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The use of the Dark Web as a COVID-19 information source: A three-country study

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ABSTRACT

The Dark Web (i.e., the anonymous web or Darknet) contains potentially harmful COVID-19-related information and content such as conspiracy theories and forged certificates. The Dark Web may particularly attract individuals who are suspicious about the pandemic, but there is no research concerning the use of the Dark Web as a COVID-19 information source. In this study, we investigated the role of COVID-19 skepticism, online activities, and loneliness in the use of the Dark Web platforms as a COVID-19 information source.

The data (N = 3000) were gathered in April 2021 from 18 to 75-year-old respondents from Finland (n = 1000), Sweden (n = 1000) and the United Kingdom (n = 1000). The respondents were asked how often they had utilized Dark Web platforms (for example via TOR-network) as a COVID-19 information source during the pandemic. Self-reported measures of institutional trust, anti-vaccine stances, restriction obedience, online activities, and loneliness were used as predictors in the logistic regression model. Age, gender, and education were also included in the model.

The Dark Web use was more prevalent in the UK and Sweden. There was an association between anti-vaccine stances and active Dark Web use in the UK and Sweden, while low institutional trust predicted use among Finnish respondents. In all countries, restriction disobedience was related to Dark Web use as a COVID-19 information source. Frequent online gambling, increased social media use, and loneliness predicted Dark Web use, and these associations were even stronger among frequent Dark Web users than occasional users. Younger age and male gender were also associated with Dark Web use.

The unregulated nature of the Dark Web makes it a risky alternative to COVID-19 information, attracting individuals who are suspicious about the pandemic and overall active online users. Misleading information and availability of forged certificates on the Dark Web challenge official health policies, posing significant risks for both individual and public health.

1. Introduction

Ever since the coronavirus (COVID-19) started to spread in late 2019, the Internet and social media have played a major role in the dissemination of pandemic-related information and health policies. Institutional authorities have shared information about the pandemic, safety measures, and vaccination rapidly and efficiently both in their official sites and social media platforms [1,2]. Additionally, individual users have widely utilized social media platforms for sharing COVID-19 related information, subjective experiences, and thoughts with one's social network [3,4]. However, the abundance of online information and diverse views concerning the pandemic (i.e., the 'infodemic') create an

information overload, and online users need to choose which sources are worth relying on [5–7]. On the Internet, credibility of information may be difficult to detect for average online users [6–8], while false and potentially dangerous information is prone to spread rapidly and gain higher visibility compared to verified information [9–11]. For example, conspiracy theories and false information concerning the COVID-19 pandemic and vaccinations have been spread rapidly in popular social media platforms such as Twitter, Facebook, and Instagram, reaching wide audiences and exposing online users to misleading and even dangerous information [12–17].

Credibility and safety of information is a particular concern in the Dark Web (i.e., the darknet or anonymous web), which is a hidden part

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of the Internet characterized by high anonymity and unregulated content, most often accessed via The Onion Router -network (i.e., TOR-network) [18]. Due to high anonymity and its unregulated nature, the Dark Web attracts individuals for illegal and criminal purposes, such as the trading of illegal drugs and weapons, forged documents, illegal gambling, and other criminal behaviors [19–21]. In relation to COVID-19, medical products, and supplies such as fake vaccines and forged certificates have been sold in Dark Web marketplaces since the beginning of the pandemic [22,23], providing means to bypass quarantines and restrictions related to travelling and public events. Additionally, false information and conspiracy theories concerning the pandemic and COVID-19 vaccines are widespread on Dark Web platforms, providing a risky alternative to official health information and research-based knowledge [24]. Moreover, the role of the Dark Web in drug marketing has been emphasized during the COVID-19 pandemic [25,26].

While mainstream social media platforms such as Twitter and Facebook strive to actively regulate and delete misinformation such as anti-vaccine content [15], the Dark Web content is considerably less regulated. Given that the Dark Web provides a fruitful environment to disseminate alternative views concerning the pandemic, the Dark Web platforms may be particularly attractive to individuals who are suspicious about the pandemic and institutional safety measures, while looking for alternative explanations. Social distancing has also increased experiences of loneliness and other psycho-social problems particularly among vulnerable individuals [27,28], which may have increased the attractiveness of online platforms and adopting new technologies such as the Dark Web. Since the coronavirus is highly contagious and potentially lethal, being exposed to and relying on false information and conspiracy theories concerning the virus poses significant challenges to both individual and public health [14,29].

In this study, we investigate whether COVID-19-related skepticism such as institutional distrust, anti-vaccine stances and restriction disobedience are associated with the use of the Dark Web as a COVID-19 information source. Moreover, we examine the roles of online activities and loneliness during the pandemic as well as sociodemographic characteristics in Dark Web use. Our study is cross-national, comprising data gathered during the peak of the COVID-19 pandemic in April 2021 from Finland, Sweden, and the United Kingdom. Chosen countries rank high in Dark Web use [30–33], making it meaningful to investigate potential Dark Web use for pandemic-related information in these countries. Regarding COVID-19, the selected countries have adopted different strategies in dealing with the pandemic [34,35], making it interesting to examine whether these countries differ in terms of Dark Web use for informational purposes. In the UK, lockdowns, and strict restrictions enforceable by law were taken to curb the spread of the virus, whereas in Finland restrictions were both legally enforced, and recommendation based. In Sweden, measures taken against the pandemic were mostly recommendation-based, with very few measures taken that would legally limit individual freedoms. Drawing on the theoretical discussion on the role of sociopsychological and technological characteristics in online environments as (mis)information sources, we approach the Dark Web as a fruitful yet risky context to seek and communicate alternative COVID-19-related information.

Our study has several contributions. First, previous research has predominantly focused on the role of the regular Internet and popular social media platforms as a source of COVID-19 related (mis)information [12,14,36–38] and there is a call for more research on the spread of (mis)information on other platforms [38]. To the best of our knowledge, there is no scientific research concerning the use of the Dark Web platforms as a COVID-19 information source. Second, because prior research has predominantly focused on the drivers and means of sharing COVID-19 (mis)information online [39,40], there is a call for more research on COVID-19 (mis)information seeking and processing [5,37,41]. Although there is empirical research about antecedents of disseminating (mis)information online [14,36,37] and the consequences of

exposure to misinformation [41], to our best knowledge, evidence of the drivers of seeking or receiving counterfactual COVID-19 information is scarce. Third, we address a call for more empirical research on different cohorts and cultures, individual characteristics, and socio-demographic factors when it comes to the spread of online information during crises [4]. Our results bring valuable insight into under-researched topics and provide understanding why risky environments such as the Dark Web attract some individuals during a global health crisis. Fourth, given the increased popularity of the Dark Web and problematic online behaviors during the pandemic [20,42], it is important to recognize how the unique technological characteristics of the Dark Web might increase and cumulate the risks associated with problematic online behaviors and exposure to risky online content.

2. Literature review

2.1. COVID-19 skepticism and health-related misinformation in the digital era: sociopsychological perspectives

One of the key roles of governmental institutions and authorities is to protect citizens from harm and to provide a sense of security. During a global crisis such as the COVID-19 pandemic, this role becomes highly emphasized in the form of public health in terms of prevention and controlling the spread of the coronavirus, which is essentially related to the public's trust towards and compliance with public health measures such as behaviors related to high hygiene, social distancing, mask wearing and vaccination [43–45]. Individuals who have high institutional trust are more likely to obey restrictions and guidelines given by authorities and to engage in prosocial behaviors during crises [45–47]. However, some individuals have suspicious beliefs and low trust in institutions and their ability to protect citizens, which might manifest in antisocial behaviors and seeking alternative explanations to occurring events [41,48]. Here, we use the term COVID-19 skepticism to cover institutional distrust, an anti-vaccine stance and restriction disobedience concerning the coronavirus pandemic.

In crisis situations that are characterized by uncertainty, fear, and a lack of control, individuals and groups have a need to make sense of the events, which is prone to foster conspiracy thinking [49]. Institutional distrust is often accompanied with conspiracy beliefs regarding these institutions [50]. From a social psychological viewpoint suggested by Douglas and colleagues [51], conspiracy beliefs are driven by three underlying motives: a desire to find explanations to events, to feel safe and in control, and to belong to a social group. However, these motives are not always satisfied; as van Prooijen and colleagues [50] argue, institutional distrust and conspiracy beliefs are prone to reduce a sense of safety and the quality of social relationships, while increasing negative group behavior such as polarization, extremism, and intergroup conflicts.

Online environments provide a fruitful context for disseminating alternative views concerning the pandemic, and to connect with others who share similar thoughts. During the time of social isolation and physical distancing, the role of the Internet as a source of social interaction becomes increasingly important. Humans are generally motivated to find similar others and join communities that fit their interests and worldviews [52,53]. In an online environment, these social needs are easily facilitated as users can seek information and create networks and communities that validate their interests and identities [53,54]. The ability of online environments to bring together like-minded individuals is prone to decrease the diversity of exposed content and information via the user's personal online preferences and platforms' algorithmic filtering technologies [53]. One-sided exposure has notable risks, particularly if shared information is misleading or promoting harmful health behaviors such as anti-vaccine attitudes [55,56].

Health-related misinformation on the Internet is a particular concern since it has the potential to influence attitudes and behaviors that have adverse effects on both individual and public health [7,17,57].

Misinformation is an umbrella term to information that is even deliberately or non-deliberately false, inaccurate, or misleading [58,59]. Online environments provide high visibility to subjective experiences and conspiracy-like narratives such as anti-vaccine argumentation, and individual users can be highly influential in disseminating such content [12,55]. False information on social media is also prone to spread more rapidly and reach wider audiences compared to verified information [9–11]. Additionally, communities and groups which are formed around communicating conspiracy beliefs, such as anti-vaccination groups, are widespread on social media [11,56,60]. These communities are characterized by high engagement by their users, as well as the utilization of fewer information sources [56]. This, in turn, is prone to decrease the information diversity the user is exposed to.

The COVID-19 pandemic is a prominent example of a societal crisis and an external threat which is prone to fuel dissemination of misinformation such as conspiracy beliefs, as well as forming related online communities. Since institutional distrust is shaped by both individual and collective perceptions of untrustworthiness [43], it is important to consider the potential of online platforms in shaping online users' attitudes via shared narratives and collective responses. Collective reactions to online content have the potential to influence online users' interest in and acting on such information [61]. Thus, online environments can normalize and foster potentially harmful health information particularly among highly active online users. Using unofficial online sources is also prone to foster conspiracy-like thinking [13] and utilizing social media sources that promote anti-vaccine argumentation is prone to fuel vaccine hesitancy [60,62]. Believing in conspiracy theories concerning the pandemic is also associated with resistance towards safety measures and vaccinations [29], making these kinds of content potentially harmful and dangerous during the pandemic.

In addition to the role of online environments in fostering COVID-19 skepticism and disobedience, there are also socio-psychological factors associated with disobedience and rule-breaking during the crises. Recent studies have shown that dark personality traits such as machiavellism and psychopathy are related to avoidance of prosocial health behaviors during the COVID-19 pandemic [63,64]. Further, Nivette and colleagues [44] found that deviant peers and antisocial characteristics such as low self-control and illegal drug use were related to non-compliance and rule-breaking during the COVID-19 pandemic. These kinds of characteristics, particularly a tendency for deviant behaviors, might be common among individuals who utilize risky and alternative platforms on the Internet such as the Dark Web which is known for its deviant and illegal content.

2.2. The Dark Web as an information source: the technological perspective

The Internet can be distinguished into three layers: the Surface Web, the Deep Web, and the Dark Web. The surface level covers only a minor peak of the Internet that is visible for the public and easily findable via common search engines such as Google. Deep Web content covers the hidden part of the Internet which is not indexed by traditional search engines. These contents often have restricted access, for example via passwords. Additionally, databases and content that exist behind paywalls are a part of the Hidden Web. The third level of the Internet is the Dark Web which is a part of the Deep Web but has its own unique characteristics. The Dark Web is accessible only via specific software such as The Onion Router -network, commonly called as TOR.

The Dark Web is essentially characterized by the concept of *anonymity*. In Internet research, anonymity is a multidimensional concept that has both technological and social affordances in online behavior and communication [65]. From a technological perspective, the Dark Web provides users high online privacy and anonymity via layered encrypting technologies which makes it near impossible to track users [21,65]. Thus, anonymity has two important functions on the Dark Web: the possibility to access the Internet anonymously and to host a website

anonymously, the latter often referred to as “hidden services” of the Dark Web [66]. Due to high anonymity, the Dark Web and its hidden services contain a myriad of illegal and deviant activities and attracts individuals who wish to operate anonymously on the Internet. Indeed, the most popular content [21,67] and common uses [66] of the hidden services located in the Dark Web are illegal. The Dark Web is commonly associated with “black markets”, i.e., marketplaces for trading items such as drugs, firearms, and forged documents [68,69] as well as other deviant and antisocial behaviors such as terrorism, illegitimate pornography, and assassination services [21,68,70,71]. Cryptocurrencies such as Bitcoins are used for laundering money anonymously [72].

Despite the popularity of illegal content and activities on the Dark Web, it is not only used for illegal purposes and not all content in the Dark Web is illegal. The benefits of high anonymity such as freedom of expression and high online privacy motivate many users [73–75], and anonymity-based Dark Web browsers such as TOR can also be used to access the Surface Web [21]. In politically repressive countries and regimes, the anonymity of the Dark Web enables free expression of political thoughts without the fear of governmental surveillance or censorship [76]. The use of a TOR-browser and the Dark Web is legal in most countries, but some countries such as China and Egypt have prohibited the use of the Dark Web [73]. This multi-functionality of the Dark Web is important to recognize since user motivations might also differ from privacy concerns to engaging in malicious and illegal activities. For example, Jardine and colleagues [77] found that in politically repressive countries, the Dark Web is more commonly used to overcome privacy issues and censorship, while users in more politically free countries utilize the Dark Web more commonly for malicious purposes.

3. Theoretical framework and hypotheses

Based on the literature review, we propose a theoretical framework where the use of the Dark Web as a source of information is explained with various social, individual, and technological factors in different countries. This is because Dark Web use requires advanced technological skills but seeking alternative information during a crisis is also driven by social, cultural, and individual factors. From a sociopsychological perspective, we study the link between perceived loneliness and seeking information from the Dark Web. We also examine the association between information seeking from the Dark Web and COVID-19 skepticism, approaching the Dark Web as a fruitful platform for seeking and communicating alternative information and deviant behavior such as rule-breaking during the crisis. From a technological perspective, we examine information seeking from the Dark Web in relation to engagement in other online activities as well as socio-demographic factors that are associated with the adaptation of new technologies. Our theoretical approach is consistent with models such as The SocioCultural-Psychology-Technology SCulPT that has been used to investigate problematic online behaviors such as the spreading of fake news during the COVID-19 pandemic or cyber bullying from various perspectives [14,78].

3.1. The association between loneliness and seeking information from the Dark Web

Since the Dark Web is accessible only via specific software, users of the Dark Web are prone to be highly engaged and advanced online users who are familiar with technology and have the required skills to access hidden parts of the Internet. High Internet use, however, is linked to various psychosocial problems such as loneliness [79–81]. Loneliness can be defined as a perceived deficiency in quality or quantity of one's social relationships, often characterized by unpleasant feelings of isolation and a lack of social connection [82,83]. Loneliness is an aversive state and individuals are motivated to seek ways to overcome it [84]. During the COVID-19 pandemic and social distancing, high

engagement in digital technologies can be a way to cope with loneliness and find company [85]. Even though online platforms and communities provide means to fulfill the basic human need for social interaction [86], high Internet use is prone to increase feelings of loneliness [79–81].

In addition to its technological side, anonymity in the Dark Web can also be approached as a degree of social presence in interaction, varying from more identifiable visual cues such as physical appearance in photos or video calls to more text-based interaction with pseudonyms, avatars, and even full anonymity, where individual users are not identifiable to each other [87]. The Dark Web is characterized by high visual anonymity where interaction is mostly text-based and lacks social cues [88, 89]. Visual anonymity facilitates self-disclosure and makes it easier to share sensitive topics [90]. This might be particularly true on the Dark Web, which provides platforms and communities for like-minded individuals whose interests can be seen as socially unacceptable, deviant, or illegal [71,91]. Thus, anonymity in the Dark Web essentially provides users with the freedom to communicate and explore ideas that are generally marginalized [88].

Ethnographic research on the Dark Web drug marketplaces reveals that these sites are not only used for drug purchasing per se, but they also provide a shared understanding, collective identity, as well as the freedom to talk about sensitive and illegal topics that would raise strong opposition and criticism outside the Dark Web [88,91]. These kinds of communities are essentially based on trust in other community members that is shaped via social mechanisms such as shared narratives and collective identity [92]. When a user is strongly attached to an online community, visual anonymity is likely to reinforce group processes such as social influence and reliance on information provided by one's in-group members, as well as a polarization between different communities and groups [89]. Based on this conceptualization, the use of the Dark Web is characterized by both antisocial behaviors and on the other hand a basic human need for social interaction. Therefore, we postulate:

H1. Loneliness during the pandemic is associated with the use of the Dark Web as a COVID-19 information source.

3.2. *The association between engagement in online activities and seeking information from the Dark Web*

Due to social isolation caused by COVID-19 restrictions, many individuals have spent more time in online environments than before to maintain social connections, pass the time, cope with pandemic-related negative feelings and to find information of the current pandemic situation. Increased Internet use might have also increased interest towards adopting new technological skills and exploring different online platforms such as the Dark Web. Although the Dark Web can be approached as a specific part of the Internet with unique technological characteristics and illegal content, the use of the Dark Web and regular Internet and social media platforms overlap. For example, users who utilize the Dark Web for drug purchasing also utilize mainstream social media platforms for such activities [30]. Additionally, some anonymity-driven and less regulated social media platforms in the surface web, such as Reddit, may act as a gateway to the Dark Web, for example, by providing information about how to access the Dark Web [93]. These kinds of “dark platforms” of the surface web, even though not located in the actual Dark Web, are also known to contain conspiracy theories concerning the COVID-19 pandemic [94]. Thus, increased interest towards social media sites and exposure to alternative COVID-19 content might have increased the likelihood of seeking out the Dark Web content as well, particularly among individuals who find such content interesting or relevant.

Regular social media platforms such as Twitter and Facebook strive to regulate harmful or misleading online content and frequently close accounts for spreading misinformation [12]. However, it is possible that these users shift to the Dark Web to continue such activities and find others who validate these ideas, and analogously, those who seek and disseminate their ideas in the Dark Web may spread such information to

regular social media as well [95]. Prior research also suggests that exposure to (mis)information can trigger individuals to seek more information to verify the information that they suspect to be false [96]. For instance, when an individual's own knowledge and judgement is insufficient to verify information on social media, they use other sources of information to authenticate [96]. Thus, instead of perceiving the Dark Web as a separate part of the Internet, it is important to acknowledge the potential overlap between the Dark Web and regular social media. Given that increased engagement in other online platforms during COVID-19 may act as catalyst for the use of the Dark Web, we suggest:

H2a. Increased social media activity during the pandemic is associated with the use of the Dark Web as a COVID-19 information source.

There is also evidence that the COVID-19 pandemic has amplified excessive online behaviors [42]. Given that Dark Web users are prone to be advanced online users, they are likely to encounter various risks on the Internet. Excessive Internet use is associated with risky online behaviors such as excessive online gambling [97,98]. These problems may further accumulate on the Dark Web which contains a myriad of opportunities for maladaptive behaviors such as illegal gambling [19] and obtaining drugs [25,91]. Thus, we hypothesize:

H2b. Frequent online gambling during the pandemic is associated with the use of the Dark Web as a COVID-19 information source.

3.3. *The association between COVID-19 skepticism and seeking information from the Dark Web*

Since content on the Dark Web is not regulated or driven by institutional interests, information disseminated on the Dark Web might be perceived as more truthful and reliable particularly for individuals who are suspicious about official institutions [24]. Distrust in the form of perceived information insufficiency is associated with the risk of information seeking, as people are motivated to seek more information to reach judgmental confidence about a topic [99]. In addition, social mechanisms in an online context are prone to foster reliance on information provided by like-minded community members, as well as acting on such information [61,89,100]. The role of online communities and their social mechanisms are widely recognized in relation to conspiracy-driven health behaviors such as those related to the H1N1 influenza [9,11,101]. According to a study by Murphy and colleagues [62], vaccine hesitant individuals are more likely to rely on unofficial online information sources. Accordingly, anonymous online platforms and groups that are formed around a shared understanding might have great potential to foster COVID-related skepticism such as conspiracy beliefs, institutional distrust, anti-vaccine stances and disobedience towards institutional restrictions and safety measures. Because the seeking of counterfactual information about COVID-19 is characterized by doubtfulness towards institutions and their COVID-19 countermeasures, we hypothesize:

H3a. Institutional distrust is associated with the use of the Dark Web as a COVID-19 information source.

H3b. Anti-vaccine stances are associated with the use of the Dark Web as a COVID-19 information source.

H3c. Restriction disobedience is associated with the use of the Dark Web as a COVID-19 information source.

3.4. *The association between socio-demographic factors and seeking information from the Dark Web*

Since access to the Dark Web requires more nuanced technological skills compared to regular Internet or social media use, users of the Dark Web are prone to be highly advanced online users [102]. According to Rojas-Méndez and colleagues [103], several prior studies have shown that male gender is associated with innovativeness and lower discomfort

and insecurity with new technologies. On the other hand, conflicting results have been found across and within several studies [104], which makes this hypothesized association worth testing. For instance, previous studies have shown that women generally give and receive social support through the Internet more than men [105,106]. Therefore, we test the association between gender and seek of COVID-19 information from the Dark Web:

H4. Male gender is associated with the use of the Dark Web as a COVID-19 information source.

Extensive research supports that younger people are more innovative and optimistic, and less uncomfortable and insecure than their older counterparts when it comes to new technologies [103]. Therefore, concerns have been raised particularly in relation to young online users' increased Dark Web usage during the COVID-19 pandemic [20], but there are also contrasting findings, which argue that age has no significance on adaptation of digital technologies [104,107]. Thus, the link between younger age and search for COVID-19 information from the Dark Web is worth testing:

H5. Younger age is associated with the use of the Dark Web as a COVID-19 information source.

In addition, higher education is linked to higher innovativeness and optimism and less discomfort and insecurity towards new technologies [103]. Therefore, educated individuals are more prone than less educated ones to adopt new technological developments, but in some studies, the effect of educational level has been found insignificant [104, 108]. Prior research has also linked lower education to compromised health literacy [109] and belief in conspiracy theories [110], which might be common for users who utilize the Dark Web as an information source. Thus, the association between level of education and the search of COVID-19 information from the Dark Web is worth testing:

H6. Either low or high education are more likely to be associated with the use of the Dark Web as a COVID-19 information source compared to secondary education.

3.5. A cross-national perspective of this study

The three countries chosen for our analysis (Finland, Sweden, and the UK), represent technologically advanced European countries with cultural similarities. Finland and Sweden, as neighboring Nordic countries, are culturally and socially close to each other. Dark Web use is legal in all these countries, and particularly drug trading on the Dark Web is highly prevalent in all these countries [30,32,33]. In 2019, Sweden and the UK were among the countries that had the most active Dark Web users [31]. Also, nearly half (46%) of the population in the UK were exposed to COVID-19 related fake news during the pandemic [14].

Despite the similarities between the three countries, they have utilized relatively different pandemic strategies. As Wilska and colleagues [34] tracked in their report, the main differences between the three were the levels of legal action taken to limit individual freedoms and control the spread of the virus. In the UK, a total of three lockdowns were experienced throughout the pandemic thus far, with legally enforceable restrictions being in place in between the lockdowns. Failing to comply with these legally enforced mandates were punishable by law and were monitored by the law. By contrast in Sweden, most measures taken were merely recommendation based, with no major restrictions imposed upon either individuals or industries, except for some limited business hours and travel restrictions. Only after the second wave of the pandemic were broader restrictions implemented in a legally enforceable manner, after a pandemic law was finally passed by the government. Finland fell in between the two in terms of leniency, with some measures being legally enforceable (e.g., limitations on the food and drink industry, mask mandates, and a shutdown of the capital region in the wake of the pandemic), but still heavily relying on individual responsibility as well.

Neither Finland nor Sweden ever went into an official lockdown, whereas the United Kingdom went through a total of three lockdowns between 2020 and 2021 [34,35].

Due to cultural and technological similarities but different COVID-19 strategies, it is meaningful to investigate whether hypothesized associations in using the Dark Web as COVID-19 information source are similar in all countries, and whether these associations differ between occasional and active Dark Web users. Our main hypotheses are summarized in Table 1.

4. Methods

4.1. Participants and procedures

Our cross-national dataset (N = 3000) of this study comprises of 18 to 75-year-old participants from Finland (n = 1000, 50.4% female, mean age = 44.60, SD = 15.67), Sweden (n = 1000, mean age = 43.84, SD = 15.78, 50.3% female) and the UK (n = 1000, mean age = 43.56, SD = 15.76, 50.8% female). Data were gathered simultaneously from these countries in April 2021 during the COVID-19 pandemic, using an anonymous online survey. The survey was designed to study the overall impact of the pandemic on one's life, such as online behavior, consumption, and wellbeing. The survey design and measures were similar in Finnish, Swedish and English.

The web panel sample for the survey was gathered by a data-provider company that recruited respondents from an online panel (CINT) using a random sample in each country. Panel members were contacted in random order. The web panelists are volunteers who choose to respond to surveys according to their likes and interests. The panelists are also awarded prizes and compensation for their time and effort. Nonresponse bias was assessed by comparing the sample to the adult population structure of countries (see Appendix 1). The web panel data was a census representative sample of each country based on age, gender, and region. Response rate of the invited respondents were 26% for Finland, 73% for the UK and 27% for Sweden. Margin of error is 3.1% for all countries. In general, the distributions of age, gender and region are within error margin when compared with the general population except for a few groups that are less than 8% over- or underrepresented in the data. Each item in this study had less than 3.7% values missing.

4.2. Measures

The use of the dark web platforms as a COVID-19 information source was used as a dependent variable. It was measured with a question: "How often have you utilized the following online sources to seek information about coronavirus pandemic: Dark web platforms (for

Table 1
Summary of hypotheses.

Hypotheses	
H1	Loneliness during the pandemic is associated with the use of the Dark Web as a COVID-19 information source.
H2a	Increased social media activity during the pandemic is associated with the use of the Dark Web as a COVID-19 information source.
H2b	Frequent online gambling during the pandemic is associated with the use of the Dark Web as a COVID-19 information source.
H3a	Institutional distrust is associated with the use of the Dark Web as a COVID-19 information source.
H3b	Anti-vaccine stances are associated with the use of the Dark Web as a COVID-19 information source.
H3c	Restriction disobedience is associated with the use of the Dark Web as a COVID-19 information source.
H4	Male gender is associated with the use of the Dark Web as a COVID-19 information source.
H5	Younger age is associated with the use of the Dark Web as a COVID-19 information source.
H6	Either low or high education are associated with the use of the Dark Web as a COVID-19 information source compared to secondary education.

example via TOR-network). The answer options were “not at all”, “sometimes”, “weekly”, “many times a week” and “daily”. For the sake of analysis, the answers were categorized into three categories based on a level of engagement in such activity (0 = not at all; 1 = occasionally, i.e., sometimes or weekly; 2 = frequently, i.e., many times a week or daily).

Level of institutional trust consisted of four items, measuring respondent’s confidence in the healthcare system, state government, researchers, and the World Health Organization (WHO) in dealing with the pandemic. Similar questions have been used in former research measuring institutional trust [111,112]. The scale ranged from 1 to 5 where a greater number stood for greater confidence. For the analyses, the scale was turned into a composite variable using the mean score and reversed so that greater score stood for lower institutional trust. Cronbach’s alphas showed an acceptable reliability in all countries: 0.78 in Finland, 0.73 in Sweden and 0.70 in the UK.

Anti-vaccine stances were measured with a question asking: “Are you going to take the COVID-19 vaccine?”. Original answer options were “Absolutely yes”, “Probably yes”, “Probably not”, “Absolutely not”, “Not sure” and “Have already taken the vaccine”. The variable was recoded as a dummy variable to measure anti-vaccine stances, that is, an explicit negative stance on taking the COVID-19 vaccine (0 = “no” for an anti-vaccine stance, i.e., absolutely/probably/have already taken the vaccine/is not sure; and 1 = “yes” for an anti-vaccine stance, i.e., probably/absolutely not taking the vaccine).

Restriction disobedience consisted of two items “To what extent have you been obeying the COVID-19 recommendations/restrictions from authorities (for example, the NHS)” and “To what extent have you been obeying the government decision on a stay-at-home order?” Questions were slightly modified for each country to represent the country-specific precautionary measures (i.e., stay-at-home recommendation in Finland and Sweden) and examples of health authorities (i.e., THL in Finland; Folkhälsomyndigheten in Sweden). The original scale was from 1 to 5 where 1 stood for “very poorly” and 5 for “very well”. For the analyses, the scale was turned into a composite variable using the mean score and reversed to represent disobedience towards COVID-restrictions. Cronbach’s alpha showed acceptable to good reliability, being 0.77 in Finland, 0.76 in Sweden and 0.84 in the UK.

Increased social media activity during the pandemic was measured with a question asking how often a respondent had “uploaded or shared content in social media during COVID-19 pandemic compared to earlier?”. Original response options were “not relevant/not at all”, “considerably less”, “less than earlier”, “the same amount”, “more to some degree” and “considerably more”. For the analyses, the variable was recoded into a dummy variable (0 = no, i.e., not at all/same amount/less than earlier; 1 = yes, i.e., more/considerably more than earlier).

Frequent online gambling during the pandemic was measured with a question asking: “How often during the past year have you done any of the following: gambled online (for example in online casinos)”. The variable was categorized into a dummy variable (0 = no, i.e., less than weekly; 1 = yes, i.e., at least few times a week).

Loneliness during the pandemic was measured with a Three-Item Loneliness scale which is a short scale developed for survey research and it is comparable with full loneliness measures [113]. The three-part question was asked: How often during the last year have you felt: 1) that you lack companionship? 2) left out? 3) isolated from others? The answer options were “hardly ever”, “some of the time” and “often”. The time frame (last year) is not given in the original measure, however, we wanted to ask about the experiences of loneliness during the pandemic. For the analysis, the scale was turned into a composite variable using the sum score, with a higher score indicating a higher level of experienced loneliness during the pandemic. Cronbach’s alpha showed good reliability in all countries (0.85 in Finland, 0.81 in Sweden and 0.83 in the UK).

Out of sociodemographic variables, **age**, **gender**, and **educational level** were also included in the model. Age was categorized into four age

groups: 18–30, 31–44, 45–59 and 60–75-year-olds, of which the latter category was used as a reference category in the analysis. Gender was treated as a dummy variable (0 = female; 1 = male). Level of education was recoded into three categories (primary, secondary, and tertiary).

4.3. Statistical techniques

We report both descriptive statistics and multinomial logistic regression analysis of the Dark Web use as a COVID-19 information source. Multinomial logistic regression analysis was chosen as a method to investigate the risk and underlying patterns in seeking COVID-19-related information from the Dark Web. With multinomial regression, we are also able to compare whether associations differ between occasional and frequent Dark Web users. Separate regression models were run for each country (Finland, Sweden, and the UK) to find out and compare whether the hypothesized associations are similar in different countries. We also report additional analyses with a combined dataset to detect the country-effects and significant country-level interaction effects in hypothesized associations. In descriptive statistics, we report means (*M*) and standard errors (*SE*) for our continuous variables, and frequencies and percentages for categorical variables. In the logistic regression model, we report odds ratios (*OR*), standard errors (*SE*) and statistical significances (*p*). We also report goodness-of-fit statistics of the model, including pseudo coefficient of determination (Nagelkerke R^2). Collinearity diagnostics were run for the model to assess potential multicollinearity issues in the independent variables. Diagnostics showed that all VIF-values were close to 1, indicating that there are no problems in multicollinearity. Statistical analyses were carried out using SPSS Statistics software (version 27).

5. Results

Reported use of the Dark Web as a COVID-19 information source was relatively high in all country samples. The use was highest in the UK, followed by Sweden and Finland. In the UK, 19.0% of the respondents reported seeking COVID-19 information from the Dark Web occasionally and 9.6% frequently. In Sweden, these rates were almost as high; 17.9% reported using the Dark Web occasionally and 7.7% frequently for information seeking. In Finland, the use was less common than in the UK and Sweden. Only 11.1% of the Finnish respondents reported occasional and 5.0% frequent use of the Dark Web as a COVID-19 information source (see Table 2 for descriptive statistics).

According to the multinomial logistic regression analysis (see Table 3), hypothesized associations were mostly similar and consistent in all countries. Feelings of loneliness during the pandemic were associated with the Dark Web use in all three countries, thus supporting our hypothesis (H1). This association was even stronger among frequent Dark Web users, odds ratios varying from 1.26 ($p = 0.003$) in the UK data to 1.23 ($p = 0.039$) in the Finnish and 1.19 ($p = 0.029$) in the Swedish data.

Of online behaviors, reported increase in social media activity (e.g., uploading or sharing content on social media) during the COVID-19 pandemic was associated with the frequent use of the Dark Web as a COVID-19 information source in all countries. In the Swedish sample, this association was found also among occasional Dark Web users ($OR = 2.12, p = 0.002$), but the association was even stronger among frequent Dark Web users ($OR = 3.93, p < 0.001$). Odds ratios among Finnish and British frequent Dark Web users varied from 5.13 ($p < 0.001$) to 2.68 ($p < 0.001$), respectively. Thus, our hypothesis (H2a) was supported in all countries.

In line with our hypothesis (H2b), frequent online gambling during the pandemic predicted the use of the Dark Web as a COVID-19 information source in all countries. In Finland, frequent online gambling was associated only with frequent Dark Web use ($OR = 5.22, p < 0.001$) but not with occasional use. In Sweden and the UK, frequent online gambling was associated with both occasional and frequent Dark Web

Table 2
Descriptive statistics of variables.

Continuous variables	Range	Finland		Sweden		The UK	
		M	SD	M	SD	M	SD
Institutional distrust	1–5	2.57	0.74	2.73	0.78	2.57	0.78
Restriction disobedience	1–5	1.89	0.91	2.05	1.00	1.79	1.00
Loneliness	0–9	5.28	1.90	5.46	1.85	5.61	1.92
Categorical variables	Coding	n	%	N	%	n	%
Dark Web use as a COVID-19 information source	Not at all	832	83.9	739	74.3	710	71.4
	Occasionally	110	11.1	178	17.9	189	19.0
	Frequently	50	5.0	77	7.7	96	9.6
Gender	Male	494	49.6	496	49.7	491	49.2
	Female	501	50.4	502	50.3	507	50.8
Age group	18–30	244	24.4	248	24.8	271	27.1
	31–44	275	27.5	291	29.1	280	28.0
	45–59	269	26.9	262	26.2	246	24.6
	60–75	212	21.2	199	19.9	203	20.3
Education	Primary	91	9.1	77	7.7	63	6.3
	Secondary	523	52.5	522	52.3	523	52.5
	Tertiary	383	38.4	400	40.0	410	41.2
Anti-vaccine stances	No	840	85.4	810	83.0	836	86.6
	Yes	144	14.6	166	17.0	129	13.4
Increased social media activity	No	885	88.7	846	85.0	736	73.8
	Yes	113	11.3	149	15.0	261	26.2
Weekly online gambling	No	872	88.1	919	92.6	890	89.9
	Yes	118	11.9	73	7.4	100	10.1

use, and the association was even stronger among frequent Dark Web users (Sweden: OR = 3.30, $p = 0.003$; the UK: OR = 3.15, $p = 0.001$).

Of measures related to COVID-19 skepticism, a positive association between institutional distrust and frequent Dark Web use was found only among Finnish respondents (OR = 2.15, $p < 0.001$). In the UK, this effect was true in reverse (OR = 0.68, $p = 0.039$), indicating that respondents with higher levels of institutional trust were more likely to frequently seek COVID-19 information from the Dark Web. In Sweden, institutional distrust predicted the use of the Dark Web as a COVID-19 information source only among occasional Dark Web users (OR = 1.41, $p = 0.010$). Thus, our hypothesis (H3a) was supported only in Finland and Sweden.

An anti-vaccine stance was associated with Dark Web use in all countries, supporting our hypothesis (H3b). In Finland, however, this association was found only among occasional Dark Web users (OR = 2.11, $p = 0.010$) but not among frequent users. In Sweden and the UK, this association was found among both occasional and frequent Dark Web users, and the association was even stronger among frequent Dark Web users (Sweden: OR = 4.04, $p < 0.001$; the UK: OR = 2.34, $p = 0.016$).

Disobedience regarding COVID-19 restrictions predicted the use of the Dark Web as a COVID-19 information source in all countries, supporting our hypothesis (H3c). Among active Dark Web users, odds ratios varied from 1.61 ($p < 0.001$) in the UK sample to 1.39 ($p = 0.020$) in the Swedish sample. In Finland, this association fell in between (OR = 1.43), being near-significant ($p = 0.051$).

Of sociodemographic factors, male gender was associated with both occasional and frequent Dark Web use in Finland and Sweden, while in the UK, gender had no statistical significance. Thus, hypothesis on gender differences (H4) was supported only in Finland and Sweden. Younger age was associated with both occasional and active Dark Web use in all three countries as was hypothesized (H5). Educational level was not associated with neither occasional nor frequent Dark Web use in any of the countries, leaving the hypothesis (H6) unsupported.

As additional analyses, we conducted multinomial regression analysis on a combined sample to detect country-effects on the Dark Web

Table 3
Multinomial logistic regression analysis on the use of the Dark Web as a COVID-19 information source.

	Finland						Sweden						The UK																	
	Occasional use			Frequent use			Occasional use			Frequent use			Occasional use			Frequent use														
	OR	SE	p	95% CI	OR	SE	p	95% CI	OR	SE	p	95% CI	OR	SE	p	95% CI	OR	SE	p	95% CI										
Male (ref. 60–75)	2.75	0.25	<0.001	1.69	4.48	2.92	0.38	0.005	1.39	6.14	1.39	6.14	1.12	2.46	2.11	0.29	0.010	1.20	3.72	1.40	0.20	0.097	0.94	2.07	1.20	0.28	0.506	0.70	2.07	
18–30	7.22	0.43	<0.001	3.13	16.68	9.54	0.67	<0.001	2.55	35.72	6.74	0.41	<0.001	3.05	14.90	9.52	0.65	<0.001	2.68	33.86	9.19	0.47	<0.001	3.67	23.01	5.23	0.59	0.005	1.65	16.58
31–44	2.67	0.43	0.022	1.15	6.27	1.86	0.71	0.385	0.46	7.51	4.87	0.40	<0.001	2.24	10.58	4.10	0.66	<0.031	1.14	14.81	5.86	0.46	<0.001	2.37	14.48	3.91	0.58	0.019	1.26	12.17
45–59	0.99	0.49	0.989	0.38	2.59	0.88	0.81	0.873	0.18	4.26	2.00	0.42	0.101	0.87	4.57	3.00	0.67	0.100	0.81	11.10	2.74	0.47	0.035	1.08	6.99	0.91	0.67	0.888	0.24	3.39
Education (ref. secondary)	1.19	0.37	0.628	0.58	2.44	1.33	0.57	0.617	0.44	4.01	1.13	0.35	0.734	0.75	2.23	1.61	0.47	0.309	0.65	4.01	1.18	0.48	0.724	0.47	3.00	2.50	0.52	0.080	0.90	6.96
Primary	0.66	0.27	0.119	0.39	1.11	1.02	0.38	0.951	0.48	2.17	1.10	0.21	0.652	0.73	1.64	1.37	0.29	0.284	0.77	2.43	1.15	0.20	0.481	0.78	1.69	1.22	0.27	0.465	0.71	2.09
Tertiary	1.35	0.16	0.060	0.99	1.85	2.15	0.23	<0.001	1.37	3.36	1.41	0.13	0.010	1.09	1.82	0.97	0.19	0.873	0.66	1.42	1.12	0.13	0.382	0.87	1.46	0.68	0.17	0.409	0.47	0.98
Institutional distrust	2.11	0.29	0.010	1.20	3.72	0.86	0.46	0.740	0.35	2.12	2.80	0.23	<0.001	1.78	4.40	4.04	0.32	<0.001	2.18	7.48	1.84	0.26	0.019	1.10	3.06	2.34	0.35	0.016	1.17	4.68
Anti-vaccine	1.29	0.13	0.046	1.01	1.65	1.43	0.19	0.051	1.00	2.06	1.45	0.10	<0.001	1.20	1.76	1.39	0.14	0.020	1.05	1.84	1.72	0.10	<0.001	1.41	2.10	1.61	0.14	<0.001	1.23	2.10
Disobedience	1.82	0.34	0.074	0.94	3.52	5.13	0.40	<0.001	2.33	11.32	2.18	0.26	0.002	1.32	3.60	3.93	0.32	<0.001	2.12	7.29	0.88	0.23	0.583	0.57	1.38	2.68	0.27	<0.001	1.57	4.57
Increased social media activity	1.70	0.34	0.113	0.88	3.28	5.22	0.40	<0.001	2.41	11.32	2.75	0.33	0.002	1.44	5.25	3.30	0.41	0.003	1.48	7.33	1.93	0.31	0.031	1.06	3.51	3.15	0.35	<0.001	1.60	6.20
Frequent online gambling	1.11	0.07	0.124	0.97	1.26	1.23	0.10	0.039	1.01	1.49	1.19	0.06	0.002	1.07	1.33	1.19	0.08	0.029	1.02	1.39	1.17	0.06	0.006	1.05	1.30	1.26	0.08	0.003	1.08	1.46
Loneliness	1.11	0.07	0.124	0.97	1.26	1.23	0.10	0.039	1.01	1.49	1.19	0.06	0.002	1.07	1.33	1.19	0.08	0.029	1.02	1.39	1.17	0.06	0.006	1.05	1.30	1.26	0.08	0.003	1.08	1.46
Likelihood ratio $\chi^2 = 225.686$; $p < 0.001$																						Likelihood ratio $\chi^2 = 254.586$; $p < 0.001$								
Nagelkerke $R^2 = 0.33$																						Nagelkerke $R^2 = 0.31$								
Likelihood ratio $\chi^2 = 289.318$; $p < 0.001$																						Likelihood ratio $\chi^2 = 289.318$; $p < 0.001$								
Nagelkerke $R^2 = 0.34$																						Nagelkerke $R^2 = 0.34$								

Note. OR = odds ratio; SE = standard error. Statistically significant p -values in bold.

use as a COVID-19 information source (Table 4). Compared to Finland (used as a reference category), both Swedish and British respondents were more likely users of the Dark Web for COVID-related information both occasionally (Sweden OR = 1.88, $p < 0.001$; the UK OR = 2.30, $p < 0.001$) and frequently (Sweden OR = 1.82, $p = 0.005$; the UK OR = 2.00, $p = 0.001$).

We also checked country-level interactions (not reported in tables) by all our independent variables to investigate whether there are significant cross-country differences in former associations. Interaction effect between country and institutional distrust was statistically significant among frequent Dark Web users; compared to Finland (used as a reference category), odds ratio for institutional distrust and frequently seeking COVID-19 information from the Dark Web was lower among both Swedish (OR = 0.48, $p = 0.008$) and British (OR = 0.38, $p < 0.001$) respondents. Additionally, interaction effect between country and anti-vaccine stances was significant among frequent Dark Web users; compared to Finnish respondents, the odds ratio for anti-vaccine stance and frequently seeking COVID-19 information from the Dark Web was notably higher among both Swedish (OR = 4.61, $p = 0.003$) and British (OR = 3.22, $p = 0.03$) respondents. These findings are in line with our country-specific analyses, showing that institutional distrust was associated with Dark Web use particularly in Finland, while anti-vaccine stance was a driver for Dark Web use in Sweden and the UK. All other country-level interactions were non-significant, supporting the finding that our hypothesized associations work in a similar manner in all three countries.

6. Discussion

In this study, we investigated the use of the Dark Web as a COVID-19 information source and associated factors using three-country data from Finland, Sweden, and the UK. We examined whether COVID-related skepticism, online activities, and loneliness during the pandemic are associated with the use of the Dark Web as a COVID-19 information source. The results were mostly consistent in all three countries, but also some country differences were found in associations. The use of the Dark Web as a COVID-19 information source was most prevalent in the UK and Sweden compared to Finland. This is plausible given that the UK and Sweden were among the most active countries in Dark Web usage even before the pandemic [31]. Even though Finnish users are highly represented on the Dark Web drug marketplaces [30,33], it may be that Finns in general associate the Dark Web more directly with such criminal activities.

Findings regarding the role of COVID-19 skepticism in seeking information from the Dark Web had both similarities and differences in countries. The association between institutional distrust and frequently seeking information from the Dark Web was found among Finnish Dark Web users, while in Sweden, this association was found only among occasional Dark Web users but not among British users. Thus, suspicious beliefs towards institutional authorities might particularly motivate Finnish users to actively seek alternative information from the Dark Web. Instead, the association between anti-vaccine stances and seeking COVID-19 information from the Dark Web was found among British and Swedish Dark Web users being even stronger among active users, while in Finland, this association was found only among occasional Dark Web users. These country differences might reflect the different COVID-19 strategies adopted in these countries [34,35] but also general cultural tendencies in the Dark Web use. Restriction disobedience regarding pandemic safety measures, however, was associated with the Dark Web use in all countries. These findings are consistent with prior research that associates the perceived information insufficiency with the seeking of risk information online during a crisis [99], as well as the role of unofficial online sources in vaccine hesitancy [62]. Availability of misinformation, conspiracy theories, and forged COVID-19 certificates are highly represented on the Dark Web [24]. Thus, the Dark Web might provide an attractive alternative for those who wish to seek and communicate alternative explanations and behaviors during a global crisis, or even finding ways to bypass quarantines or restrictions related to travelling or public events.

The findings about the role of loneliness in seeking COVID-19 information from the Dark Web is in line with the fact that users of the Dark Web are prone to be advanced online users [102], which is associated with loneliness [79–81]. During the COVID-19 pandemic, physical distancing and lockdown measures have also increased experiences of loneliness particularly among vulnerable individuals [27,28], and high technology use might have acted as a way to cope with loneliness. Additionally, given that times of crises are known to emphasize a need for social belonging [51], lonely or socially excluded individuals may have been motivated to find social connections and a sense of belonging from the Dark Web. Given the risky and maladaptive communities available on the Dark Web, compensating the perceived loneliness with connections found from online communities pose further risks.

Of online activities, both reported increase in social media activity and frequent online gambling during the COVID-19 pandemic were associated with the Dark Web use as a COVID-19 information source in all countries. In all countries, these associations were even stronger

Table 4
Multinomial Logistic Regression Analysis on the Dark Web use as a COVID-19 information source on combined three-country dataset.

	Occasional Dark Web use				Frequent Dark Web use					
	OR	SE	<i>p</i>	95% CI		OR	SE	<i>p</i>	95% CI	
Male	1.76	0.12	<0.001	1.39	2.24	1.91	0.17	<0.001	1.36	2.67
Age (ref. 60–75)										
18–30	7.49	0.25	<0.001	4.63	12.13	7.16	0.36	<0.001	3.54	14.49
31–44	4.33	0.24	<0.001	2.69	6.97	3.14	0.36	0.002	1.54	6.41
45–59	1.84	0.26	0.019	1.11	3.06	1.43	0.39	0.360	0.66	3.09
Education (ref. secondary)										
Primary	1.19	0.22	0.424	0.78	1.83	1.74	0.29	0.053	0.99	3.05
Tertiary	1.00	0.12	0.986	0.79	1.28	1.22	0.17	0.259	0.87	1.71
Institutional distrust	1.30	0.08	<0.001	1.12	1.52	1.05	0.11	0.674	0.84	1.30
Anti-vaccine	2.27	0.14	<0.001	1.70	3.02	2.32	0.20	<0.001	1.56	3.45
Disobedience	1.50	0.06	<0.001	1.33	1.69	1.45	0.08	<0.001	1.23	1.71
Increased social media activity	1.37	0.15	0.036	1.02	1.85	3.46	0.18	<0.001	2.43	4.92
Frequent online gambling	2.16	0.18	<0.001	1.51	3.08	3.93	0.21	<0.001	2.60	5.94
Loneliness	1.16	0.03	<0.001	1.09	1.24	1.24	0.05	<0.001	1.13	1.36
Country effects (ref. Finland)										
Sweden	1.88	0.15	<0.001	1.40	2.52	1.82	0.21	0.005	1.20	2.77
The UK	2.30	0.15	<0.001	1.71	3.10	2.00	0.21	0.001	1.32	3.04

Likelihood ratio $\chi^2 = 753.743$; $p < 0.001$
Nagelkerke $R^2 = 0.32$

Note. OR = odds ratio; SE = standard error. Statistically significant *p*-values in bold.

among frequent Dark Web users compared to occasional users, suggesting that active Dark Web users are also likely to be actively engaged in other online activities. During the pandemic and social isolation, increased interest towards online platforms might have also increased the interest towards adopting new technological skills and exploring different online platforms such as the Dark Web [20]. In relation to the COVID-19 pandemic, this is important given that active use of the Internet and social media is related to conspiracy and anti-vaccine beliefs [29,56]. Being advanced and active online users, Dark Web users might be more susceptible to online-related risks and problems such as excessive online gambling. Indeed, problematic online behaviors such as excessive Internet use and online gambling overlap [98]. Additionally, there is evidence that online gambling has increased during the pandemic particularly among those who have already been excessively involved in gambling and have comorbid psychosocial problems such as excessive alcohol use [114]. Thus, our results suggest that the Dark Web attracts individuals who are in a vulnerable position and have adopted risky online habits such as excessive online gambling. Using the Dark Web has the potential to further amplify these problems given the availability of such activities.

Younger adults were more likely to be users of the Dark Web compared to older adults, and male gender was associated with Dark Web use in Finland and Sweden. These results are plausible given that young individuals and particularly men are typically advanced online users and likely to adopt various technologies efficiently [103,115], and the COVID-pandemic has increased particularly young people's interest towards the Dark Web [20].

In the digital era, it is necessary to recognize the role of various online platforms and how they can shape perceptions, opinions, and even behavior in the time of a global crisis. While some misinformation might be harmless by nature, misinformation related to the COVID-19 pandemic is likely to pose risks for both individual and public health. Due to information overload in online environments, conspiracy theories are prone to become normalized and cause resistance towards safety measures and vaccinations [29]. As Topor and Shuker [24] argue, users of the Dark Web might perceive information found on the Dark Web as more authentic and reliable than information provided by official authorities, which makes it dangerous in relation to the COVID-19 pandemic. While the Dark Web and other alternative online platforms are likely to attract individuals who are skeptical about the pandemic, it is important to understand how these attitudes might further get reinforced in favorable online environments. Indeed, online environments make it particularly easy to find and connect with others who validate one's beliefs, and these beliefs are prone to become reinforced in a like-minded environment. Online communities tend to get highly polarized, and exposure to opposing information or criticism can cause a backfire effect, reinforcing group attachment and echo chambers [56]. Since the anonymous nature of online interaction may further reinforce the reliance of shared information [61,89,100], the Dark Web provides a particularly fruitful environment for such polarization and the forming of online cliques.

It is also worth noting that surface web such as mainstream social media platforms contain false information and conspiracy theories as well. Our finding on the association between increased social media use and the Dark Web use for COVID-19 information source indicates that conspiracy theories and misinformation concerning the pandemic have the potential to spread from the Dark Web to regular social media via active online users, reaching a wider audience than on the Dark Web [95]. Additionally, some users on regular social media platforms provide information on accessing the Dark Web [30,93]. Since individual online users have a significant role in the dissemination and visibility of conspiracy-like content on social media platforms [12], it is important to acknowledge the overlap between the Dark Web and regular social media platforms in terms of (mis)information dissemination. However, many social media platforms strive to regulate potentially harmful content, and accounts can be banned or shut down for spreading

misinformation [12,15,16,94]. It is possible that individuals who are banned from social media platforms for spreading false information shift to the Dark Web to continue communicating such activities due to the highly anonymous and unregulated nature of the Dark Web platforms [95].

6.1. Limitations

This study was cross-sectional and relied on self-reported measures which might be prone to biases. Due to the cross-sectional design, all assumptions of causal directions between variables are purely theoretical. While we have argued that factors related to COVID-19 skepticism such as institutional distrust and anti-vaccine attitudes can drive the Dark Web use, it is also plausible that using the Dark Web and consuming such content reinforces these kinds of attitudes. Second, we did not investigate the explicit motives for utilizing the Dark Web as an information source. More detailed research is needed to understand the motives of finding COVID-19 information from the Dark Web, as well as the variety and credibility of COVID-19 content that is disseminated on the Dark Web. Third, the chosen countries for this research were culturally relatively similar European countries which might explain the cross-country similarities in the main results. Future research should compare the Dark Web use and underlying associations in countries with more diverse cultural characteristics and examine cross-country differences in more detail. Also, more detailed analysis, such as focusing on potential mediating effects in the Dark Web use and associated factors, would be beneficial in widening the understanding of the phenomenon. Longitudinal research would provide important insight into the Dark Web usage and motivational factors over time.

It is also worth noting that the number of respondents who reported having used the Dark Web for seeking COVID-19 information was relatively high in our data. However, all of our three countries are known to have active Dark Web users [30,32,33] and there is evidence that interest toward and users of the Dark Web have increased during the pandemic [20]. Additionally, an anonymous online survey has been likely to better reach individuals who are active online users and utilize the Dark Web, as well as lower the threshold to report about such activity that might be considered generally deviant. Additionally, some Dark Web users might utilize anonymity-based browsers merely to access Surface Web and not to access malicious content located specifically in the hidden services of the Dark Web [77]. This multi-functionality of the Dark Web browsers such as TOR might also partially explain high prevalence rates in our data. More research is needed to understand the prevalence and motives of the Dark Web usage, also among underaged individuals.

Despite the aforementioned limitations, this study has provided valuable insight into an unexplored research area, the Dark Web as a source of pandemic information and underlying associations during the COVID-19 pandemic in different countries.

6.2. Theoretical implications

Theoretically, this study has contributed to ongoing discussion on the role of online environments as an information source and associated risks during crises such as the COVID-19 pandemic. First, our study is among the first that has focused on the Dark Web as a source of risky COVID-19 information, while prior studies have focused on mainstream social media platforms [4,12,14,37]. Even though the use of social media and the Dark Web is likely to overlap [30,93], it is important to acknowledge the unique characteristics of the Dark Web, such as its unregulated and highly anonymous nature, in relation to online information seeking and underlying motives [24]. Second, we have also contributed to discussions on (mis)information seeking online by exploring underlying socio-cultural, technological, and sociopsychological factors [14,78]. Third, we were able to show how these patterns work in different countries. When investigating the role of online

environments in information seeking, it is crucial to recognize how technological, individual, and social mechanisms intertwine. More detailed research would be required on how the anonymous nature of the Dark Web might facilitate online group processes such as acting on shared information, and whether these mechanisms differ between regular social media and the Dark Web platforms.

6.3. Practical implications

According to our study, Dark Web users are likely to be young, advanced online users, thus providing insight on which demographic cohorts are more inclined to engage in Dark Web use. Since the Dark Web requires advanced online skills and is not stumbled upon accidentally, it is important to understand why some individuals choose to use it for informational purposes. Young people in particular have relatively high media literacy and they are known to utilize various information sources [116]. However, those in vulnerable positions in life might be more likely to engage in risky platforms and maladaptive online behaviors to escape or distract themselves from unideal situations in their own lives. During the COVID-19 pandemic, feelings of loneliness and related psychosocial problems have increased particularly among the vulnerable population [27,28], with also Internet-based problems having increased [42]. Thus, our study adds understanding on how psychosocial problems and maladaptive behaviors manifest in an online environment during the pandemic and might accumulate in the Dark Web. Adopting new behaviors and maladaptive habits during the crisis, such as Dark Web usage or excessive online gambling, may also have long-lasting consequences even in post-pandemic life. Given the various risks involved with the Dark Web, improving and promoting health-related media literacy would be crucial [6]. Additionally, it would be important to curb obsessive, fear-induced mental states as has been seen in the beginning of the pandemic, when high rates of health-related media were being published, thus leading to an increase in obsessive health behaviors and information seeking [117].

Despite some benefits of anonymous surfing, it is clear that the Dark Web contains multiple risks particularly to young users and other vulnerable groups [20]. The unregulated nature, questionable source credibility and availability of forged certificates make the Dark Web a

risky alternative to official health policy and information during the COVID-19 crisis. Our study shows that the Dark Web is an attractive COVID-19 information source to tech-savvy individuals who are suspicious about the pandemic and highly engaged in online activities. Due to the availability of other risky content on the Dark Web such as drug marketplaces and illegal gambling sites [25,26], maladaptive behaviors and related problems during the pandemic might cumulate on the Dark Web and pose risks particularly for vulnerable individuals. Given the increased popularity of the Dark Web during the pandemic, it is important to understand factors that motivate such use, as well as acknowledge unique characteristics and risks of the Dark Web compared to regular social media use. Understanding the role of technological and sociopsychological mechanisms in seeking COVID-19 information from different online sources is also important to better understand how critical media and health literacy could be promoted among population and to design targeted interventions.

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Author contributions

Anu Sirola: Conceptualization, methodology, investigation, data curation, formal analysis, writing-original draft, writing – review and editing. **Julia Nuckols:** Conceptualization, investigation, writing – original draft, writing – review and editing. **Jussi Nyrhinen:** Conceptualization, investigation, writing – original draft, writing – review and editing. **Terhi-Anna Wilska:** Conceptualization, investigation, project administration, supervision, funding acquisition, writing – original draft, writing – review and editing.

Declaration of competing interest

None.

APPENDICES.

Appendix 1

Sample characteristics

FINLAND			SWEDEN			The United Kingdom		
Gend.	Smp	Pop.	Gend.	Smp	Pop.	Gend.	Smp	Pop.
Man	50%	50%	Man	50%	50%	Man	49%	49%
Woman	50%	50%	Woman	50%	50%	Woman	51%	51%
Age	Smp	Pop.	Age	Smp	Pop.	Age	Smp	Age
18–22	8%	8%	18–22	8%	8%	18–22	6%	8%
23–35	26%	23%	23–35	24%	25%	23–35	30%	24%
36–55	38%	34%	36–55	40%	36%	36–55	38%	37%
56–75	29%	36%	56–75	28%	31%	56–75	26%	30%
Region	Smp	Pop.	Region	Smp	Pop	Region	Smp	Pop
S.Fin.	46%	52%	Mid-Nrdlnd	4%	4%	East England	9%	11%
E.Fin.	11%	11%	NCentral Sweden	9%	8%	London	14%	15%
W.Fin	31%	25%	Småland islands incl.	9%	8%	Midlands	16%	10%
N.Fin	12%	12%	Stockholm	21%	23%	Yorkshire and Humber	12%	9%
			S. Swe	15%	15%	Northwestern	11%	12%
			W.Swe	19%	20%	N.Ireland	3%	3%
			E.Central Sweden	17%	17%	Scotland	8%	9%
			Uppr. Norland	6%	5%	SE.England	15%	16%
						SW.England	8%	9%
						Wales	5%	5%

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