

## **Impact of COVID-19 on pornography use: evidence from big data analyses**

Way K.W. Lau, Randolph C.H. Chan, Lionel H.M. Ngan, Willian K.K. Wu, Benson W.M. Lau

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

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## Abstract

**Background:** Coronavirus disease 2019 (COVID-19) has led to radical changes in social distancing awareness and affected social relationship. Due to the large-scale lockdown, home quarantine and maintaining social distance, it was anticipated that sexual activities would be severely impacted. In contrast, retrospective self-report studies showed that pornography use and autoerotism increased during the pandemic.

**Objective:** The current study used big-data databases available on internet to investigate factors that modulated the pornography use under the pandemic.

**Methods:** Daily relative search volume (RSV) data from Google Trends spanning from 24th Feb, 2020 to 13th Jul, 2020 were extracted. Traffic data of Pornhub was extracted from the website Pornhub Insights, spanning from 24th Feb, 2020 to 13th Jul, 2020. The parameter is defined as 'percent change in traffic compared to an average day in 2019'. Number of daily new case of COVID-19 was extracted from database on Our World in Data.

**Results:** Google Trends showed that the relative search volume (RSV) for pornography increased after late March 2020, which was dated close to the announcement of the pandemic by the World Health Organization. The number of daily new cases of COVID-19 was positively correlated with the traffic of Pornhub, a popular pornography website, and the RSV of 'pornography'. Moderation analysis demonstrated a significant main effect of daily new case of COVID-19 and the RSV of 'social distancing' in predicting Pornhub traffic / RSV of 'pornography'. Furthermore, the RSV of 'social distancing' significantly moderated the relationship between daily new cases and Pornhub traffic / RSV of 'pornography'. A stronger COVID-pornography use association was observed in heightened social distancing awareness.

**Conclusions:** To conclude, increased pornography consumption during the pandemic was identified, which was associated with the severity of the pandemic. Social distancing awareness may be a key factor influencing interest and use of pornography. Further studies on the changes in sexual desire, and birth-rate control are worthwhile since the long-term public health may be affected by the changes in sexual behaviour during the pandemic.

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## Original Manuscript

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

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## **Impact of COVID-19 on pornography use: evidence from big data analyses**

### **Abstract**

Background: Coronavirus disease 2019 (COVID-19) has led to radical changes in social distancing awareness and affected social relationship. Due to the large-scale lockdown, home quarantine and maintaining social distance, it was anticipated that sexual activities would be severely impacted. In contrast, retrospective self-report studies showed that pornography use and autoerotism increased during the pandemic. The current study used big-data databases available on internet to investigate factors that modulated the pornography use under the pandemic. Methods: Daily relative search volume (RSV) data from Google Trends spanning from 24<sup>th</sup> Feb, 2020 to 13<sup>th</sup> Jul, 2020 were extracted. Traffic data of Pornhub was extracted from the website Pornhub Insights, spanning from 24<sup>th</sup> Feb, 2020 to 13<sup>th</sup> Jul, 2020. The parameter is defined as ‘percent change in traffic compared to an average day in 2019’. Number of daily new case of COVID-19 was extracted from database on Our World in Data. Results: Google Trends showed that the relative search volume (RSV) for pornography increased after late March 2020, which was dated close to the announcement of the pandemic by the World Health Organization. The number of daily new cases of COVID-19 was positively correlated with the traffic of Pornhub, a popular pornography website, and the RSV of ‘pornography’. Moderation analysis demonstrated a significant main effect of daily new case of COVID-19 and the RSV of ‘social distancing’

in predicting Pornhub traffic / RSV of 'pornography'. Furthermore, the RSV of 'social distancing' significantly moderated the relationship between daily new cases and Pornhub traffic / RSV of 'pornography'. A stronger COVID-pornography use association was observed in heightened social distancing awareness. Conclusion: To conclude, increased pornography consumption during the pandemic was identified, which was associated with the severity of the pandemic. Social distancing awareness may be a key factor influencing interest and use of pornography. Further studies on the changes in sexual desire, and birth-rate control are worthwhile since the long-term public health may be affected by the changes in sexual behaviour during the pandemic.

Keywords: Covid-19; Social distancing; Pornography; Pornhub

## Introduction

Coronavirus disease 2019 (COVID-19) is caused by the infection of the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). The initial signs and symptoms, including fever, cough, and dyspnoea are mild but may develop later into life-threatening acute respiratory stress syndrome <sup>1</sup>. Asymptomatic carriers seem to occupy for approximately 40% to 45% of SARS-CoV-2 infected person. They can spread the virus to others for an extended period, possibly longer than 14 days and significantly induce the risk of silent transmission in public <sup>2</sup>. On 11<sup>th</sup> Mar, 2020, the World Health Organization (WHO) announced COVID-19 to be a global pandemic <sup>3</sup>. To minimize the risk of human-to-human transmission, government of different countries released quarantine and social distancing guidance, which aimed at minimizing direct interpersonal physical contact <sup>4</sup>. Since the disease can be transmitted through respiratory droplet and short-distance interhuman contact, social distancing was considered as an effective prevention measure. Nevertheless, the social measures have changed dramatically the interpersonal, social and potentially sexual relationships <sup>4</sup>.

From the early studies on the transmission of SARS-CoV-2, respiratory droplet, urine and faeces were proven to be the media of contagion <sup>5-6</sup>. Traces of SARS-CoV-2 have been detected in the semen in up to 25% of male patients in the acute stage of COVID-19 and

not detectable in the vaginal fluid of women with severe COVID-19<sup>7,8</sup>. The virus uses angiotensin converting enzyme II (ACE 2) as the entrance point to infect the host cells<sup>9</sup>. Though there is still no concrete evidence on the sexual transmission of SARS-CoV-2, different sexual practices including kissing, anal intercourse and anilingus were theoretical possible ways of transmission<sup>9-10</sup>, given ACE 2 is highly expressed in testis<sup>11</sup> and it also expressed in internal mucous membranes of oral cavity and rectum, and there is evidence of oral-fecal transmission<sup>4,9</sup>.

It is postulated that sexuality of the general public would be affected by the transmission of SARS-CoV-2. For instance, survey studies conducted in different countries revealed that participants reported decreased frequency of sexual interaction and risky sexual behaviours among heterosexual and homosexual adults<sup>12-14</sup>. Among different studies, there are a few unambiguous findings and one of these is the increased use of pornography. Pornhub, one of the largest providers of free online pornographic videos, has reported an increased traffic after the outbreak when compared to the average traffic in 2019<sup>15</sup>. In a study which used Google Trend(s), the tool that indicates the interest of public interest on a particular search term, reported that the relative search volume (RSV) of Pornhub soared after the beginning of the pandemic<sup>16</sup>. The frequency of autoerotism, pornography consumption and use of phone sex were reported to be increased<sup>17</sup>. Since large scale lockdown is common during

the pandemic, pornography use and autoerotism may become an important channel to express sexuality, which serves to fulfil sexual desire during the period which emphasizes social distancing.

Early studies on the sexual activity (including autoerotism) during the pandemics, however, were usually conducted in the format of online survey, which may be subjected to self-reporting bias. In addition, customized, non-standardised questionnaires and questions were usually 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 which may mediate or moderate the sexual activities. There is still lacking objective data to study the impact of COVID-19 on sexual lives<sup>18</sup>.

In light of the above-mentioned research gaps, this study aims at exploring the change in pornography use with big data databases available on internet. The objective of the current study was to explore associations among the emerging situation of COVID-19, awareness of social distancing and pornography use. In addition, we hypothesized that the awareness of social distancing would moderate the association between the severity of the COVID-19 infection and pornography consumption during the pandemic. Our findings add to a growing body of the literature on our understanding of the relationship between the

pandemic and pornography use by providing objective data from internet behaviour to reflect the changes in pornography use during the pandemic.

## Methods

### *Data*

Google trend: Daily relative search volume data from Google Trend spanning from 24<sup>th</sup> Feb, 2020 to 13<sup>th</sup> Jul, 2020, from worldwide, was extracted. The data was expressed as relative search volume (RSV). The search terms include 'COVID', 'social distancing' and 'pornography'.

Traffic data of Pornhub: data was extracted from the website 'Pornhub Insights<sup>19</sup>', spanning from 24<sup>th</sup> Feb, 2020 to 13<sup>th</sup> Jul, 2020. The parameter is defined as 'percent change in traffic compared to an average day in 2019'.

Number of daily new case of COVID-19 was extracted from database on Our World in Data<sup>20</sup>.

### *Statistical analysis*

Normality of the data was tested by Shapiro-Wilk analysis. All variables included in this study were non-normally distributed. Therefore, non-parametric tests or parametric tests with bootstrapping method were adopted where appropriate.

The association among the RSV of 'social distancing', 'COVID', 'pornography', the number of daily new case, and the traffic rate of Pornhub, was analysed using Spearman-rho correlation analysis. Ten comparisons were conducted, thus,  $P < .005$  ( $0.05/10$ ) is defined as statistically significance after Bonferroni correction.

To determine the role of the awareness of social distancing on the association between the number of daily new case and pornography use, moderation analyses were performed using model 1 in the PROCESS macro for SPSS that was developed by Hayes<sup>21</sup>. The PROCESS macro is based on ordinary least squares regression and adopts a nonparametric bootstrapping procedure (5000 bootstrapped samples in this study), which gives rise to a bias-corrected confidence interval (CI) for effect size inference<sup>22</sup>. Statistical significance is denoted if the 95% CI does not cross zero<sup>23</sup>. The number of daily new case (predictors) and the RSV of 'social distancing' (moderators) were mean-centered. The mean-centered variables as well as their interaction term were entered in the linear regression model for predicting traffic rate of Pornhub or the RSV of 'pornography'. The binary variable i.e. free promotion period of Pornhub (yes/no) was entered to the regression model as a controlled variable.

## Results

### *Positive association between the number of daily new COVID-19 case and Pornhub traffic*

A total of 141 data points was collected from February 24<sup>th</sup> to July 13<sup>th</sup>, 2020 via sources described above. The RSV for the terms 'COVID', 'social distancing' and 'pornography' were shown in Figure 1. A notable increase in RSV of 'COVID' and 'social distancing' was found in early March, and that of 'pornography' was found in late March. Figure 2 shows

the scatter plots between the traffic data of Pornhub and daily new cases of COVID-19, and the RSVs of 'social distancing' and 'COVID'. Briefly, a strong positive association between the number of daily new case and the traffic rate of Pornhub was observed at the initial phase of the pandemic, in which the number of new case was around 50,000. The growth of the traffic rate was being plateau when the number of new case exceeded 50,000. It was noteworthy to mention the positive influence of the free promotion period of Pornhub (from March 25<sup>th</sup> to 27<sup>th</sup>, 2020) on the traffic rate of Pornhub (Figure 2a). A positive correlation between the RSV of 'COVID' and 'social distancing' was observed (Figure 2b).

*Associations among RSV of "social distancing", "COVID", "pornography", the daily new cases and the traffic rate of Pornhub from February 24 to July 13, 2020*

Correlation coefficients among the variables (RSVs, number of daily new case, and traffic data) by Spearman's rho are shown in Table 1. The number of daily new case of COVID-19 was positively related to the traffic of Pornhub ( $\rho=0.562$ ,  $P<.000$ ) and the RSV of 'pornography' ( $\rho=0.698$ ,  $P<.000$ ), and negatively related to the RSV of social distancing ( $\rho=-0.284$ ,  $P<.001$ ). As expected, the RSV of 'pornography' was significantly correlated to traffic of Pornhub ( $\rho=0.343$ ,  $P<.000$ ). There was a positive, strong association between the RSVs of 'social distancing' and 'COVID' ( $\rho=0.849$ ,  $P<.000$ ).

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

The regression model in predicting traffic rate of Pornhub using the number of daily new case, the RSV of 'social distancing' and their interaction term was significant after controlled for the effect of free access to Pornhub premium service [ $F_{(4, 136)}=52.571$ ,  $P<.000$ ], which explained 60.73% variance of traffic rate of Pornhub. The number of daily new case (in 10,000) ( $\beta=0.012$ ,  $SE=0.001$ , 95%  $CI=0.010-0.015$ ,  $P<.000$ ), the RSV of 'social distancing' ( $\beta=0.003$ ,  $SE=0.001$ , 95%  $CI=0.002-0.004$ ,  $P<.000$ ), and their interaction term ( $\beta=0.0003$ ,  $SE=0.0001$ , 95%  $CI=0.0001-0.0004$ ,  $P<.000$ ) were significant predictors of traffic rate of Pornhub. The addition of the interaction term significantly increased the  $R^2$  of the model [ $R^2$ -change=0.043,  $F_{(1,136)}=14.991$ ,  $P<.000$ ]. The significant interaction term supported the moderating role of RSV of 'social distancing' on the relationship between the number of daily new case and traffic rate of Pornhub, in which an increase in the RSV of 'social distancing' enhanced such association (Figure 3a).

To further confirm our findings, the same moderation analysis was performed by replacing the dependent variable with the RSV of 'pornography'. The RSV of 'pornography' represented the interest in pornography, which might include the surfing of pornography websites other than Pornhub. The regression model in predicting RSV of 'pornography' was significant [ $F_{(4, 136)}=29.828$ ,  $P<.000$ ], which explained 46.73% of variance of the RSV

of 'pornography'. The number of daily new case (in 10,000) ( $\beta=2.907$ ,  $SE=0.368$ , 95%  $CI=2.179-3.635$ ,  $P<.000$ ), the RSV of '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%  $CI=0.050-0.131$ ,  $P<.000$ ) were significant predictors of the RSV of 'pornography'. The addition of the interaction term significantly increased the  $R^2$  of the model [ $R^2$ -change=0.075,  $F_{(1,136)}=19.181$ ,  $P<.000$ ] (Figure 3b). The increase in the awareness of social distancing enhanced the association between the number of daily new case and the RSV of 'pornography'. Interestingly, the moderation effect of social distancing awareness at the first 10<sup>th</sup> percentile was non-significant ( $P=0.17$ ).

## Discussion

According to Pornhub Insight, an increase in traffic of Pornhub.com was observed from early March 2020, which reached the peak (+23.1% compared to average daily traffic in 2019) on March 24, 2020 and maintained at a level from +9.8% to +22.8% until June 2020<sup>19</sup>. Our results showed that the increase in Pornhub traffic was significantly associated with the daily new cases of COVID-19, and the traffic can be predicted by the daily new cases. These findings imply that the trend of pornography usage may be in line with the development of the pandemic. The findings agree with previous studies that the frequency of autoerotism and pornography usage were reported to increase during the pandemic<sup>17,24</sup>.

Over 40% of respondents in a survey conducted in Italy reported an increase in sexual desire during the quarantine <sup>17</sup>. Similarly, elevated libido was reported in another study conducted in south-east Asian countries <sup>25</sup>. However, the increase in desire is not associated with an increase in sexual intercourse. Instead, autoerotism and pornography usage may substitute the actual sexual intercourse to fulfil the sexual needs. Further empirical studies are required to confirm this speculation.

The stressors related to the pandemic, together with the increased sexual desire, may urge people to engage in pornography usage. Negative emotion and psychological effects including anger, confusion, anxiety and depression were reported to be caused by the quarantine, fear of infection, boredom and inadequate supports from others <sup>26</sup>. Significant reduction in female sexual functioning and quality of life was found during the pandemic <sup>27</sup>. Furthermore, the presence of anxiety and risk perception of COVID-19 were negatively associated with the frequency of sexual activity <sup>28</sup>. Since it is known that wellbeing is positively associated with the number of sexual intercourse <sup>29</sup>, the reduction in sexual intercourse may indicate/associate with a worsen mental wellbeing, even with autoerotism and pornography usage are used as substitute.

During the pandemic, the public has increased awareness and/or concerns in 'social

distancing', which is reflected by the increased RSV and the strong positive correlation between the RSVs of 'Social Distancing' and 'COVID'. Based on this, we hypothesized that the awareness of social distancing would moderate the association between the severity of COVID-19 infection and pornography consumption, and this is supported by the moderation analysis in the current study. The results showed that the positive association between the severity of COVID-19 infection and pornography consumption was stronger in times of heightened awareness of social distancing. Interestingly, on the dates when the RSV of 'social distancing' is at a relatively low level (below 10<sup>th</sup> percentile), the number of daily new case was not associated with the RSV of 'pornography'. This implicates that the consumption of pornography increased with the daily new cases of COVID-19 only when the general public became aware of social distancing. This reflects that the awareness of social distancing could be a key factor which affects the display of autoerotism.

The search volume of social distancing increased rapidly from early March and reached a peak at the end of March 2020, which is temporally close to the WHO's declaration of COVID-19 as a global pandemic. The rise in concern of social distancing indicates the increased awareness of transmission routes of COVID-19. Since sexual intercourse is a possible way of SARS-CoV-2 transmission, sexual activity among non-habitual partners with possibility of carrying the disease was believed to be suppressed<sup>30</sup>. However, sexual

activity among habitual partners who are not infected are considered as safe <sup>10</sup>, though the frequency of sexual intercourse may be suppressed by factors including the presence of children at home and negative psychological factors and mood <sup>18</sup>. With a heightened awareness on maintaining interpersonal distance, it is understandable that sexual intercourse may be avoided, and being substituted by autoerotism to fulfil sexual desire.

According to the findings from the transmission of COVID-19, the Italian Society of Andrology (ISA) has provided guidelines on sexual activities to avoid the infection <sup>4</sup>. The encouraged and theoretically safe sexual activities include intercourse between de-facto couples not infected, use of sex toys with disinfection and masturbation, while kissing, analingus and sex contact with partner outside family environment should be avoided. The Spanish Association of Sexuality and Mental Health provides recommendations similar to the ISA, with additional suggestions on avoiding sexual activities during quarantine, and substituting intercourse with masturbatory or virtual sexual activity <sup>31</sup>.

A future research question worth pursuing is the reason whether and why sexual desire is increased during the pandemic. Loneliness and negative emotions during quarantine and lockdown may be the potential causes, which may urge one to pursue intimate relationship for the benefit of being resistant to stress and even better physical health <sup>32</sup>. Though

pornography usage or autoerotism may satisfy solitary sexual desire, the lack of intimate relationship and the unfulfillment of dyadic sexual desire cannot be addressed through this means and this may be the reason why sexual pleasure and satisfaction cannot be achieved even with increase pornography usage <sup>17</sup>.

Another research question is the fertility trajectories after the pandemic. In human history, the fertility rate after disasters, wars, and pandemics were frequently followed by a short period of fewer births, and subsequent years of rebound <sup>33</sup>. From the current findings of the sexual behaviour changes, stress related to the disease has discouraged sexual intercourse of non-habitual partners and unfamiliar individual through dating apps. It was speculated that the stress related to the pandemic including loss of job, emotional impact may accelerate the number of divorce <sup>18</sup>, may put couples at an increased risk of infidelity and slower recovery from the affected relationship <sup>34(p19)</sup>. In contrast, increase in sexual intercourse among couples was reported in a survey study which explored the desire of reproduction <sup>35</sup>. The desire to be pregnant, reported by the participants, had decreased during the pandemic, but the use of contraception decreased significantly. Another study in three south-east Asian countries (Nepal, India and Bangladesh) even suggests a positive influence on emotional bonding between couples during the lockdown, though the frequency of sexual intercourse was similar before and during the pandemic <sup>25</sup>. These

factors revealed that the birth rate after disasters would be affected by complicated factors, and the post-COVID studies would further increase the understanding on the baby boom or 'baby bust' after a global pandemic.

Since the pandemic is still progressing, the whole picture of its impact on sexuality is yet to be fully disclosed. In this paper, we found that the severity of the COVID-19 infection and the awareness of social distancing are associated with increased pornography consumption during the pandemic. As sexual behaviour is closely related to mental and sexual health, follow up work is needed to understand the influence of the changes on these areas, which may be the secondary impacts of COVID-19.

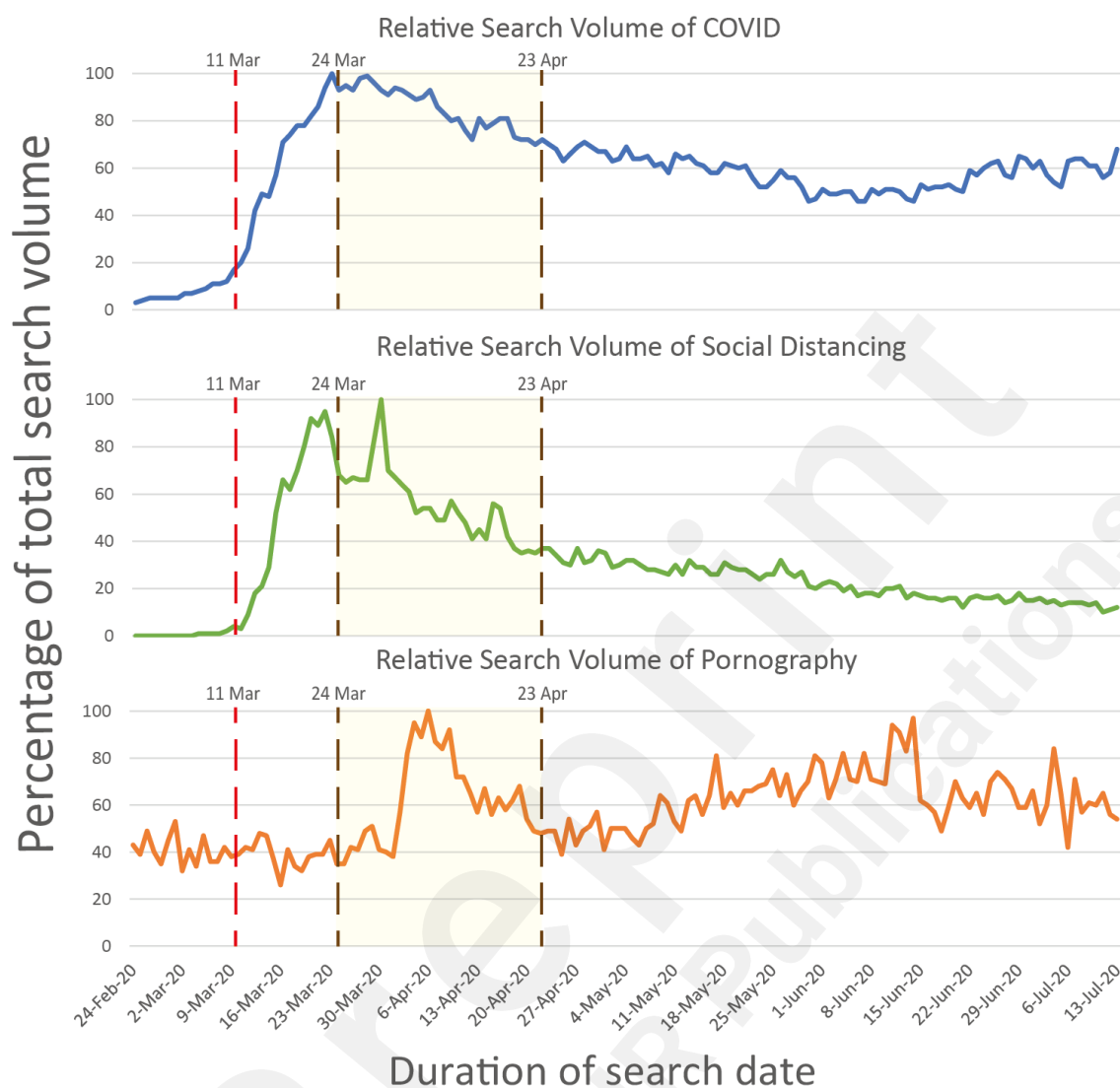
### **Acknowledgements**

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### **Conflicts of Interest**

The authors declare no conflicts of interest in this study

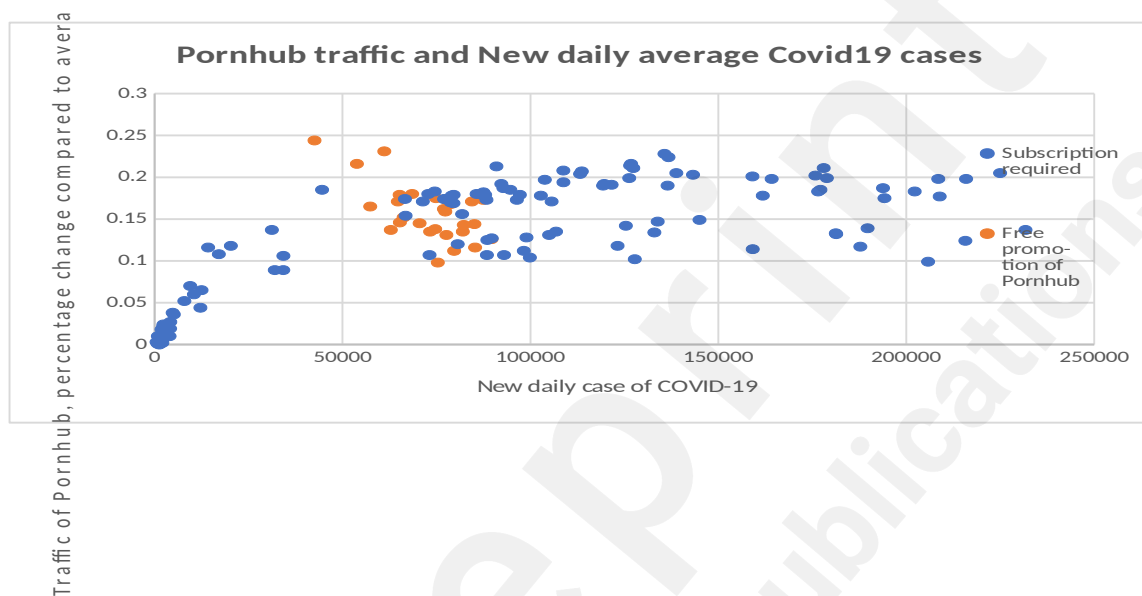
**Figure 1: Relative search volume of 'COVID', 'Social Distancing' and 'Pornography' from Google Trend(s).**



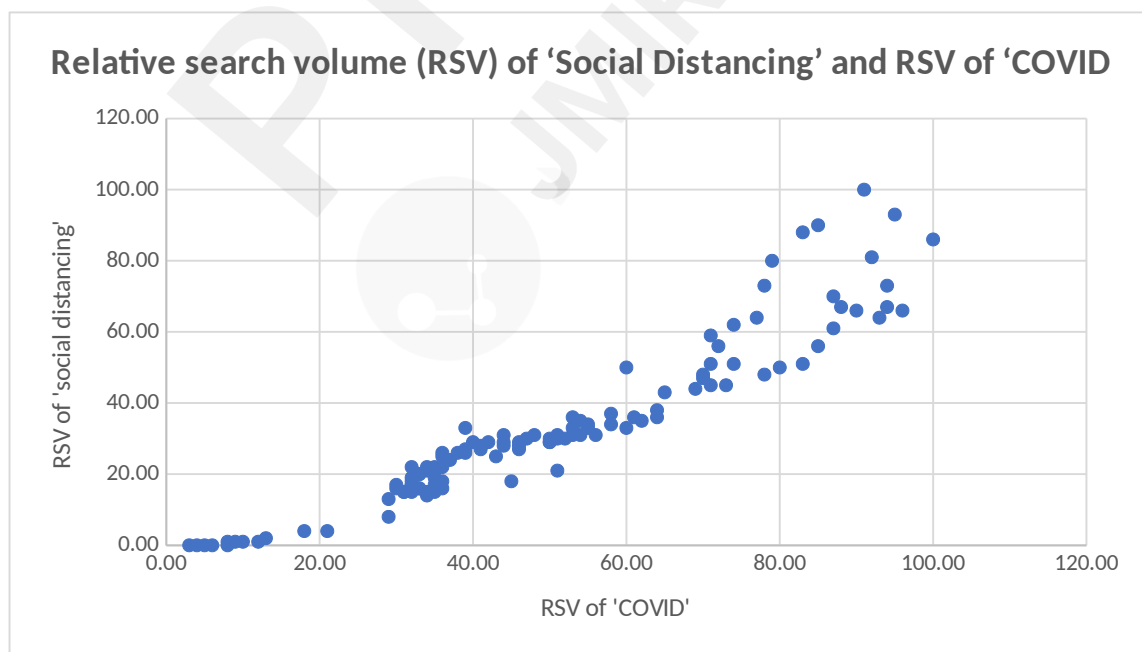
Note: On Mar 11, 2020, the World Health Organization (WHO) announced COVID-19 to be a global pandemic. Free promotion period of Pornhub (Premium) from Mar 24 – Apr 23, 2020.

**Figure 2: Scatter plots showing correlation between a) Pornhub traffic and New daily average Covid19 cases; b) Relative search volume (RSV) of 'Social Distancing' and RSV of 'COVID'**

a)

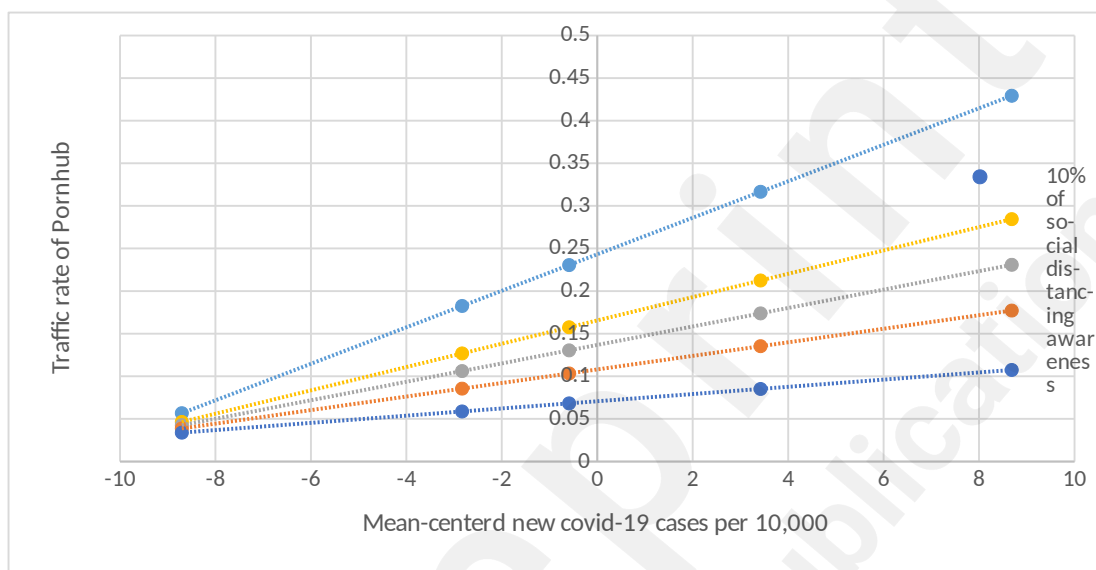


b)

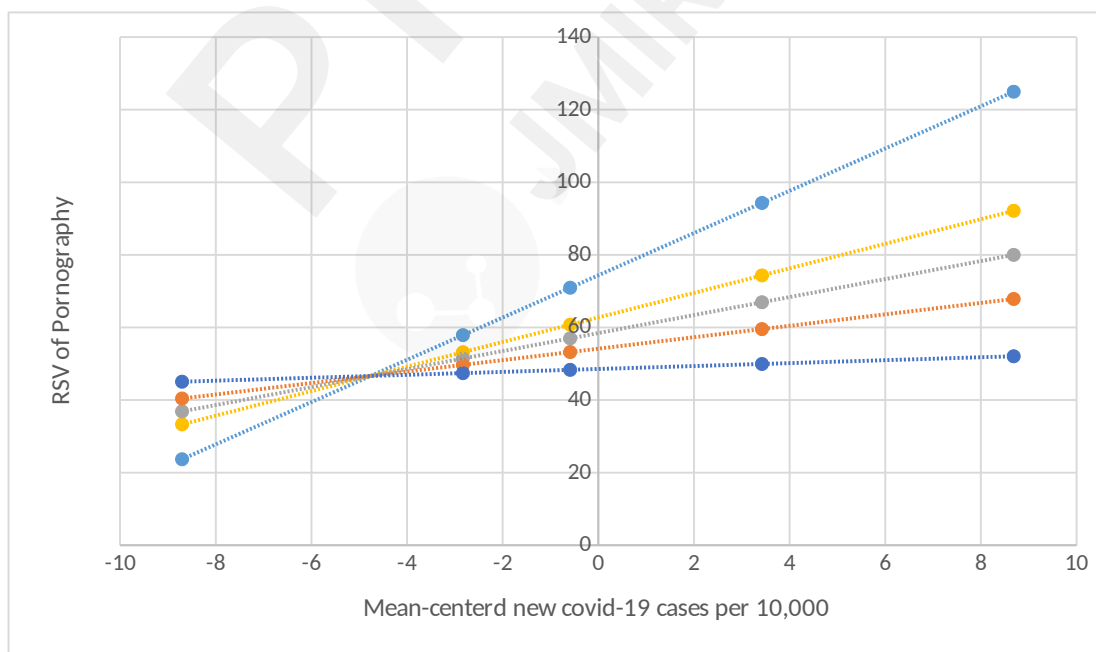


**Figure 3: Moderation effect of the awareness of social distancing on the relationship between a) covid-19 new cases and traffic rate of Pornhub, b) covid-19 new cases and RSV of 'pornography'**

a)



b)



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

	1	2	3	4
<b>1. RSV of 'Social Distancing'</b>	---			
<b>2. RSV of 'COVID'</b>	<b>0.849</b> <b>(.000)</b>			
<b>3. RSV of 'Pornography'</b>	-0.085 (.31)	-0.082 (.34)		
<b>4. Daily new case of COVID-19</b>	<b>-0.284</b> <b>(.001)</b>	-0.101 (.23)	<b>0.698</b> <b>(.000)</b>	
<b>5. Traffic of Pornhub</b>	0.144 (.09)	<b>0.229</b> <b>(.006)</b>	<b>0.343</b> <b>(.000)</b>	<b>0.562</b> <b>(.000)</b>

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

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#### Abbreviations

ACE2

CI

COVID-19

ISA

RVS

rho

SARS-CoV-2

WHO

#### Definition

Angiotensin converting enzyme II

Confidence interval

Coronavirus disease 2019

The Italian Society of Andrology

The relative search volume

Spearman's rho correlation

The severe acute respiratory syndrome coronavirus 2

The World Health Organization

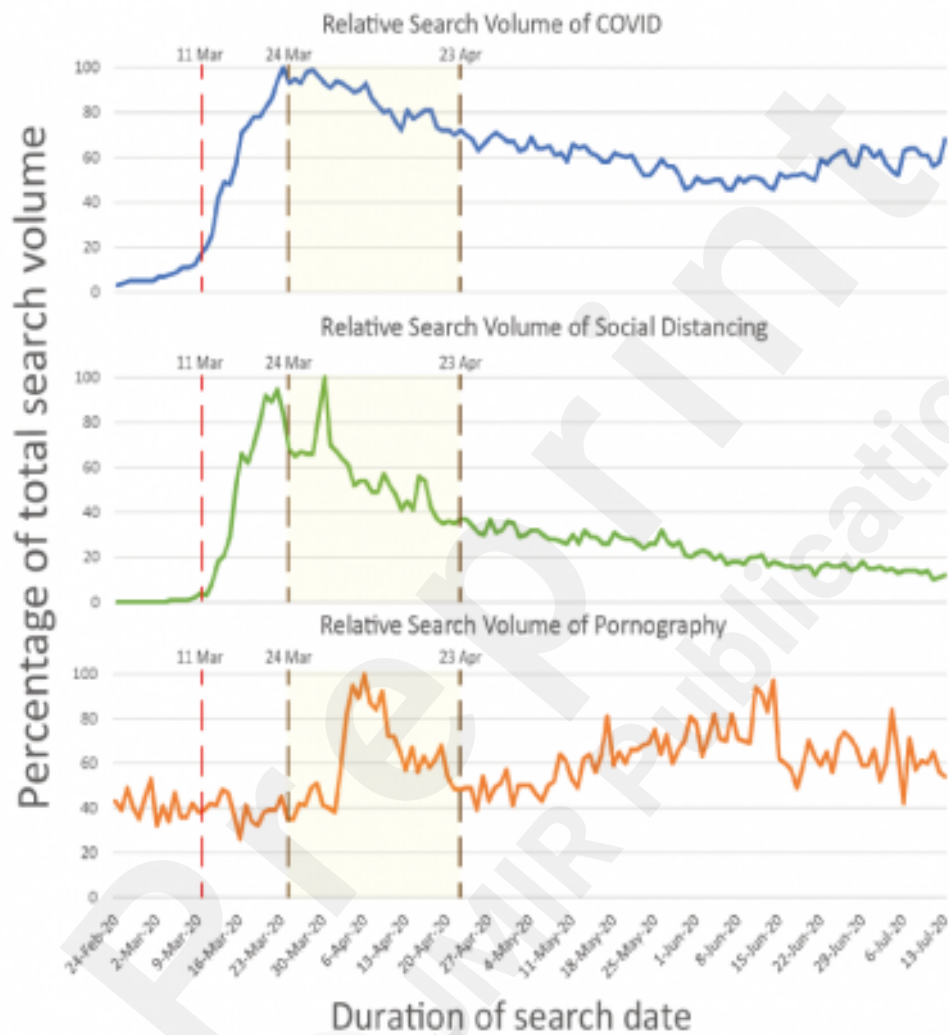
## Supplementary Files

## Figures

Relative search volume of 'COVID', 'Social Distancing' and 'Pornography' from Google Trend(s).

**Figure 1: Relative search volume of 'COVID', 'Social Distancing' and 'Pornography'**

**from Google Trend(s).**

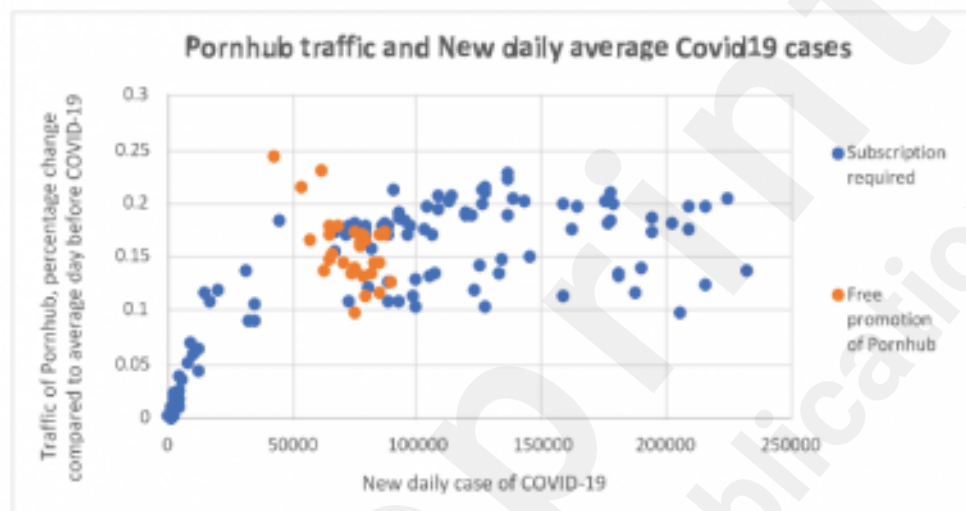


Note: On Mar 11, 2020, the World Health Organization (WHO) announced COVID-19 to be a global pandemic. Free promotion period of Pornhub (Premium) from Mar 24 – Apr 23, 2020.

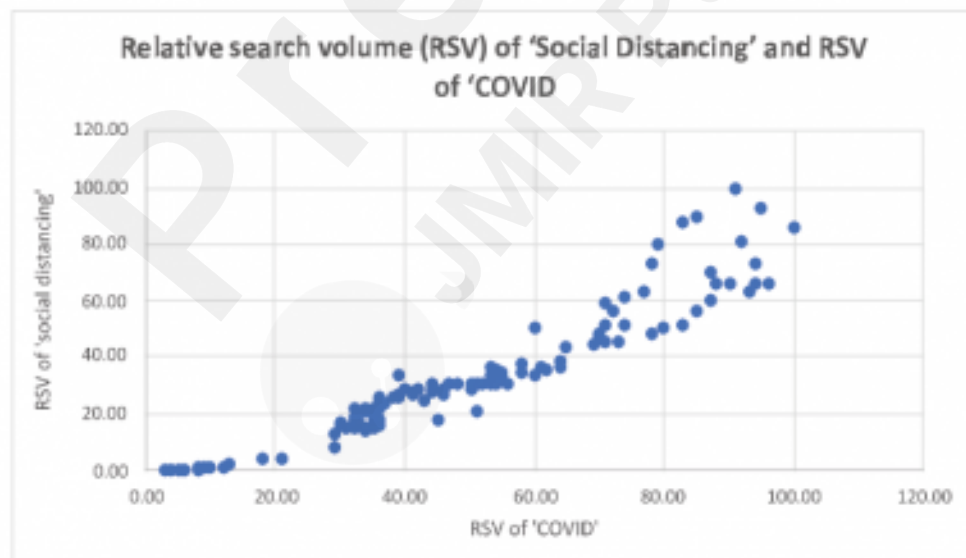
Scatter plots showing correlation between a) Pornhub traffic and New daily average Covid19 cases; b) Relative search volume (RSV) of 'Social Distancing' and RSV of 'COVID'.

**Figure 2: Scatter plots showing correlation between a) Pornhub traffic and New daily average Covid19 cases; b) Relative search volume (RSV) of 'Social Distancing' and RSV of 'COVID'**

a)



b)



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

**Figure 3: Moderation effect of the awareness of social distancing on the relationship between a) covid-19 new cases and traffic rate of Pornhub, b) covid-19 new cases and RSV of 'pornography'**

