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The Lived Experience of Gambling-Related Harm in Natural Language

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Objective: Gambling-related harms can have a significant negative impact on disordered gamblers, lower risk gamblers, and affected others. Yet, most disordered and lower risk gamblers will never seek formal treatment, often due to the stigma and shame surrounding gambling. Online self-help forums are a popular alternative way for gamblers to anonymously seek help from others. Analysis of these interactions can provide a deeper understanding of gambling than more commonly used research methodologies. ***Method:*** In the present study, we leverage recent developments in natural language processing to analyze posts on a U.K.-based online self-help gambling forum. Using correlated topic modeling, we canvass the various types of discussions among forum members. We also combine this approach with semantic similarity analysis based on sentence embeddings, to map first the posts, and then the 10 topics, onto six previously established gambling-related harm domains. ***Results:*** The topic modeling revealed a cluster of discussions of many negative emotions, a topic regarding the positive emotions underlying the potential for change, a distinct topic regarding gambling's relationship harms, and numerous environmental factors that contributed to harm. Emotional/psychological and health harms were most strongly associated with users' posts, illustrating the multidimensionality of severe gambling-related harm. ***Conclusions:*** Our results reveal the co-occurrence of different harms, such as the frequent mentions of financial harms and concomitant emotional/psychological harms. The analysis of the lived experiences of gambling-related harm in natural language represents a useful tool for gambling research and can provide a different perspective to inform policy.

Public Health Significance Statement

This study identifies and quantifies diverse types of gambling-related harms that feature in anonymous online forum posts. Our results show a high prevalence of harms related to emotional well-being, health, and work and study. A key finding is that many forum users seek support dealing with the impact of gambling on their relationships and family.

Keywords: natural language processing, gambling-related harm, disordered gambling, self-help forums, naturalistic data

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Disordered gambling is a behavioral addiction recognized in the *Diagnostic and Statistical Manual of Mental Disorders, fifth edition*, which can be as detrimental to quality of life as alcohol abuse disorder (Browne et al., 2017). Stakeholders have become adept at estimating the prevalence of disordered gambling via large telephone or web-based surveys, with the latest estimates putting the prevalence rates at 2.5% of Great Britain's (Gambling Commission, 2023) and 3.3% of Ireland's (Ceallaigh et al., 2023) adult populations. These rates are well within the normal international range (Calado & Griffiths, 2016). However, prevalence surveys teach us little about the psychological experiences of disordered gamblers, as they require gamblers to respond to specific questions such as "Have you bet more than you could really afford to lose?" without providing gamblers with either the space or the opportunity to provide their own personal reflections. Other methodologies for collecting and analyzing gamblers' accounts of their own experiences are therefore likely needed for researchers to understand the full extent of gambling-related harm. In the present article, we demonstrate how large volumes of text-based data from online discussion forums can be used to understand the complex interplay between different types of gambling harm. We begin by discussing the importance of treating gambling-related harm as a multidimensional construct, before we turn to online support communities as a source of insight into the lived experiences of people affected by gambling. Finally, we lay out the objective of the following article, which is to use a combination of supervised and unsupervised natural language processing (NLP) methods to establish the prevalence and interdependence of gambling harm on one of the U.K.'s largest online gambling forums.

Understanding *who* experiences harms and *what* kinds of harms are caused by gambling is imperative for the development of effective prevention and intervention strategies. Indeed, existing work shows that most sufferers of gambling-related harm will not seek formal treatment, with only around 20% of disordered gamblers and 4% of lower risk gamblers presenting at available services (Bijker et al., 2022). Perceived stigma and shame are two key drivers of this low rate of formal help-seeking (Hodgins & El-Guebaly, 2000). With the other legal activities of smoking tobacco and drinking alcohol, the public is likely more aware of how the ingestion of chemicals can cause both physical dependence and harm, by causing cancer and other illnesses. Even though gambling disorder is in the *Diagnostic and Statistical Manual of Mental Disorders, fifth edition*, the lack of chemical ingestion likely makes the potential behavioral addiction to gambling less understandable to the public (Leslie & McGrath, 2024; Quigley, 2022). Potential gambling-related harms are numerous and moderated by social (such as the strength of a person's support network) and economic (such as the person's income) factors (Browne et al., 2023), and this additional complexity could contribute to this lack of understanding among the public and perceived stigma among gamblers.

The complexity of gambling-related harm can be illustrated via its multidimensionality. Previous research has mapped 72 distinct harms occurring across six domains (Langham et al., 2015): financial harms ($M = 1.0$ self-reported harm per gambler), emotional/psychological harms ($M = 0.9$), health harms ($M = 0.8$), relationship harms ($M = 0.6$), work/study harms ($M = 0.4$), and other harms, such as the impact one's gambling might have on one's cultural participation or violent behavior ($M = 0.3$; Browne & Rockloff, 2018). This research is important as it underlines the complex interrelations between different harms. To illustrate, consider Kate whose gambling has become a daily activity. Beyond the financial losses incurred by Kate, she finds herself losing sleep as she stays up to gamble until late. Due to sleep deprivation, Kate's performance at work declines and her relationship with her partner suffers. This situation takes a toll on Kate's mental health, who becomes anxious and depressed. In this example, it would be inappropriate to describe Kate's harm in terms of her financial losses alone. Equally, it would not be optimal to design an intervention that fails to address typical experiences of harm, which can include a wider range of personal and social issues. In sum, gambling-related harm needs to be treated as a multidimensional construct of interrelated harms.

The complexity and multidimensionality of gambling harm are exemplified by the results of studies involving people with lived experience of gambling. Results show that those who incur significant financial losses experience long-term negative effects in many aspects of their social and personal lives. Such "legacy harms" can include the deterioration of people's relationships, emotional well-being, cultural participation, and professional lives (Marko et al., 2023; Rockloff et al., 2022). These harms also contribute to the stigma and self-stigma associated with gambling, reducing the chances that an affected individual will seek help and support (Hing et al., 2014, 2016). Studies with lived experience population provide a valuable insight into people's unique experiences. However, they often rely on qualitative methods (e.g., surveys) and small samples, thus limiting the generalizability of their findings.

In order to overcome this challenge, some researchers recently turned to online support communities to better understand the lived experience of gambling-related harm (Bradley & James, 2020; Cooper, 2004; Rodda et al., 2018; van der Maas et al., 2022; Wood & Wood, 2009). These online forums are popular, with 34.3% of treatment-presenting gamblers having used them, and help reduce the cost, inconvenience, delay, and potential embarrassment of help-seeking (Mudry & Strong, 2013). Online support forums contain data from those who are not yet prepared to seek formal help (Bijker et al., 2022) and might also yield more open and honest perspectives than when gamblers are contacted by researchers or population-based surveys (Harrison et al., 2020; Productivity Commission, 2010). Researchers have used online forum data to track whether changes in the legal availability of gambling are associated with increases in harm (van der Maas et al., 2022) and to track the online social connections supporting recovery (Yokotani, 2022). Online support forum data can also be qualitatively analyzed to discover the strategies underlying recovery from gambling-related harm (Rodda et al., 2018). Since online discourse is, unlike surveys, not constrained to researcher-set topics, such approaches can be well-suited to uncovering an interrelated and multidimensional representation of harm.

One way to combine the value of in-depth qualitative synthesis with the analysis of thousands of online posts is to use the most recent advances in NLP methods. NLP tools provide quantitative methodologies for discovering the underlying (latent) themes and sentiments expressed on self-help online forums. NLP methods therefore can complement qualitative approaches by handling large data sets and by minimizing human coders' potential biases (Brown et al., 2021). Bradley and James (2020) performed an NLP "topic modeling" analysis of 2,298 initial posts on threads from https://www.gamblingtherapy.org. The authors found many negative emotions and concerns associated with specific gambling products, such as poker or sports betting (Bradley & James, 2020). Forum

users were also found to often share intimate information about gambling's harms to their mental health and well-being, including the emotional impact gambling had on a gambler and their social circle (family, friends, coworkers). In fact, the results showed that online discussions concerning the social impact of gambling were more prevalent than discussions that mapped on the topic capturing the financial consequences of gambling. Their study showcases how online forum data can provide a unique insight into gambling-related harm by overcoming some of the limitations associated with self-reported data or resource-intensive qualitative analysis.

The present article aims to contribute to the understanding of gambling-related harms, extending previous work in several ways. We analyze large volumes of natural language from the GamCare self-help online forum. We focus exclusively on the "Overcoming Problem Gambling" subforum, which is well-suited for uncovering potential domains of gambling-related harm among those who struggle with gambling in their lives. We use three cutting-edge NLP methodologies to better understand gambling-related harm in natural language. First, we use topic modeling to reveal the underlying themes among the original posts on the GamCare forum. Since gambling harms are unlikely to occur in isolation (as per our example of Kate earlier on), we utilize a correlated topic model (Blei & Lafferty, 2007), which, unlike other topic modeling approaches, estimates topic composition for each post under the assumption that some topics can co-occur. Second, we develop a new method to measure how different types of harm feature in the forum posts. This method relies on sentence embeddings to determine how the forum posts map onto the six domains of gambling-related harm. More specifically, we utilize text tags assigned to the 72 distinct gambling-related harms from previous self-report studies (Browne et al., 2018) and measure the semantic association between each post and each of the six harm domains, to determine how often each harm domain is expressed on the forum. Third, we combine the results of the topics with measures of gambling harm in a single analysis by calculating the correlations between the 10 themes revealed by the topic modeling with those six domains of gambling-related harm. This analysis further allows us to determine the interrelation between topics of discussion and expressions of harm in the online support community. Together, the three methods described above provide a comprehensive and descriptive account of the lived experience of gambling-related harm from natural language.

Method

Data Extraction

Data from the U.K.-based GamCare forum was collected with a custom scraper built in R (R Core Team, 2023). The scraping function collected data about each thread published on the "Overcoming Problem Gambling" subsection of the forum (https://community.gamcare.org.uk/forum/overcoming-problem-gambling/). Ethical approval for this project was obtained from the University of Warwick, No. 528322977. The scraper was run on April 18, 2021, collecting data from 2,316 unique threads and 32,352 individual posts.

Twenty-four informational threads created by the forum administrators were deleted. Next, we identified several large threads that are used by forum users to log how long they have been able to stay clear of gambling activities. As such, there were eight threads with the word "challenge" in their titles; these were removed from the sample. After retaining only the original posts (i.e., first posts in the thread), and after applying text preparation steps (see below), the sample consisted of 2,253 posts made by 1,290 unique users. The median length of the posts was 72 words, with the longest post consisting of 1,108 words.

Text Preparation

Text data was preprocessed in two steps. First, text data were normalized to the Unicode Transformation Format 8-bit (UTF-8) standard, while formatting data (e.g., removing /n, /r, etc.) and links (i.e., URLs) were removed. All text was converted to lowercase. Second, we applied several data cleaning methods to each post for the topic modeling only. We removed 175 stop words (e.g., ought, am, which, would, ours) using the dictionary included in the quanteda package in R (Benoit et al., 2018). All text was then lemmatized (e.g., "improving," "improves," and "improvement" are simplified to "improve") using the nltk module (Version 3.6.5) from Python (Version 3.9.7). Next, each post was tokenized (i.e., long words were cut up into smaller blocks) and all punctuations and symbols were removed. We then computed collocation scores for our tokens to identify tokens that tend to go together (e.g., to turn "New" "York" into "New York") via quanteda's collocation detection algorithm (with a setting to search for collocations made of two to three tokens occurring at least 50 times; Benoit et al., 2018). Domain-specific stop words such as references to gambling and time were removed at this time, as well as usernames appearing within posts' text.[1] If at this stage a post did not contain any tokens, it was removed.

Analytical Approach

The analyses for this study were not preregistered. We first identified latent themes in the posts using a correlated topic model (Roberts et al., 2014, 2016). This approach assumes that all posts can be described using a mixture of distinct topics, each of which consists of a probability mass function over all words used in a corpus of texts organized within documents (here posts). A grid search was used with the searchK function in the stm package (Roberts et al., 2019) to identify the optimal number of topic numbers ranging from 4 to 40 (in steps of two; see Supplemental Material A for further details). Ten topics were selected based on the available coherence metrics for the final models. Interpretation of topics was based on the qualitative evaluation of the representative posts and evaluation of the most representative words for each topic. To interpret what each topic meant, the first, fourth, and fifth authors of the present work then independently reviewed the 25 most representative posts for each topic. Similar to a thematic analysis from qualitative research (Braun & Clarke, 2019), the authors attempted to summarize these representative posts in terms of their underlying themes. The authors' different perspectives, and particularly their different levels of immersion in gambling research, led to some slightly different initial interpretations of these themes. However, after discussion, the three authors all agreed upon the final set of interpretations. Quotes from these representative posts were then selected for the Results section to demonstrate these underlying themes.

[1] Full list: gamble, gambling, time, day, week, month, ago.

The second sentence-embedding analysis computes the semantic similarity between the forum posts and the text-based descriptions of 72 unique gambling-related harms (Browne et al., 2018). For example, for each post in our data set, we calculated a similarity between that post's content and labels such as "neglected my relationship responsibilities" (relationship harm), "feelings of hopelessness about gambling" (emotional/psychological harm), and "loss of sleep due to stress or worry about gambling or gambling-related problems" (health harm). We interpret the similarity scores here as a degree to which the content of the post shares semantic similarity with unique types of gambling-related harm. To calculate the similarity metric, the posts were first converted to normalized sentence embeddings using a pretrained distilBERT model (Sanh et al., 2020). Analysis of sentence embeddings was performed in Python using the sentence_transformers module (Reimers & Gurevych, 2019). For each one of the 72 harm descriptions, the similarity score was calculated by calculating the cosine similarity between one vector for the harm descriptor and one for the contents of a post. We then averaged scores for the six harm domains: financial, relationship, health, emotional, work/study, and other. Averaging similarities gives us therefore six scores per post. As an illustration of this approach, consider a hypothetical sentence that reads "I lost so much money that I am struggling to pay for groceries and I am concerned about the next time I have to pay rent." Turning this sentence into an embedding can be used to obtain a similarity score with a sentence embedding for financial harm ("Reduction of my available spending money") or an embedding for relationship harm ("Neglected my relationship responsibilities"). The cosine similarity with the financial harm is higher (0.30) than that for the relationship (0.15), showcasing how the model captures the unique meanings of these sentences. Notably, these scores accurately reflect the semantic similarity of the sentences even though the three possible sentences do not share any words in common.

The third analysis combined the results of the topic modeling and sentence-embedding analysis. More specifically, we calculated the correlation between the probability of each topic in each post and similarity scores for each type of harm. That is, for each post, we correlate the probability of each topic being discussed in that post (e.g., 60% chance this topic is about Topic 1) with the similarity of that post's content to one of the gambling harm categories (e.g., this post has .81 similarity with emotional harm). Thus, for each topic, we measured the extent to which the occurrence of this topic is associated with specific types of harm. This analysis can reveal the interrelationships underlying the six harm domains.

Results

Correlated Topic Modeling

Figure 1 shows the 50 highest probability words/phrases for each topic, with word size corresponding to their probability. In constructing this figure, we selected words based on their probability of belonging to each topic, and we also used the top five terms with the highest probability to label our topics. In our Supplemental Material B, we provide lists of words that are representative of each topic, but which were selected using alternative methods.

Topic 1's five highest probability words were "account," "site," "deposit," "bank," and "open." These posts revealed aspects of self-blame, but then also many frustrations with online gambling websites making it too easy for users to gamble despite these harmful patterns of gambling:

> I'm feeling bitter about the money I lost during my gambling days, acknowledging it was a result of my own reckless choices. However, I believe there is also some responsibility on [gambling operator group] for allowing me to repeatedly open accounts.[2]

> Why bother asking for a permanent closure of your casino account if they can simply offer a bonus, reactivate the account, and let you deposit more money, resulting in additional losses?[3]

Topic 1 therefore revealed an environmental factor which certainly contributed to harm—gambling operators' systemic failings—despite users' tendencies to primarily blame themselves.

Topic 2 (with five most probable words: "tell," "know," "help," "family," "thing") was largely focused on the impact gambling has on close others. Indeed, in terms of most representative words (see Figure 1), this topic contained many references to others, including family, partner, wife, husband, and child (e.g., "My family perceives me as a gambler who has been untruthful, and my friends only see vulnerability."). Many posts focused on the challenges associated with opening up and disclosing significant monetary losses to one's family. Some users discussed challenges from having unsupportive family members who knew about their gambling or worrying about family members that they had not yet been honest with. One user, for example, wrote about the physical and mental toll of hiding their gambling from their partner:

> My significant other is completely unaware of my gambling and the resulting debt. Every morning, I wake up feeling sick, unable to eat, overwhelmed by the guilt of betraying them. I find it incredibly challenging to bring myself to confess.

In cases when others were aware of the user's gambling, several users discuss the emotional impact that their gambling has on others, often referencing emotions such as anger, grief, sadness, and disappointment. Such posts also include experiences of those who opened up to their family about their gambling experiences and describe the challenges that this has introduced to their relationships (e.g., "My spouse is struggling to accept my addiction, and it has led to my entire family getting involved, resulting in ongoing arguments with everyone."). Some users had however successfully opened up to their family and received positive support in response (e.g., "Here's my suggestion: if you feel you're approaching a critical point with your gambling issue or if you're attempting to quit and finding it tough, consider opening up to your family about it.").

Topic 3 ("now," "get," "post," "advice," "bookie") contained posts in which new users to the forum introduce themselves to others, often describing their gambling experiences. Users frequently discussed their experiences of individually blocking themselves from specific gambling formats, such as self-excluding from nearby bookmaker shops and separately self-excluding online. For example, some users talk about specific types of gambling they have engaged with (e.g.,

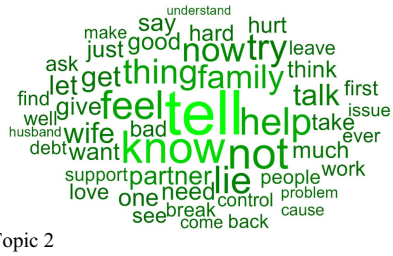
[2] In interpreting the topics, we only discuss the frequency in the context of a smaller sample of the top 25 most representative posts that were manually evaluated. Therefore, statements such as "many" and "often" should be interpreted with caution.

[3] Examples of posts have been modified to preserve users' anonymity. Specifically, exemplar sentences from individual posts were submitted to ChatGPT3.5 with the instruction to paraphrase the content while preserving the meaning and sentiment expressed in the text.

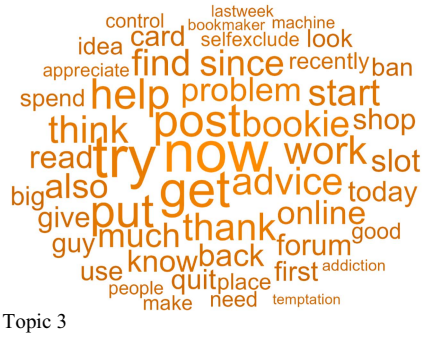
Figure 1

Wordclouds Representing Top 50 Most Probable Terms for Each Topic (Size Relative to Probability)

Topic 1

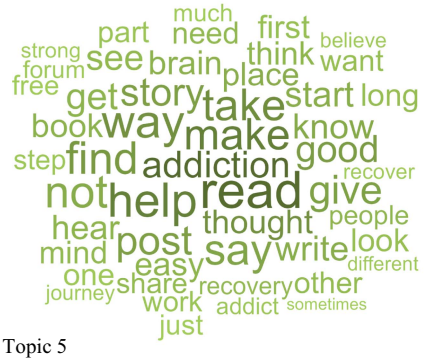


Topic 2



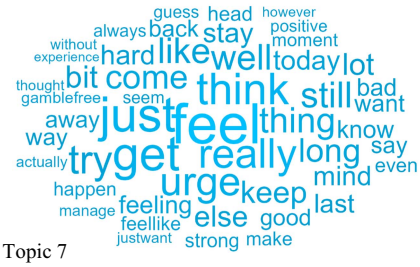
Topic 3

Topic 4



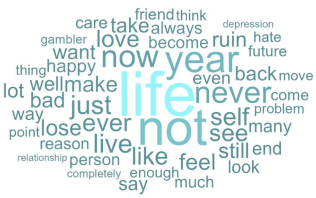
Topic 5

Topic 6

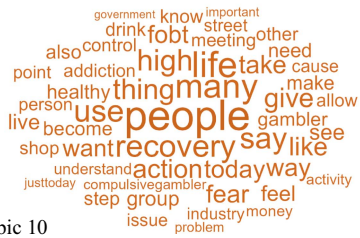


Topic 7

Topic 8



Topic 9



Topic 10

Note. See the online article for the color version of this figure.

"The primary source of my gambling issues stemmed from Fixed Odds Betting Terminals (FOBT) machines, online casinos, and betting on football.") However, users also mentioned frustrations with the difficulty of self-excluding from all gambling formats and could experience secondary problems with new gambling formats such as scratchcards after self-excluding from their original gambling format, for example:

> I consider myself 44 days free from gambling, with no cravings for casino games, etc. However, I've been struggling with the urge to buy scratchcards lately. I'm seeking tips or stories from anyone who has successfully avoided purchasing them. Yesterday, I created an online account on the national lottery website, deposited £40, managed to reach £75, but ended up losing it all.

Similar to Topic 1, Topic 3 therefore revealed an environmental factor outside of gamblers' personal control (the lack of universal self-exclusion schemes) that could also be contributing to gambling-related harm.

Topic 4 ("money," "debt," "get," "pay," "lose") contained posts providing detailed information about gambling's negative financial consequences. Here, users often described in painstaking detail how they gradually lost all their salaries and savings. In some cases, users wrote about how they found additional money to gamble with, using various credit cards, payday loans, and by borrowing from others. For example, one user wrote about the loan they took out to pay off credit card debt accrued due to gambling:

> I secured a loan to settle my credit card debts and put myself in a situation where I make a monthly payment of £250. This is the true cost I bear for my addiction.

Users often mentioned the difficulty of paying off their accumulated debts and maintaining enough left over to continue living. Oftentimes, this difficulty of recovering their financial circumstances was a significant push factor to return to gambling:

> I find myself in a debt of around 15k with no clear means to repay it, aside from resorting to crime or continuing to gamble in hopes of a big win.

> My son has started talking about Christmas, and I'm anxious about how I'll afford it. Despite everything, there's still this lingering hope that I might win some back.

Topic 4 therefore also similarly revealed that the relative ease of obtaining money for gambling, for example, via credit cards or other methods of borrowing, is another environmental factor contributing to gambling-related harm.

Topic 5 ("addiction," "read," "make," "help," "take") contained sources of inspiration and support for overcoming gambling. Users' posts often included positive and uplifting stories about finding motivation to overcome disordered gambling (e.g., "To those embarking on their journey, find solace in the fact that if I can overcome it, anyone can!"). Posts that were best represented by this topic include recommendations for books about addiction, motivational techniques, religious meetings, or even keeping a diary of own experiences. Overall, posts in this topic seemed to be broadly associated with psychological (and at times spiritual) ways to overcome gambling-related harm.

Topic 6 ("block," "not," "phone," "just," "gamcare") was predominantly concerned with blocking software to prevent access to gambling accounts or content. Posts that fit with this topic are mainly descriptions of software and services that users found helpful. Other posts contained questions about the best solutions for blocking gambling software and sites (e.g., "Hello, I'm seeking a method to restrict access to gambling sites and apps on my iPhone"). The cost, accessibility, and effectiveness of gambling blocks could therefore be considered another environmental factor that is highly relevant to gambling-related harm.

Topic 7 ("feel," "really," "think," "just," "get") related to attempts to resist temptation and refrain from gambling. Most posts in this topic included descriptions of people being challenged by the urge to gamble, but having not yet succumbed to it (e.g., "But tonight is particularly challenging; the urges are intense, and I'm feeling vulnerable."). Often, users described that they were at an early stage of being gamble free (often only several weeks or less) but feared that they might relapse. The urge to gamble was omnipresent to many users (e.g., "I struggle to sleep at night; my mind is racing.").

Topic 8 ("lose," "bet," "win," "play," "loss"), similarly to Topic 3, included personal accounts of users being unable to stop gambling despite its negative consequences. These stories often yielded negative emotions about users' inability to stop themselves from gambling:

> I'm experiencing a deep sense of despair and worthlessness, and it seems like there's no purpose for me on this earth. I can't continue living like this any longer.

However, these posts again often pointed to environmental factors that contributed to their losses:

> With the easy accessibility of the internet these days, it's become more challenging to quit, but I am determined to stop. I'm seeking guidance on how to do it.

One environmental factor mentioned was the £100 betting limit on U.K. electronic gaming machines, which was reduced to £2 in 2019 ("I've been involved in roulette gambling at betting shops since 2001, a time when these machines had no betting limits."). Other users mentioned the environmental factors tempting them to bet on sports such as football with high frequency, due to the combination of in-play betting and the ability to bet on sporting events from all over the world:

> It's just some Saturday match like Deportivo vs. Elche, but because I've placed money on a goal or corners, it has become interesting to me. Feeling frustrated with myself. (I dislike Spanish football; I always end up regretting chasing Saturday afternoon losses).

Topic 8, similar to Topics 1 and 4, therefore revealed how the easy access to gambling can contribute to gambling-related harm.

Topic 9's posts ("life," "not," "year," "never," "now") contained personal stories of long-term gamblers who have struggled with addiction for many years. Many of the relevant posts describe how one's life has been ruined by gambling. The sentiment of many posts was of despondence and hopelessness:

> Despite not engaging in gambling again, the lasting effects from years of it have resulted in mental issues, casting a shadow over my future. My confidence and self-esteem have taken a severe hit.

In these posts, some users explicitly admit to contemplating suicide (e.g., "Hello, I'm just another illustration of a life ruined by gambling." or "This year, I lost everything to gambling to the point that if I didn't live with my family, I would be homeless right

now."). Unlike posts in other similar topics (e.g., seven), Topic 9 captured less hopeful accounts of people who have battled gambling-related harm for a long time.

Topic 10 ("people," "recovery," "many," "thing," "life") captured various political, social, and philosophical questions related to gambling. For example, some posts commented on government regulations and the evidence base underlying gambling-related harm (e.g., "The 2010 British Gambling Prevalence Survey indicated a 50% rise in problem gambling compared to the previous survey conducted in 2007.") and others on the nature of addictions in general:

> Addictions are attempts to cope with the most significant emotional challenges in your life. Understanding them is inherently linked to understanding yourself as an individual.

Taken together, Topic 10 is probably the least well-defined in terms of a single unified theme.

Figure 2 shows that some topics are more common than others. The most common topics were Topic 8 (12.5%), Topic 4 (12.5%), and Topic 7 (12.5%), which collectively capture discussions about biographical accounts of gambling harm, but also current attempts to resist the many easily available gambling opportunities. The two least prevalent topics (Topic 10—5.6%; Topic 6—7.1%) regarded technical aspects of blocking software and broader discussion about the nature of gambling (Topic 10). Note that mere proportions should be interpreted with caution, as each post is a combination of all topics. Our subsequent analyses provide a better insight into the nature of the topics in the corpus.

Sentence-Embedding Modeling

Figure 3 shows the similarities between the six harm domains and posts on the forum. The scores can range from −1 to 1, and any score above 0 indicates a positive semantic association, and so therefore, Figure 3 demonstrates that all six harm domains associate positively with the posts, as expected. However, there are considerable differences between the categories. Emotional/psychological harm has the strongest association—the median cosine similarity equals 0.31. This association reflects that many of the topics, and therefore many of the posts, reference the emotional impact gambling has on a person and on others. These results show that these self-report items from previous gambling research do reflect the lived experience of gambling-related harm.

Health harms were the second most strongly associated harm domain, reflecting issues such as lack of sleep, stress, reduced physical activity, neglected hygiene, smoking, depression, and

Figure 2

Topic Proportions Across the Entire Sample of Original Posts on the Forum

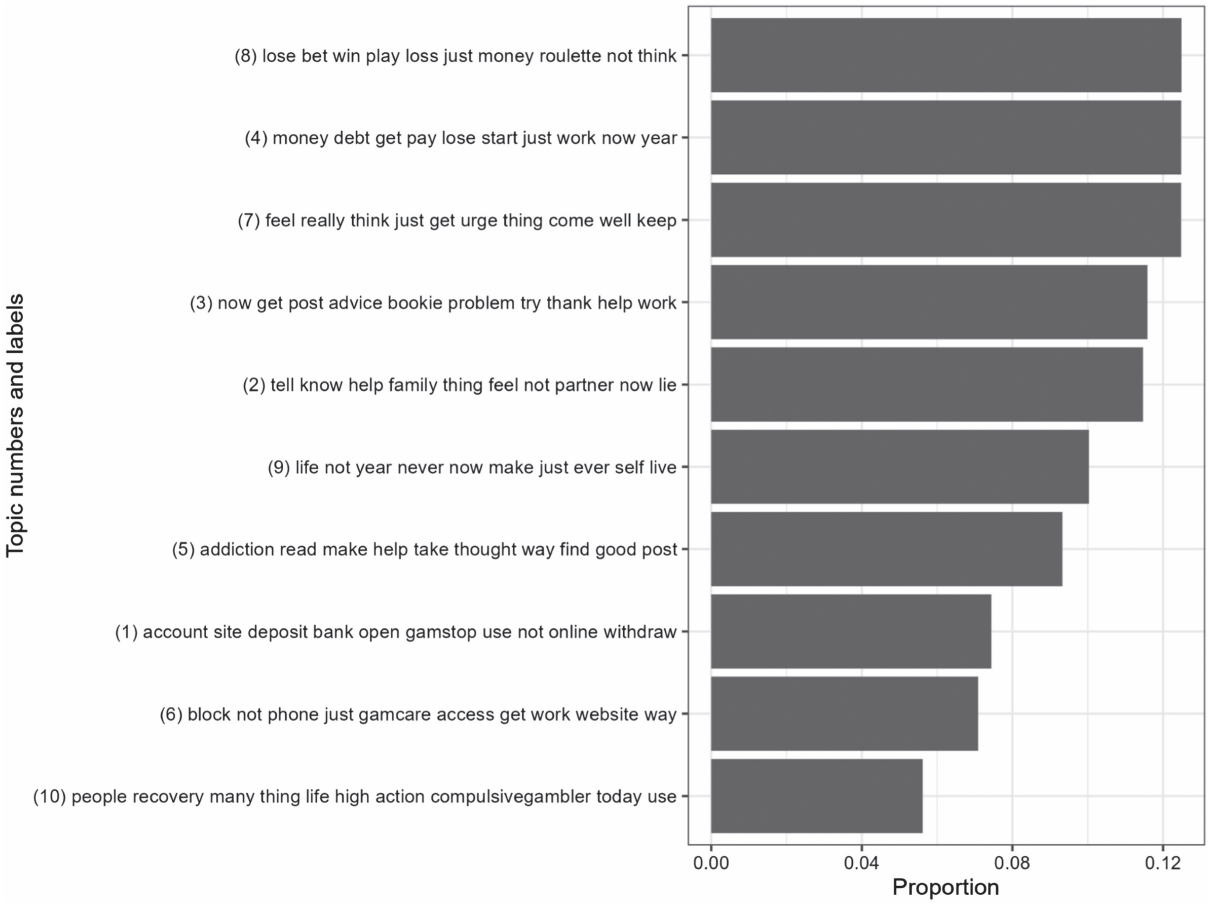
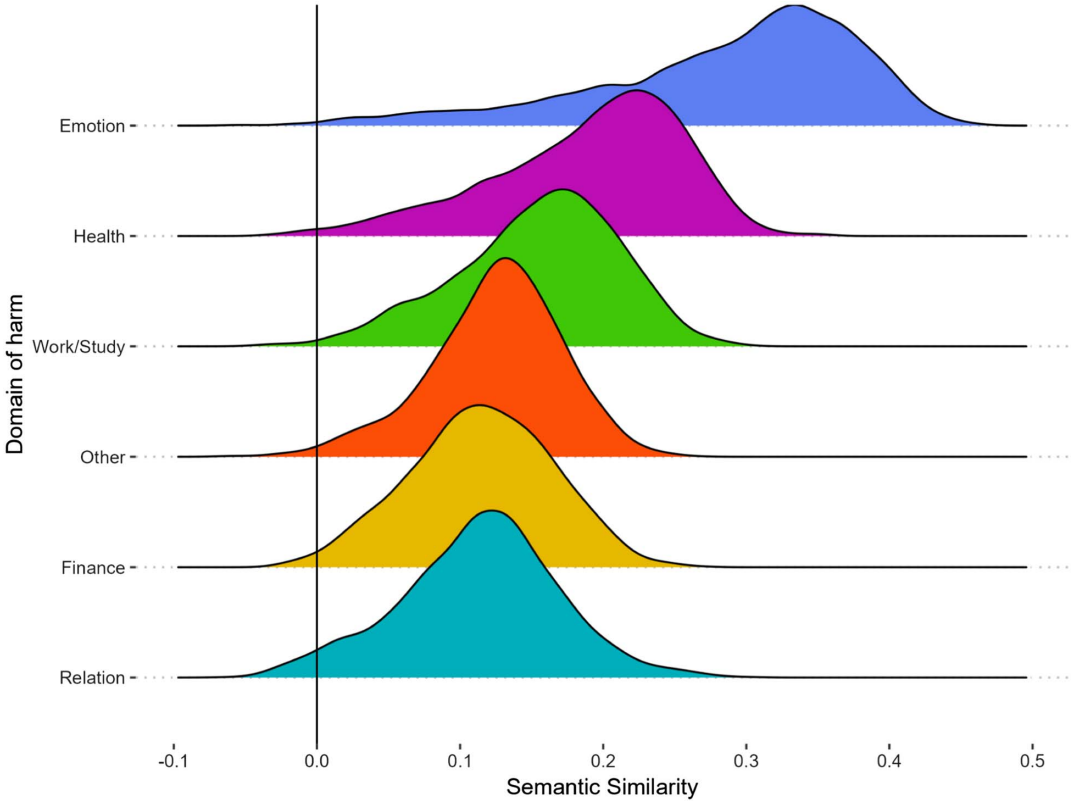


Figure 3

Density Plots of Semantic Similarity Scores Between Harms in Each Category (Averaged Over Multiple Harms)



Note. Scores range from −1 to 1, with 1 representing the strongest positive association between two texts. See the online article for the color version of this figure.

self-harm (among others). Given the frequent mentions of mental health issues (e.g., referencing suicide in Topic 9 or preoccupation with gambling in Topic 7), we performed additional analysis to determine if the results are primarily driven by the associations with mental health harm (rather than physical health). To test this, we calculated the average similarity scores separately for gambling harm items that were clearly referencing mental health-related harm (stress-related health problems, e.g., high blood pressure, headaches; loss of sleep due to stress or worry about gambling or gambling-related problems; increased experience of depression; committed acts of self-harm; attempted suicide) versus those that were related to non-mental-health harms. We found an average similarity of 0.15, which was lower than the average of all items (0.19). We then inspected the average for each item separately and discovered that only one mental health-related harm—loss of sleep due to gambling-related worries—was among the top four most strongly associated health-related harms (with similarity scores >.30). This result is important as it shows that health-related harm is not limited to mental health and that health harms are distinct from emotional/psychological harms.

The four remaining associations were all positive but weaker than those for emotion and health. In descending order, we found an average similarity of 0.15 for work/study harms, 0.13 for other harms (which includes diverse harms such as being arrested, being outcast from a religious or cultural community, or experiencing violence), 0.11 for financial harms, and 0.11 for relationship harms. Taken together, despite the financial difficulty that is a common root to most gambling issues, the language used to describe people's experience with gambling is also semantically closely related to terms and phrases used to describe emotional, social, and interpersonal pain caused by gambling.

Combination of Topic Modeling and Sentence-Embedding Analysis

The results presented in the preceding section are limited in that they only describe how the language in the entire corpus relates to specific descriptions of harm. In other words, it is not clear how the six harm domains relate to the topical structure identified by the topic modeling analysis. To address this, we computed the zero-order correlations between similarity scores for each domain of harm of each post and the proportion of the post best explained by a particular topic. To illustrate the logic of this approach, consider Topic 2 which primarily identifies language discussing the impact gambling has on family and significant others. For each post, we have a γ score of Topic 2, which represents how well each topic describes each post. We also have, for each post, a similarity-based metric for health-related harm (as well as other harms). A correlation between these two will show whether a post's likelihood of discussing gambling's effects on others (i.e., Topic 2) is correlated with the occurrence of health-related harm in the posts' content. The result answers a simple

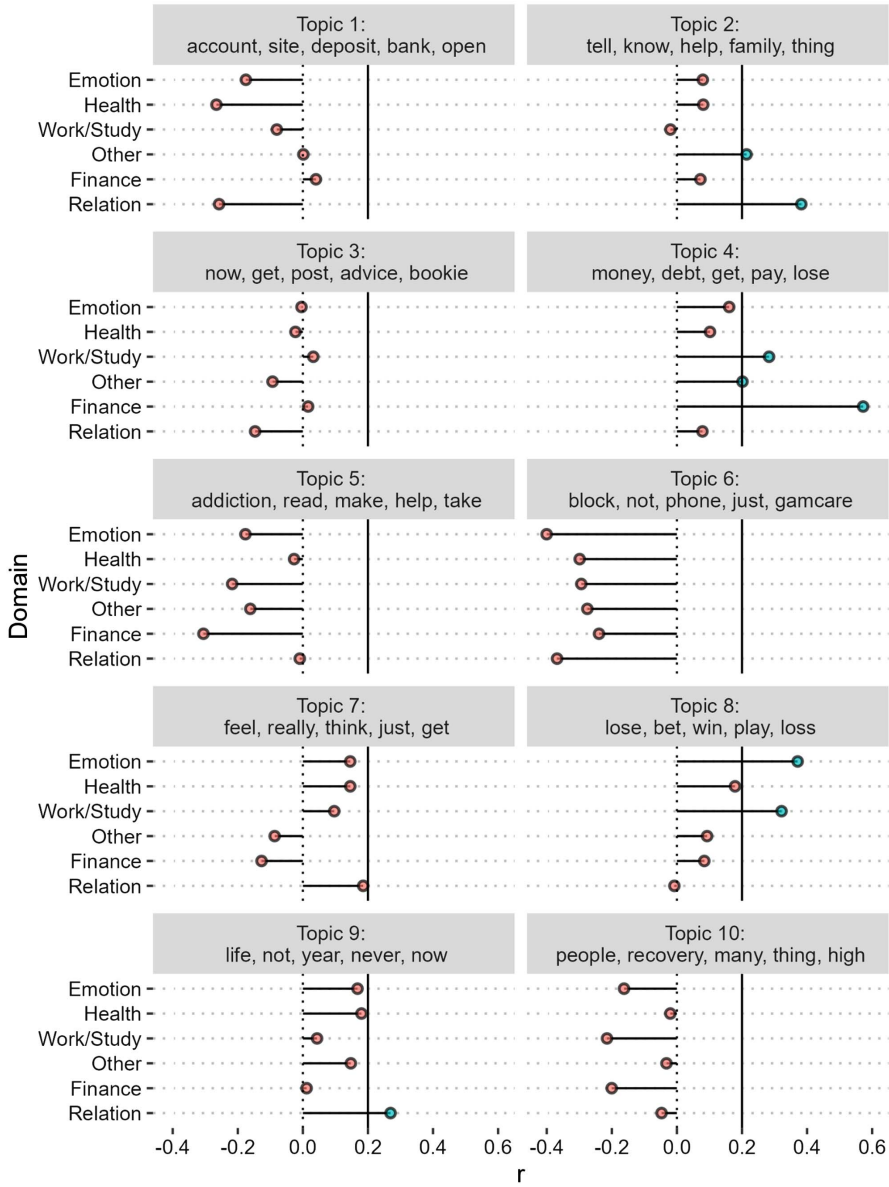
question, which in this instance is as follows: When people post about the impact of gambling on their families and friends, what type of gambling-related harm do they talk about the most?

The correlation coefficients between the 10 topics and six domains of harm are summarized in Figure 4. This figure shows the semantic similarity between posts associated with the topics and the six domains of harm. Only the positive correlations are interpretable, as negative correlations merely imply that the post is associated with things other than the gambling-related harm. That is, a negative correlation does not mean a post is associated with a gambling-related "benefit." For the sake of clarity and brevity, we focus on correlations that pass the threshold of $r = 0.2$.

With respect to emotional/psychological harm, we find a positive association (0.37) with Topic 8. The positive association maps onto Topic 8's meaning rather well as this topic focuses on monetary losses experienced by the gamblers. Combined with the interpretation of the topic presented earlier on, it seems that people often post about the emotional harm due to the easy availability of gambling opportunities. Given that Topic 8 is the most prevalent one in the entire corpus (see Figure 2), we can then understand

Figure 4

Correlation Coefficients (Pearson's r) Between Semantic Similarities of Posts and Harms and Topic Proportions Within Each Post



Note. Each panel shows the correlations for six types of harms for a given topic (described in the panel title). Blue dots represent the instances where the correlation is higher than .2, which is also indicated by the solid line. See the online article for the color version of this figure.

why the second analysis revealed that emotional/psychological harm is so prevalent.

Financial harm had a strong (0.57) correlation with Topic 4 (money debt get pay lose start just work now year). Once again, this result is to be expected as this topic is largely focusing on the discussion of money lost by the gamblers. And again, it is worth noting that this is the second most prevalent topic (see Figure 2). Together, it is clear that discussions of financial losses and experience of betting large sums are associated with expressions of harm, both emotional and financial.

Neither health nor "other" category includes any correlations >0.2, but it is notable that health-related harms are more likely to be found for Topics 7, 8, and 9, which all relate to various descriptions of gambling experiences (from the most recent temptation to the more general autobiographical accounts spanning multiple years). In the health category, there are also mentions of eating disorders and self-harm using euphemisms, slang, or ambiguous terms that semantic models have more trouble picking up (e.g., cutting, yeeting, or cat scratches).

Consistent with our interpretation that Topic 2 largely focuses on the interpersonal consequences of gambling, we find a positive (0.38) correlation with relationship-related harms. This result confirms that mentions of family members and friends occur in the context of the harm that one's gambling inflicts on them.

Finally, work/study-related harm was positively associated with Topics 4 and 8. These are also the same topics that find strong positive associations with financial and emotional harm, respectively. Together, these results paint a bleak picture of the interconnected nature of harms, which are created in an environment where it is easy to borrow money to gamble, to deposit that money to gamble at any time and on many different gambling products, and yet contrastingly difficult to self-exclude and block oneself from gambling. Many posts discuss financial losses, which are associated with financial-, emotional-, and work/study-related harms. Those three harm domains are by far the most prevalent, as can be clearly seen by inspection at the correlations in Figure 4 and overall topic loadings from Figure 2.

Discussion

The present article set out to uncover and quantify expressions of gambling-related harms on a U.K.-based online forum where people discuss their journeys in overcoming disordered gambling. To gain new insights from this rich data set, we used a three-stage NLP approach. First, a correlated topic modeling assigned posts on the forum into related clusters of common themes and interpreted these topics qualitatively. Second, a sentence-embedding analysis assessed the meaning of the posts in relation to the six domains of gambling-related harm. Lastly, a combination of these first two analyses quantified how different harms occur across different topics of discussion on the forum. Our results shed new light on the lived experience of gambling, specifically the breadth, complexity, and interrelatedness of gambling-related harms.

The topic model revealed 10 related and yet distinct topics, reflecting the multidimensional nature of gambling-related harm. Two results are particularly notable. First, while gamblers instinctively blame themselves, Topics 1, 3, 4, and 8 reveal distinct environmental factors which also contribute to harm. This is consistent with the underlying evidence base, where gambling products such as online gambling, electronic gambling machines, and in-play sports betting appear strongly associated with harm (Allami et al., 2021; Vieira et al., 2023). The Great British regulator, the Gambling Commission, has also in recent years fined a number of gambling operators for allowing gamblers displaying risky behavioral patterns to continue gambling. While some of the accounts from Topic 1 may therefore reflect historical rather than current failings, Great Britain does appear to have a more harmful gambling environment than, for example, Norway or Finland, whose state monopoly gambling operators both cap gamblers' annual losses (Rossow & Hansen, 2016; Veikkaus, 2022). These two state monopoly systems also make it easy for gamblers to set self-imposed limits on their gambling spend, while contrastingly in Great Britain the large number of gambling opportunities makes it harder for gamblers to impose external blocks against gambling urges. These findings add further weight to recent calls for more jurisdictions to introduce gambling player-tracking systems such as in Norway and Finland (Newall & Swanton, 2024). Topic 2 entirely captured gambling's relationship harms (Langham et al., 2015) and showed how gambling also harms affected others (Tulloch et al., 2022). Healthy relationships, where the gambler feels able to be open about their financial losses while they are still at an early stage, can allow the affected other to help the gambler recover sooner. This therefore demonstrates the need to communicate the evidence base underlying gambling-related harms to the whole public, so that affected others can help provide supportive environments for disordered gamblers. GambleAware's recent "stigma reduction" campaign attempted just this (GambleAware, 2023), and this campaign's 30-s TV commercials have also been shown in an independent evaluation to reduce gambling urges among gamblers (Newall et al., 2024). Therefore, the analysis of naturalistic data using NLP approaches can inform debates around various policy measures to reduce gambling-related harms.

The present results are complemented by our usage of previously designed items used to measure the six domains of gambling-related harm. While all six harm domains from previous research appear in users' posts (Langham et al., 2015), emotional/psychological harm was particularly salient. The prevalence of discussions on emotional harm might be because the forum's anonymity allowed users to be more open than they would, for example, be in an interview with a researcher. Forum users wrote expressively to convey regret, disappointment, sadness, and helplessness. Forum users also discussed their urges and mental preoccupation with gambling (e.g., being unable to sleep because of gambling, which is a health harm simultaneously). Many of the harms discussed seem to generate positive feedback loops, for example, a lack of sleep increases impulsivity (Gillett et al., 2021), risky decision-making (Mckenna et al., 2007), and reward seeking (Mullin et al., 2013), thus likely increasing urges to gamble in daily life (van Baal et al., 2022). Forum users also mentioned at times their tragic inability to see any hope of repairing their financial situation via any route other than gambling (Topic 4). The U.K. government announced in its 2023 White Paper its intention to take the design of safer gambling messages away from the industry, to reflect the independently designed health warnings used on, for example, tobacco products (DCMS, 2023). It may be that short accounts attributed to anonymous gamblers could do better at communicating the severe and multidimensional nature of gambling-related harms than the other types of messages that have been proposed thus far (Chapman & Priestly, 2022; Mills et al., 2023; Newall et al., 2023).

Finally, the third analysis which combined the earlier two analyses offered a nuanced view of the multidimensionality of gambling-related harms. For example, we found a strong association between the prevalence of Topic 2 and relationship harm, which aligns with the interpretation of the topic as referring mainly to people's accounts of how their gambling affects those they care about. Other harm domains occurred across multiple topics, demonstrating the interrelations between harms. Indeed, harms to health, work/study, and relationships emerged across a broad spectrum of discussion topics. For example, Topic 4 (on debts and getting more money to gamble with) had a strong association with financial harms, but many posts in that topic also tended to refer to work/study-related harm. Associations with emotional/psychological harms were weak for this topic, which is somewhat surprising considering the documented mediating link of debt stress between gambling and mental health (Swanton & Gainsbury, 2020). Work/study harms featured in Topic 8, which captured discussions of harms relating to the availability of many gambling products. Finally, some topics do not appear to include language pertaining to harms, which illustrates a number of unique functions of the online forum. For example, discussions of harm were generally absent (signified by the negative correlations in Figure 4) from the posts devoted to the subjects of self-exclusion and account management (e.g., Topics 1 and 6). Similarly, less discourse about harms could be found in posts that primarily included words of inspiration (Topic 5) or focus on broader debates about gambling policies (Topic 10). We were therefore able to identify exactly where the negative impact of gambling is most discussed on the forum.

These results are subject to various limitations. Caution is required when interpreting semantic associations obtained from pretrained models, which may not fully capture the nuances, context, and ambiguity expressed in people's posts on the forum, for example, the specifics of various British slang or dialects. In an effort to minimize this issue, we used complementary analysis that combines semantic associations, along with qualitative and quantitative analysis of the topic modeling (Dehghani & Boyd, 2022). Ultimately, any experience of harm is subjective and likely differs from person to person. Other NLP tools could also have been used and lie beyond the scope of the present work, such as large language models (e.g., ChatGPT, Bard). For example, one advantage of large language models is that they can extract specific meaning from each post. Rather than relying on bottom-up topic recovery, or by calculating semantic similarity with predetermined words and phrases, one could simply query a model of a series of specific questions about an online post (Le Mens et al., 2023). More powerful NLP tools will continue to emerge and could be used to yield fresh insights into gambling-related harm. Our data also lacks other data about users that might be helpful, such as the results of a later linked survey to better understand the circumstances underlying successful recovery from gambling.

The contribution of our work falls into three categories. First, our findings advance the understanding of the multidimensional and interrelated nature of gambling harm. As our methods relied on unsolicited online data, we provide new evidence for the prevalence of different types of harm among those who have intimate and personal experience of gambling. Second, our methodological approach showcases how a combination of NLP tools (supervised and unsupervised) with a large corpus of textual data can be used to reveal and quantify gambling-related harms. Our analytical approach can be easily applied to other sources of textual data. Finally, our results speak directly to the public policy interventions which aim to prevent harm. Interventions that can convey the sentiment and breadth of harm associated with gambling, as revealed through our analysis, could provide a very powerful message to at-risk individuals. Our hope is that these results will contribute to the ongoing debates regarding communicating the significance of and preventing gambling-related harm.

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