PLOS ONE

RESEARCH ARTICLE

Impact of COVID-19 on pornography use: Evidence from big data analyses

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Abstract

Introduction

Coronavirus disease 2019 (COVID-19) has led to radical changes in social distancing awareness and affected social relationships. Owing to large-scale lockdown, home quarantine and social distancing requirements, it was anticipated that sexual activities would be severely impacted. However, retrospective self-report studies showed that pornography use and autoerotism increased during the pandemic.

Aim

This study used big-data databases available on the Internet to investigate factors that modulated pornography use during the pandemic.

Methods

Daily relative search volume (RSV) data from Google Trends for the period from 24 February 2020 to 13 July 2020 were extracted. Pornhub traffic data were extracted from the Pornhub Insights website, for the period from 24 February 2020 to 13 July 2020. The parameter was defined as 'percent change in traffic compared to an average day in 2019'. The number of daily new cases of COVID-19 was extracted from the database on Our World in Data.

Outcome measures

The normality of the data was examined using the Shapiro-Wilk test. All variables included in this study were non-normally distributed. Therefore, non-parametric tests or parametric tests with bootstrapping were adopted where appropriate.

Results

According to Google Trends, the RSV for 'pornography' increased after late March 2020, which is close to the date when the World Health Organization declared COVID-19 a global pandemic. The number of daily new cases of COVID-19 was positively correlated with the

traffic of Pornhub, a popular pornography website, and the RSV for 'pornography'. Moderation analysis demonstrated a significant main effect of daily new cases of COVID-19 and the RSV for 'social distancing' in predicting Pornhub traffic/RSV for 'pornography'. Furthermore, the RSV for 'social distancing' significantly moderated the relationship between daily new cases and Pornhub traffic/RSV for 'pornography'. A stronger COVID-pornography use association was observed with increased social distancing awareness.

Conclusion

Increased pornography consumption during the pandemic was observed, and it was associated with the severity of the pandemic. Social distancing awareness could be a key factor influencing interest in and use of pornography. Further studies on the changes in sexual desire and birth-rate control are worthwhile because long-term public health may be affected by the changes in sexual behaviour during the pandemic.

Introduction

Coronavirus disease 2019 (COVID-19) is an infectious disease caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). According to early studies on the transmission of SARS-CoV-2, the virus is mainly spread through respiratory droplets; other potential transmission routes such as urine and faeces are under investigation [1, 2]. Although there is still no concrete evidence on the sexual transmission of SARS-CoV-2, sexual practices such as kissing, anal intercourse and analingus can increase the risk of SARS-CoV-2 transmission [3, 4] owing to the close interpersonal contact. On 11 March 2020, the World Health Organization (WHO) declared COVID-19 a global pandemic [5]. To minimise the risk of human-to-human transmission through direct interpersonal physical contact [6], governments of different countries issued quarantine and social distancing guidelines. Because the disease can be transmitted through respiratory droplets and short-distance interhuman contact, social distancing is considered an effective prevention measure. Nevertheless, these measures have dramatically changed interpersonal, social and potentially sexual relationships [6].

It is postulated that the sexuality of the general public can be affected by the transmission of SARS-CoV-2. For example, survey studies conducted in different countries have reported a decreased frequency of sexual interaction and risky sexual behaviours among heterosexual and homosexual adults [7–9]. Various studies have presented a few unambiguous findings such as the increased use of pornography. Pornhub, one of the largest providers of free online pornographic videos, has reported increased traffic after the outbreak of the disease compared with the average traffic in 2019 [10]. A study that used Google Trends, a tool that indicates the interest of the public in a particular search term, reported that the relative search volume (RSV) of Pornhub increased after the beginning of the pandemic. During this period, Pornhub showed the highest increase of interest worldwide compared with other popular porn websites such as Porn, NXX, xVideos and xHamster [11]. The same study concluded that Pornhub was the most popular porn website during the pandemic [11], making it the ideal marker for pornography consumption. It was also reported that the frequency of autoerotism, pornography consumption and use of phone sex increased [12]. Because large-scale lockdowns are common during the pandemic, pornography use and autoerotism may become important channels

through which to express sexuality, thus enabling the fulfilment of sexual desires during this period that emphasises social distancing.

Early studies on sexual activities, including autoerotism, during the pandemic used online surveys, with possible self-reporting bias. In addition, customised, non-standardised question-naires and questions were often used, which may increase difficulties in comparing results among studies and potentially lead to invalid conclusions. Furthermore, it is difficult to explore the possible underlying factors that may mediate or moderate sexual activities. Objective data on the impact of COVID-19 on sex are therefore lacking [13].

In light of the above-mentioned research gaps, this study aims to explore the change in por-nography use with big data databases available on the Internet. The objective of this study is to explore associations between the emerging situation of COVID-19, social distancing awareness and pornography use. In addition, we hypothesise that social distancing awareness can moder-ate the association between the severity of the COVID-19 infection and pornography con-sumption during the pandemic. Our findings add to a growing body of the literature and improve our understanding of the relationship between the pandemic and pornography use by providing objective data from the Internet to analyse the changes in pornography use during the pandemic.

Methods

Data extraction

Data used in this study were extracted from three different sources, namely, 'Google Trends', 'Pornhub Insights' [14] and 'Our World in Data' [15], in July 2020. We extracted daily RSV data for the period from 24 February 2020 to 13 July 2020. The search terms included 'COVID', 'social distancing' and 'pornography'. The extracted data were denoted as RSV. Porn-hub traffic data were extracted from the website 'Pornhub Insights' [14]. The parameter was defined as 'percent change in traffic compared to an average day in 2019'. The number of daily new cases of COVID-19 globally was extracted from the database on Our World in Data [15].

Statistical analysis

The normality of the data was examined using the Shapiro-Wilk test. All variables included in this study were non-normally distributed. Therefore, non-parametric tests or parametric tests with bootstrapping were adopted where appropriate.

The associations between the RSVs for 'social distancing', 'COVID' and 'pornography', the number of daily new cases, and the Pornhub traffic rate were analysed using Spearman-rho correlation analyses. Ten comparisons were conducted; thus, $P < .005$ (0.05/10) is defined as statistically significant after Bonferroni correction.

To determine the role of social distancing awareness on the association between the num-ber of daily new cases and pornography use, moderation analyses were performed using model 1 in the PROCESS macro for Statistical Package for Social Science (SPSS) that was developed by Hayes [16]. The PROCESS macro is based on ordinary least squares regression and adopts a nonparametric bootstrapping procedure (5000 bootstrapped samples in this study), which provides a bias-corrected confidence interval (CI) for effect size inference [17]. Statistical significance is established if the 95% CI does not cross zero [18]. The number of daily new cases (predictors) and the RSV for 'social distancing' (moderators) were mean-cen-tred. The mean-centred variables and their interaction term were entered into the linear regression model for predicting the traffic rate of Pornhub or the RSV for 'pornography'. The binary variable, i.e. free promotion period of Pornhub (yes/no), was entered into the regres-sion model as a control variable.

All statistical analyses were conducted using SPSS v24 (IBM). A *P*-value < 0.05 is considered statistically significant unless otherwise specified.

Results

Positive association between the number of daily new COVID-19 cases and Pornhub traffic

In total, 141 data points were collected from 24 February to 13 July 2020 through the sources described above. The RSVs for the terms 'COVID', 'social distancing' and 'pornography', the Pornhub traffic rate and COVID-19 daily new cases are presented in Fig 1. A notable increase in the RSVs for 'COVID' and 'social distancing' was observed in early March and that for 'pornography' was observed in late March. A strong positive association between the number of daily new cases and the Pornhub traffic rate was observed at the initial phase of the pandemic when the number of new cases was approximately 50,000 globally. The growth curve of the traffic rate exhibited a plateau when the number of new cases exceeded 50,000. The free promotion period of Pornhub (from 25 to 27 March 2020) also had a positive effect on the Pornhub traffic rate. S1 Fig shows the scatter plot of the Pornhub traffic data and daily new cases of COVID-19.

Associations among RSVs for 'social distancing', 'COVID' and 'pornography', the daily new cases and the Pornhub traffic rate from 24 February to 13 July 2020.

Correlation coefficients among the variables (RSVs, number of daily new cases and traffic data) by Spearman's rho are shown in Table 1. The number of daily new cases of COVID-19 was positively related to the Pornhub traffic (rho = 0.562, *P* < .001) and the RSV for 'pornography' (rho = 0.698, *P* < .001) and negatively related to the RSV for 'social distancing' (rho = -0.284, *P* < .001). As expected, the RSV for 'pornography' was significantly correlated with the Pornhub traffic (rho = 0.343, *P* < .001). There was a positive, strong association between the RSVs of 'social distancing' and 'COVID' (rho = 0.849, *P* < .001).

Moderating role of social distancing awareness in daily new cases-pornography use association

The regression model for predicting Pornhub traffic rate using the number of daily new cases, the RSV for 'social distancing' and their interaction term was significant after we controlled for the effect of free access to Pornhub premium service [$F_{(4, 136)}$ = 52.571, *P* < .001], which explained 60.73% variance of Pornhub traffic rate. The number of daily new cases (10,000 per unit) (β = 0.012, *SE* = 0.001, 95% *CI* = 0.010–0.015, *P* < .001), the RSV for 'social distancing' (β = 0.003, *SE* = 0.001, 95% *CI* = 0.002–0.004, *P* < .001) and their interaction term (β = 0.0003, *SE* = 0.0001, 95% *CI* = 0.0001–0.0004, *P* < .001) were significant predictors of Pornhub traffic rate. The addition of the interaction term significantly increased the R^2 of the model [R^2-change = 0.043, $F_{(1,136)}$ = 14.991, *P* < .001]. The significant interaction term supported the moderating role of RSV for 'social distancing' on the relationship between the number of daily new cases and the Pornhub traffic rate in which an increase in the RSV for 'social distancing' enhanced such an association (Fig 2a).

To further confirm our findings, the same moderation analysis was performed by replacing the dependent variable with the RSV for 'pornography'. The RSV for 'pornography' indicated the interest in pornography, which may include the surfing of pornography websites other than Pornhub. The regression model for predicting the RSV for 'pornography' was significant [$F_{(4, 136)}$ = 29.828, *P* < .001], which explained 46.73% of variance of the RSV for 'pornography'. The number of daily new cases (10,000 per unit) (β = 2.907, *SE* = 0.368, 95% *CI* = 2.179–3.635,
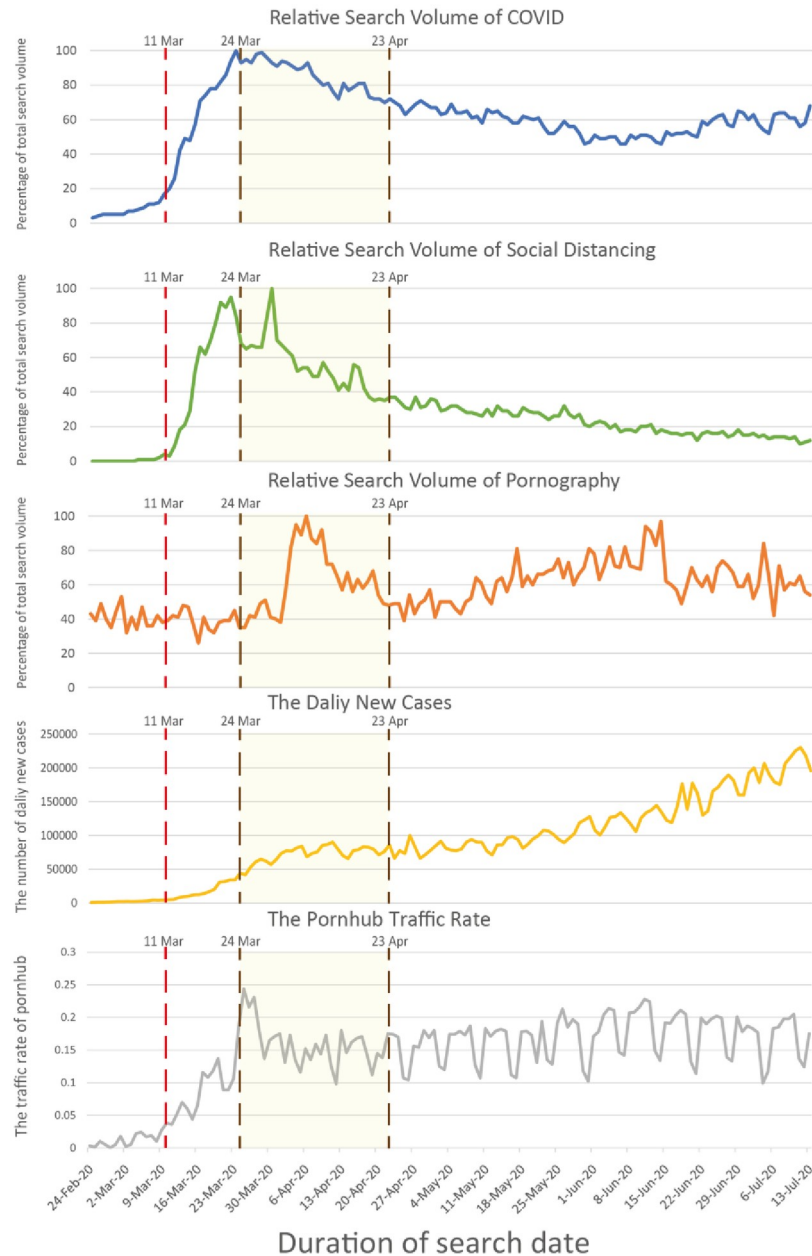
Fig 1. Relative search volume of 'COVID', 'Social distancing' and 'Pornography' from Google Trend(s); the Pornhub traffic rate and COVID-19 daily new cases. Note: On Mar 11, 2020, the World Health Organization (WHO) announced COVID-19 to be a global pandemic. Free promotion period of Pornhub (Premium) from Mar 24 –Apr 23, 2020.

https://doi.org/10.1371/journal.pone.0260386.g001

$P < .001$), the RSV for 'social distancing' ($\beta = 0.430$, $SE = 0.133$, 95% $CI = 0.167–0.693$, $P = .002$) and their interaction term ($\beta = 0.090$, $SE = 0.021$, 95% $CI = 0.050–0.131$, $P < .001$) were significant predictors of the RSV for 'pornography'. The addition of the interaction term significantly increased the R^2 of the model [R^2-change = 0.075, $F_{(1,136)} = 19.181$, $P < .001$] (Fig 2b). The increase in the RSV for 'social distancing' enhanced the association between the number of daily new cases and the RSV for 'pornography'. Interestingly, the moderation effect of the RSV for 'social distancing' at the first 10th percentile was non-significant ($P = 0.17$).

Table 1. Spearman's rho correlation among studied variables.

	1	2	3	4
1. RSV for 'Social Distancing'	- - -			
2. RSV for 'COVID'	**0.849 (.001)**			
3. RSV for 'Pornography'	-0.085 (.31)	-0.082 (.34)		
4. Daily new cases of COVID-19	**-0.284 (.001)**	-0.101 (.23)	**0.698 (.001)**	
5. Traffic of Pornhub	0.144 (.09)	0.229 (.006)	**0.343 (.001)**	**0.562 (.001)**

Numerical data represent the Spearman's rho values and the corresponding P-values in brackets. $P < .005$ is defined as statistically significant after Bonferroni correction. Significant correlations are written in bold text.

Discussion

According to Pornhub Insights, an increase in traffic on Pornhub.com was observed from early March 2020. This increase in traffic peaked (+24.4% compared to average daily traffic in 2019) on 25 March 2020, and it was maintained at a level from +9.8% to +22.8% until June 2020 [14]. Our results showed that the increase in Pornhub traffic was significantly associated with the daily new cases of COVID-19, and the traffic could be predicted by the daily new cases. These findings imply that the trend of pornography use may be consistent with the development of the pandemic. The findings agree with previous studies in which the frequency of autoerotism and pornography use was reported to increase during the pandemic [12, 19].
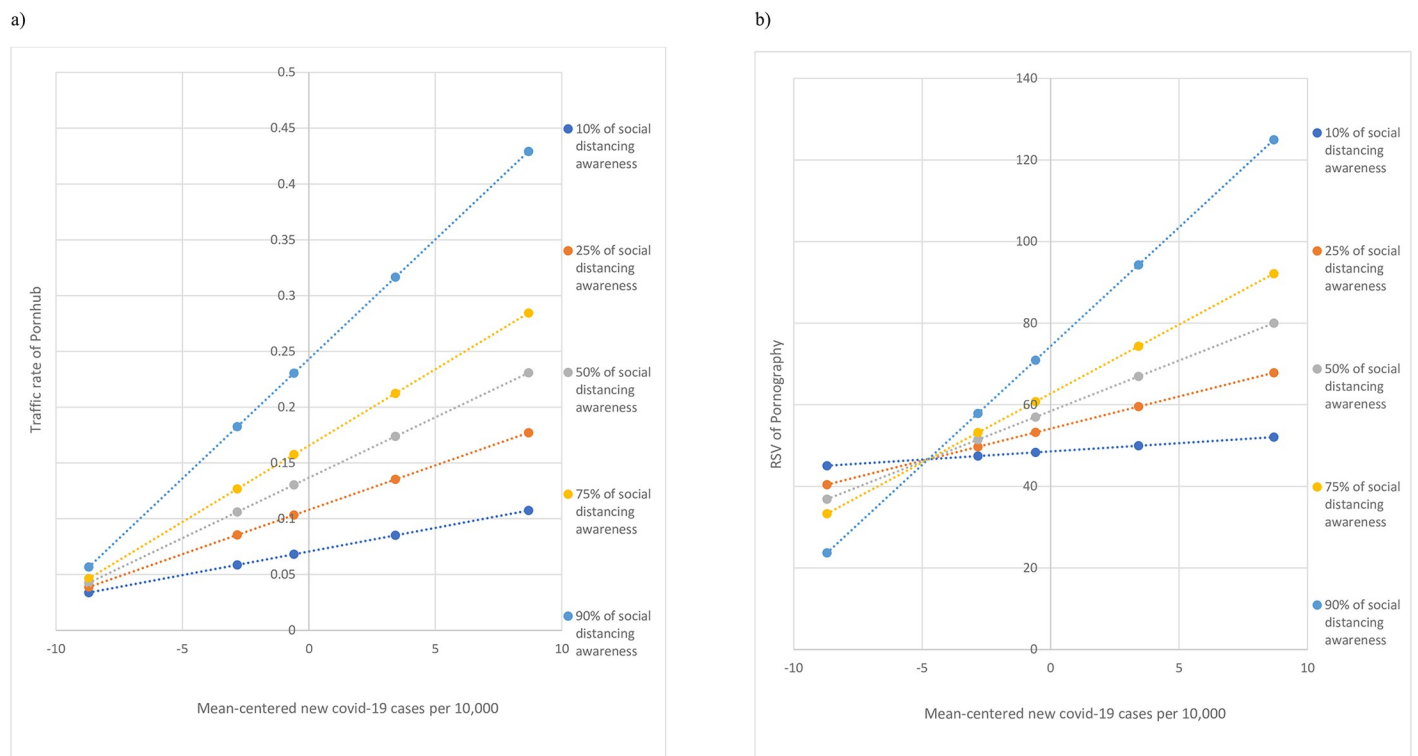

Fig 2. a: Moderation effect of the awareness of social distancing on the relationship between covid-19 new cases and traffic rate of Pornhub. b: Moderation effect of the awareness of social distancing on the relationship between covid-19 new cases and RSV of 'pornography'.

The increase in pornography consumption could represent a maladaptive coping strategy toward stressors, i.e. fear and feelings of powerlessness triggered by the pandemic. Masaeli and Farhadi suggested that long-term increased pornography consumption could result in Internet addiction, which could negatively impact an individual's psychosocial and/or physical well-being [20]. Consistent with this idea, Marchi and colleagues proposed that problematic por-nography consumption, i.e. high-frequency consumption that can cause possible side effects in legal, psychological and physical health, might be considered a type of addiction requiring clin-ical attention [21]. Awan and colleagues further reviewed the plausible neuropsychological mechanisms of pornography addition that involve the inhibitory and reward systems to explain this phenomenon [22]. For example, more frequent consumption of pornographic content was associated with smaller right caudate volume, suggesting a constant stimulation of the reward system or a neuroplastic change that further enhances the pleasant feeling of con-suming pornographic content [23]. Furthermore, problematic Internet behaviours were found to be negatively correlated and positively correlated with the brain activities in default mode network and inhibitory control network, respectively, similar to other substance and beha-vioural addictions [24]. Our findings indicate the potential role of social distancing awareness as a positive moderator of the relationship between daily new cases of COVID-19 and pornog-raphy use, which supports the notion that the current pandemic has increased the odds in the development of pornography addiction that requires clinical attention.

More than 40% of respondents in a survey conducted in Italy reported an increase in sexual desire during quarantine [12]. Similarly, another study conducted in Southeast Asian countries reported elevated libido [25]. However, the increase in sexual desire was not associated with an increase in sexual intercourse [12]. Instead, autoerotism and pornography use may have replaced actual sexual intercourse to fulfil sexual needs. These findings support the idea that pornography is an example of supranormal stimuli [26]. Supranormal stimulus in the context of pornography refers to the greater stimulation of the reward system by pornography materi-als, i.e. porn videos or photos, than by actual sexual intercourse [27]. Overconsumption of por-nography can cause loss of interest in actual sexual intercourse because individuals cannot achieve the same responses in real life as those they achieve from pornography [28], which may negatively impact their mental well-being. Further empirical studies are required to inves-tigate this area.

There are many reasons why there is an increase in pornography consumption during the pandemic and lockdowns. According to the 'Triple A Engine' hypothesis suggested by Cooper [29], the accessible, affordable and anonymous nature of the Internet makes online consump-tion of pornography relatively easy. The key characteristics of the three 'A's are easy accessibil-ity, provision of free pornography services and privacy of an individual's identity. These characteristics of the internet allow individuals to easily express their sexualities online and provide sexual outlets for them to meet their sexual needs and reduce loneliness during lock-downs. Stressors related to the pandemic and increased sexual desire may encourage people to engage in pornography use. Negative emotions and psychological effects including anger, con-fusion, anxiety and depression were reported to be caused by quarantines, fear of infection, boredom and inadequate support from others [30]. Another possible reason for increased por-nography use may be 'forced abstinence' [31]. It is reported that when the servers for a popular video game crashed, Pornhub traffic increased and the keyword search for pornographic vid-eos with the game's name increased by 60%. This observation suggests that the gamers may have developed a compensatory behaviour (viewing pornography) during the period of 'forced abstinence (cannot access game servers)'. In the current pandemic situation, the increased por-nography consumption may be viewed as a compensatory behaviour that compensates for the sexual needs of 'abstinence' from real-life sexual activities. Interestingly, the increased

pornography consumption may also be attributed to opinions from professionals [32]. During lockdowns, staying at home and using pornography were seen less as problematic and risky behaviour, and it was viewed as a desirable behaviour to prevent the transmission of COVID-19. Pornography and masturbation were viewed as low-risk sexual outlets to ensure safety and maintain social distance among people.

A significant reduction in female sexual functioning and quality of life was observed during the pandemic [33]. Furthermore, the presence of anxiety and risk perception of COVID-19 were observed to be negatively associated with the frequency of sexual activity [34]. As wellbeing is generally considered to be positively associated with the frequency of sexual intercourse [35], a decrease in the frequency of sexual intercourse may indicate a decrease in mental wellbeing, even when autoerotism and pornography are used as substitutes for sexual intercourse. It was hypothesised that pornography consumption is used as a coping mechanism to deal with affection deprivation [36]. However, its long-term effect on mental health is still controversial. It was observed that pornography consumption is inversely related to relationship satisfaction and closeness, and it is positively related to loneliness and depression. This finding agrees with our observation that lockdowns are positively associated with increased pornography use. In different hypotheses, decreased sexual satisfaction owing to unrealistic expectations of sexual partners and performance may be caused by long-term pornography use [37]. It was suggested that this effect of pornography use is associated with a changed brain reward circuit in response to pornography, as the real-life situation may not be as ideal, novel and attractive as online pornography [38]. The disappointment resulting from comparing real-life to online images may cause dissatisfaction in sex.

Increased pornography consumption was associated with lower commitment to a romantic partner [39] and more frequent flirting with an extradyadic partner. However, because association does not imply causation, the association between pornography consumption and infidelity may not imply the long-term consequence of pornography consumption. Similarly, it was hypothesised that pornography can potentially cause sexual dysfunction, but the association between pornography consumption and sexual dysfunction was found to be weak. Therefore, pornography consumption appears not to be a major risk factor of sexual dysfunction [40].

During the pandemic, the public has increased awareness and/or concerns of 'social distancing', which is indicated by the increased RSV and the strong positive correlation between the RSVs for 'Social Distancing' and 'COVID'. Therefore, we hypothesised that social distancing awareness would moderate the association between the daily number of new COVID-19 cases and pornography consumption. This hypothesis is supported by the moderation analysis in this study. The results showed that the positive association between the daily number of new COVID-19 cases and pornography consumption was stronger during periods of increased social distancing awareness. Interestingly, when the RSV for 'social distancing' was at a relatively low level (below 10th percentile), the number of daily new cases was not associated with the RSV for 'pornography'. One explanation for this finding is that pornography consumption increased with the daily new cases of COVID-19 only when the general public became aware of social distancing, suggesting that social distancing awareness could be a key factor affecting the display of autoerotism. However, we cannot rule out the possibility that quarantine and lockdown policies indifferent countries during the pandemic could have resulted in increased pornography consumption [11].

The search volume for social distancing increased rapidly from early March and peaked at the end of March 2020, which is temporally close to the date when WHO declared COVID-19 a global pandemic. The increased concern about social distancing could imply the increased awareness of transmission routes of COVID-19. The idea that sexual intercourse can transmit SARS-CoV-2, may decrease sexual activity among non-cohabiting partners [32]. However,

sexual activity among non-cohabiting partners may also be reduced because of quarantines. Meanwhile, sexual activity among non-infected cohabiting partners is considered safe [4], although the frequency of sexual intercourse may be suppressed by factors including the presence of children at home (privacy issue) and negative psychological factors and mood [13]. With increased social distancing awareness, it is understandable that sexual intercourse may be avoided and substituted by autoerotism to fulfil sexual desires. Other confounding factors such as quarantines, privacy issues at home and negative moods could also reduce sexual activity among non-cohabiting and cohabiting partners, resulting in increased consumption of pornography for compensation. Future studies that control these factors can further confirm our findings.

According to findings on the transmission of COVID-19, the Italian Society of Andrology (ISA) provided guidelines on sexual practices to minimise the risk of infection [6]. They suggested possible safe sexual practices including intercourse between uninfected partners, use of sex toys and masturbation; however, they advised against practices such as kissing, analingus and sexual contact with partners outside of the home. The Spanish Association of Sexuality and Mental Health provided recommendations similar to those of ISA, with additional suggestions on avoiding sexual activities during quarantine and substituting intercourse with masturbatory or virtual sexual activity [41]. Our findings indicate that these guidelines may have influenced the increase in social distancing awareness, thus facilitating the positive relationship between pandemic severity and pornography consumption.

A future research question worth exploring is why sexual desire is increased during the pandemic. Loneliness and negative emotions may increase the urge for intimate relationships to reduce stress and improve physical health [42]. Moreover, increased pornography consumption could be attributed to the increased use of the Internet during lockdowns [43]. A study conducted on elderlies aged 60 years or more observed a significant increase in Internet use among the subjects; Internet use and online communication increased by 64.1% and 41.7%, respectively. It was suggested that the increase in Internet use led to an increase in the consumption of online pornography [44]. According to the findings of Awan et al. [22], the peak increase in Pornhub traffic often coincides with or appears soon after the beginning of a lockdown. From the data available on Pornhub Insights, this phenomenon can be observed in countries such as Italy, France, Spain, the US, Brazil, UK and India.

Although pornography use or autoerotism may satisfy solitary sexual desires, the lack of intimate relationships and the unfulfillment of dyadic sexual desire cannot be addressed through this means, and thus sexual pleasure and satisfaction may not be achieved even with increased pornography use [12]. Furthermore, there are concerns about mental health problems due to increased pornography consumption [22]. It is suggested that online pornography consumption can cause addiction owing to multiple reasons (accessibility, affordability and anonymity) [45], and its detrimental effects may be similar to those of Internet addiction and behavioural addiction, which are characterised by excessive preoccupations, urges or behaviours regarding the consumption. These effects may cause distress at the individual level, failure to reduce the consumption and other adverse psychological consequences. In addition, the supranormal nature of pornography may increase the difficulty in experiencing sexual satisfaction in real life, which would also distress the affected individuals.

As the pandemic is ongoing, its full impact on sexuality is yet to be seen. In this study, we found that the daily new cases of COVID-19 globally and social distancing awareness are associated with increased pornography consumption during the pandemic. We attempted to present a global picture regarding the associations between COVID-19 new cases, social distancing awareness and pornography consumption. Such associations can vary in individual countries because the timeline of the outbreak, number of new cases and lockdown policies are different

across countries. Future studies are required to further investigate the cross-countries effect on these associations. As sexual behaviour is closely related to mental and sexual health, follow-up research is required to understand the influence of the changes on these areas, which may be the secondary impacts of COVID.

Supporting information

S1 Fig. Scatter plots showing correlation between Pornhub traffic and new daily average Covid19 cases. Traffic of Pornhub, percentage change compared to average day before COVID-19.
(PDF)

Author Contributions

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References

1. Wölfel R, Corman VM, Guggemos W, Seilmaier M, Zange S, Müller MA, et al. Virological assessment of hospitalized patients with COVID-2019. Nature. 2020; 581(7809):465–9. https://doi.org/10.1038/s41586-020-2196-x PMID: 32235945

2. Yeo C, Kaushal S, Yeo D. Enteric involvement of coronaviruses: is faecal-oral transmission of SARS-CoV-2 possible? Lancet Gastroenterol Hepatol. 2020; 5(4):335–7. https://doi.org/10.1016/S2468-1253(20)30048-0 PMID: 32087098

3. Patrì A, Gallo L, Guarino M, Fabbrocini G. Sexual transmission of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2): A new possible route of infection? J Am Acad Dermatol. 2020; 82(6): e227. https://doi.org/10.1016/j.jaad.2020.03.098 PMID: 32278800

4. Aversa A, Jannini EA. COVID-19, or the triumph of monogamy? Minerva Endocrinol. 2020; 45(2):77–8. https://doi.org/10.23736/S0391-1977.20.03207-1 PMID: 32270992

5. Cipriano M, Giacalone A, Ruberti E. Sexual Behaviors During COVID-19: The Potential Risk of Transmission. Arch Sex Behav. 2020; 49(5):1431–2. https://doi.org/10.1007/s10508-020-01757-0 PMID: 32504235

6. Maretti C, Privitera S, Arcaniolo D, Cirigliano L, Fabrizi A, Rizzo M, et al. COVID-19 pandemic and its implications on sexual life: Recommendations from the Italian Society of Andrology. Arch Ital Urol Androl. 2020 Jun 23; 92(2). https://doi.org/10.4081/aiua.2020.2.73 PMID: 32597102

7. Hammoud MA, Maher L, Holt M, Degenhardt L, Jin F, Murphy D, et al. Physical Distancing Due to COVID-19 Disrupts Sexual Behaviors Among Gay and Bisexual Men in Australia: Implications for Trends in HIV and Other Sexually Transmissible Infections. J Acquir Immune Defic Syndr. 2020 Nov 1; 85(3):309–15. https://doi.org/10.1097/QAI.0000000000002462 PMID: 32740374

8. Li W, Li G, Xin C, Wang Y, Yang S. Challenges in the Practice of Sexual Medicine in the Time of COVID-19 in China. J Sex Med. 2020; 17(7):1225–8. https://doi.org/10.1016/j.jsxm.2020.04.380 PMID: 32418751

9. Suen YT, Chan RCH, Wong EMY. To Have or Not to Have Sex? COVID-19 and Sexual Activity Among Chinese-Speaking Gay and Bisexual Men in Hong Kong. J Sex Med. 2020 Nov 19;. https://doi.org/10.1016/j.jsxm.2020.10.004 PMID: 33223429

10. Mestre-Bach G, Blycker GR, Potenza MN. Pornography use in the setting of the COVID-19 pandemic. J Behav Addict. 2020 Jun; 9(2):181–3. https://doi.org/10.1556/2006.2020.00015 PMID: 32663384

11. Zattoni F, Gül M, Soligo M, Morlacco A, Motterle G, Collavino J, et al. The impact of COVID-19 pandemic on pornography habits: a global analysis of Google Trends. Int J Impot Res. 2020 Nov 28;. https://doi.org/10.1038/s41443-020-00380-w PMID: 33249423

12. Cocci A, Giunti D, Tonioni C, Cacciamani G, Tellini R, Polloni G, et al. Love at the time of the Covid-19 pandemic: preliminary results of an online survey conducted during the quarantine in Italy. Int J Impot Res. 2020 Sep; 32(5):556–7. https://doi.org/10.1038/s41443-020-0305-x PMID: 32409643

13. Ibarra FP, Mehrad M, Di Mauro M, Godoy MFP, Cruz EG, Nilforoushzadeh MA, et al. Impact of the COVID-19 pandemic on the sexual behavior of the population. The vision of the east and the west. Int Braz J Urol. 2020; 46(suppl.1):104–12. https://doi.org/10.1590/S1677-5538.IBJU.2020.S116 PMID: 32550703

14. *Coronavirus Update—June 18 —Pornhub Insights*. Retrieved December 23, 2020, from https://www.pornhub.com/insights/coronavirus-update-june-18.

15. Coronavirus (COVID-19) Deaths. (n.d.). Our World in Data. Retrieved December 23, 2020, from https://ourworldindata.org/covid-deaths.

16. Bolin JH. Hayes Andrew F. (2013). Introduction to Mediation, Moderation, and Conditional Process Analysis: A Regression-Based Approach. New York, NY: The Guilford Press. Journal of Educational Measurement. 2014; 51(3):335–7.

17. Shrout PE, Bolger N. Mediation in experimental and nonexperimental studies: new procedures and recommendations. Psychol Methods. 2002 Dec; 7(4):422–45. PMID: 12530702

18. Preacher KJ, Hayes AF. Contemporary Approaches to Assessing Mediation in Communication Research. In: The SAGE Sourcebook of Advanced Data Analysis Methods for Communication Research [Internet]. 2455 Teller Road, Thousand Oaks California 91320 United States: Sage Publications, Inc.; 2008 [cited 2020 Dec 4]. p. 13–54. http://methods.sagepub.com/book/sage-srcbk-adv-data-analysis-methods-comm-research/n2.xml.

19. Shilo G, Mor Z. COVID-19 and the Changes in the Sexual Behavior of Men Who Have Sex With Men: Results of an Online Survey. J Sex Med. 2020; 17(10):1827–34. https://doi.org/10.1016/j.jsxm.2020.07.085 PMID: 32883631

20. N M, H F. Prevalence of Internet-based addictive behaviors during COVID-19 pandemic: a systematic review. Journal of addictive diseases. Mar 22,2021, from: https://pubmed.ncbi.nlm.nih.gov/33749537/.

21. Marchi NC, Fara L, Gross L, Ornell F, Diehl A, Kessler FHP. Problematic consumption of online pornography during the COVID-19 pandemic: clinical recommendations. Trends Psychiatry Psychother. 2021 May 21;. https://doi.org/10.47626/2237-6089-2020-0090 PMID: 34043899

22. Awan HA, Aamir A, Diwan MN, Ullah I, Pereira-Sanchez V, Ramalho R, et al. Internet and Pornography Use During the COVID-19 Pandemic: Presumed Impact and What Can Be Done. Front Psychiatry. 2021; 12:623508. https://doi.org/10.3389/fpsyt.2021.623508 PMID: 33796031

23. Kühn S, Gallinat J. Brain structure and functional connectivity associated with pornography consumption: the brain on porn. JAMA Psychiatry. 2014 Jul 1; 71(7):827–34. https://doi.org/10.1001/jamapsychiatry.2014.93 PMID: 24871202

24. Darnai G, Perlaki G, Zsidó AN, Inhóf O, Orsi G, Horváth R, et al. Internet addiction and functional brain networks: task-related fMRI study. Sci Rep. 2019 Oct 31; 9(1):15777. https://doi.org/10.1038/s41598-019-52296-1 PMID: 31673061

25. Arafat SMY, Alradie-Mohamed A, Kar SK, Sharma P, Kabir R. Does COVID-19 pandemic affect sexual behaviour? A cross-sectional, cross-national online survey. Psychiatry Res. 2020; 289:113050.

26. Barrett D. Supernormal Stimuli: How Primal Urges Overran Their Evolutionary Purpose. W. W. Norton & Company; 2010. 224 p.

27. Tinbergen N. The study of instinct. New York, NY, US: Clarendon Press/Oxford University Press; 1951. xii, 237 p. (The study of instinct).

28. By P, G W, J B, M C, B R, F B, et al. Is Internet Pornography Causing Sexual Dysfunctions? A Review with Clinical Reports. Behavioral sciences (Basel, Switzerland). Aug 5, 2016; 6(3), from: https://pubmed.ncbi.nlm.nih.gov/27527226/.

29. Sexuality and the Internet: Surfing into the New Millennium | CyberPsychology & Behavior. Sep 23, 2021, from: https://www.liebertpub.com/doi/10.1089/cpb.1998.1.187.

30. Brooks SK, Webster RK, Smith LE, Woodland L, Wessely S, Greenberg N, et al. The psychological impact of quarantine and how to reduce it: rapid review of the evidence. Lancet. 2020 14; 395 (10227):912–20. https://doi.org/10.1016/S0140-6736(20)30460-8 PMID: 32112714

31. Castro-Calvo J, Ballester-Arnal R, Potenza MN, King DL, Billieux J. Does "forced abstinence" from gaming lead to pornography use? Insight from the April 2018 crash of Fortnite's servers. J Behav Addict. 2018 Sep 1; 7(3):501–2. https://doi.org/10.1556/2006.7.2018.78 PMID: 30203695

32. Döring N. How Is the COVID-19 Pandemic Affecting Our Sexualities? An Overview of the Current Media Narratives and Research Hypotheses. Arch Sex Behav. 2020; 49(8):2765–78. https://doi.org/10.1007/s10508-020-01790-z PMID: 32761282

33. Schiavi MC, Spina V, Zullo MA, Colagiovanni V, Luffarelli P, Rago R, et al. Love in the Time of COVID-19: Sexual Function and Quality of Life Analysis During the Social Distancing Measures in a Group of Italian Reproductive-Age Women. J Sex Med. 2020; 17(8):1407–13. https://doi.org/10.1016/j.jsxm.2020.06.006 PMID: 32653391

34. Ko N-Y, Lu W-H, Chen Y-L, Li D-J, Chang Y-P, Wu C-F, et al. Changes in Sex Life among People in Taiwan during the COVID-19 Pandemic: The Roles of Risk Perception, General Anxiety, and Demographic Characteristics. Int J Environ Res Public Health. 2020 11; 17(16).

35. Cito G, Micelli E, Cocci A, Polloni G, Russo GI, Coccia ME, et al. The Impact of the COVID-19 Quarantine on Sexual Life in Italy. Urology. 2020 Sep 1;. https://doi.org/10.1016/j.urology.2020.06.101 PMID: 32888982

36. Hesse C, Floyd K. Affection substitution: The effect of pornography consumption on close relationships. Journal of Social and Personal Relationships. 2019 Nov 1; 36(11–12):3887–907.

37. Kirby M. Pornography and its impact on the sexual health of men. Trends in Urology & Men's Health. 2021; 12(2):6–10.

38. Dwulit AD, Rzymski P. The Potential Associations of Pornography Use with Sexual Dysfunctions: An Integrative Literature Review of Observational Studies. J Clin Med. 2019 Jun 26; 8(7):E914. https://doi.org/10.3390/jcm8070914 PMID: 31247949

39. Lambert NM, Negash S, Stillman TF, Olmstead SB, Fincham FD. A Love That Doesn't Last: Pornography Consumption and Weakened Commitment to One's Romantic Partner. Journal of Social and Clinical Psychology. 2012 Apr 1; 31(4):410–38.

40. Landripet I, Štulhofer A. Is Pornography Use Associated with Sexual Difficulties and Dysfunctions among Younger Heterosexual Men? J Sex Med. 2015 May; 12(5):1136–9. https://doi.org/10.1111/jsm.12853 PMID: 25816904

41. Cabello F, Sánchez F, Farré JM, Montejo AL. Consensus on Recommendations for Safe Sexual Activity during the COVID-19 Coronavirus Pandemic. J Clin Med. 2020 Jul 20; 9(7). https://doi.org/10.3390/jcm9072297 PMID: 32698369

42. Marshall WL. Intimacy, loneliness and sexual offenders. Behav Res Ther. 1989; 27(5):491–503. https://doi.org/10.1016/0005-7967(89)90083-1 PMID: 2684132

43. G N. Changes in Internet Use When Coping With Stress: Older Adults During the COVID-19 Pandemic. The American journal of geriatric psychiatry: official journal of the American Association for Geriatric Psychiatry. 2020 Oct; 28(10), from: https://pubmed.ncbi.nlm.nih.gov/32771312/

44. T K, A U, D A. Assessment of internet addiction and loneliness in secondary and high school students. JPMA The Journal of the Pakistan Medical Association. 2014 Sep; 64(9), from: https://pubmed.ncbi.nlm.nih.gov/25823176/

45. de A R, de la I Ji, C Nm, M Al. Online Porn Addiction: What We Know and What We Don't-A Systematic Review. Journal of clinical medicine. 2019 Jan 15; 8(1), from: https://pubmed.ncbi.nlm.nih.gov/30650522/