gambling	100	concept	aposta	>5000%	concept
addiction	23	concept	cờ bạc	>5000%	concept
gambling addiction	22	concept	apostas	>5000%	concept
judi	15	concept	minuman keras	>5000%	other addiction
ギャンブル	15	concept	judi online	>5000%	concept
gamble	12	concept	glücksspiel	>5000%	concept
도박	10	concept	قمار	>5000%	concept
ギャンブル 依存	8	concept	hazard	>5000%	concept
ギャンブル 依存 症	6	concept	القمار	>5000%	concept
kumar	6	concept	tệ nạn cờ bạc	>5000%	consequence
aposta	5	concept	leczenie hazardu	>5000%	consequence
gambling rehab	5	treatment	gambling treatment centers	>5000%	treatment
賭博	5	concept	kumar tedavisi	>5000%	concept
gambling treatment	4	treatment	gambling meaning	>5000%	concept
pathological gambling	4	concept	bahaya judi	>5000%	consequence
gambling disorder	4	concept	rehab for gambling	>5000%	treatment
cờ bạc	4	concept	rahapelit netissä	>5000%	online
gamblers	4	concept	tệ nạn xã hội	>5000%	concept
도박 중독	4	concept	abilify gambling	>5000%	concept
gambling online	3	online	野球 賭博	>5000%	concept
compulsive gambling	3	concept	clube da aposta	>5000%	concept
gokken	3	concept	kumar bağımlılığı tedavisi	>5000%	treatment
quit gambling	3	treatment	csgo gambling	>5000%	online company
apostas	3	concept	ギャンブル 依存 症 治療	>5000%	treatment
kockanje	3	concept	ギャンブル 依存 症 チェック	>5000%	diagnostic

Similarly, rising related queries revolved around different terms and languages for gambling concepts, and their online extension including online gambling companies such as "csgo gambling." Notably, there were also rising related queries regarding gambling addiction consequences such as "bahaya judi (dangers of gambling)" and diagnosis including "ギャンブル依存症チェック (gambling addiction diagnosis)." All of these rising related queries increased by over 5,000%. While most of these were searched in the same language as the top rising queries, there were new languages noted in the rising queries including Malay, German, Persian, Arabic, Polish, and Finnish, possibly indicating increasing interest in gambling among the speakers of these languages.

Discussion

This study's findings indicate that after an initial decrease, there has been a generally increasing trend in online interest in gambling as a health topic since 2004. The initial decrease is in line with the previously reported decreasing prevalence of gambling health-related problems among populations (Abbott, 2017; Calado & Griffiths, 2016), but the more recent increase explain recent concerns about gambling an emerging public health issue (Atherton & Beynon, 2019; Hofmarcher et al., 2020; "Gambling: A neglected public health issue", 2021; van Schalkwyk et al., 2021). As noted in the top and rising topics and queries, these concerns revolve around gambling-related treatment, diagnostics, and consequences. Based on the ARIMA models, this public interest might further increase in the future. This possible increase in public interest in gambling might be related to the proliferation of online gambling, since they are often more readily accessible than physical venues (Abbott, 2017; Atherton & Beynon, 2019; Hofmarcher et al., 2020; "Gambling: A neglected public health issue", 2021). Nonetheless, comparative analysis of the different countries showed that public interest in gambling varies among countries. Thus, further analysis and studies are needed to ascertain differences and changes in public interest in gambling between and within countries and regions.

The findings also revealed that search volumes for gambling in both health and leisure categories showed a positive correlation that may become stronger going forward, suggesting that public interest in gambling as health and leisure topics are intertwined. Gambling venues can address public concerns by disseminating information about the health aspects of gambling in. For instance, online venues can include information about the manifestation and treatment of gambling disorders on their websites. This could be similar to tobacco warnings which have been found to be effective (Hammond, 2011), though further studies would be needed to verify the effectiveness of these warnings in the context of gambling disorders.

The findings also showed that gambling disorder concepts were among the top interests related to gambling as a health category. Given that the internet is highly utilized for health-related information (Eysenbach,

2020; Knipe, 2020; Moalong et al., 2021; Nuti et al., 2014; Zhao et al., 2021), this could indicate that the public's concern about the health consequences of gambling revolves around its addictive potential. It was also found that there were rising queries and topics regarding other substances of abuse such as alcohol, indicating parallel concerns about gambling and substance use problems—which is plausible since they are known to co-occur (Barnes et al., 2009; Peters et al., 2015).

Notably, both related topics and queries revealed searches about different types of games including online games and gaming companies. Similar to substance use, this may indicate paralleled public concerns about gaming and gambling, and the intersection of the two such as traditional sports betting and gambling mechanics in video games like CS:GO that give random loot boxes, which have flourished in recent years (Abbott, 2017; Montiel, 2021). For instance, online gambling on the internet has been concerning in India prompting new legislation regarding it (Balasubramanyam, 2022). These findings support the hypothesis that gambling as a public health concern is growing due to the increasing use of online gambling (Abbott, 2017; "Gambling: A neglected public health issue", 2021).

Another notable finding was the languages used in the top and rising related queries. The top queries showed that speakers of English, Indonesian, Japanese, Korean, Turkish, Portuguese, Chinese, Vietnamese, Dutch, and Croatian may have a higher interest in gambling disorder. Likewise, the rising queries suggest that health concerns regarding gambling may be increasing among speakers of Malay, German, Persian, Arabic, Polish, and Finnish. These are consistent with the languages spoken among the top ten countries with the highest search volumes.

Strikingly, the country with the highest search volume for gambling as a health category was South Korea, indicating particularly strong health concerns regarding gambling in the country. The top queries also suggest that these may pertain to gambling disorder and its treatment. This is despite the fact that gambling is mostly criminalized in South Korea, with a few exceptions such as horse race betting (Wolken, 2018). This high concern might therefore reflect the additional legal consequences of gambling more than any particular focus on health in South Korea. This can also be explained by previous reports that South Koreans seek online information about gambling disorders rather than join support groups (Williams et al., 2013). This indicates the importance of keeping online gambling health information up-to-date, reliable, and easily understandable to the public.

Limitations

While this study may be the first study that explored global search volume regarding gambling as a health topic, several caveats are worth mentioning. First, the results from Google Trends only reflect the interest of those who use the Google search engine (Moalong et al., 2021), and therefore may not be fully generalizable to the general population. Second,

Google Trends provides a relative value (Google, n.d.), and not a precise number of searches for gambling. Third, Google Trends data might be occasionally faulty as some users can be using a virtual private network (VPN) or IP masking (Al-Iman, 2018). Lastly, while previous studies showed that online search volume analysis has a moderate to high correlation with surveillance datasets (Nuti et al., 2014), it remains to be an alternative measure of public interest. Thus, traditional assessments such as surveys can be done to provide a better perspective of the public's health concerns about gambling (Moalong et al., 2021). Nonetheless, this approach can be a cost-effective alternative measure for resource-scarce countries and can be used to complement traditional surveys in analyzing public health concerns regarding addiction.

Conclusion

This study found that online interest in gambling as a health topic has been gaining traction in recent years, and is predicted to continue to increase in the next few years. This may be more pervasive with online gambling platforms, as suggested by the increasing searches for online games related to gambling. Moreover, the findings revealed that the public has also been increasingly searching the internet for information regarding gambling disorder treatment and diagnostics,. indicating an emerging public concern about the health consequences of gambling. Given this, it is important to ensure that online information regarding the health aspects of gambling including treatment, diagnostics, and consequences is up-to-date and accurate, especially in countries with high levels of concern such as South Korea, Croatia, and Bosnia &Herzegovina. Likewise, different languages can be used to help ensure that a wider audience understands gambling-related health information.

Declaration of conflict of interest
None declared.

Statement of Competing Interests
None declared.

Ethics
The data is publicly available and there was no human participant involved, therefore this study does not necessitate local ethical approval.

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