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Male Sexual Health and Sexual Behaviors during the First National COVID-19 Lockdown in a Western Country: A Real-Life, Web-Based Study

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Abstract: Restriction measures enacted during the COVID-19 pandemic had severe effects on male sexual and reproductive health. We aimed to investigate the real-life impact and perception of sexual function in 2020 in Italy, as the first Western country experiencing a national lockdown by measuring relative search volume for keywords pertaining to sexual health and behaviors provided by Google Trends and sales data for pro-erectile treatments. No significant change was observed for erectile dysfunction and premature ejaculation. Interest towards most phosphodiesterase type 5 inhibitors decreased significantly during lockdown (e.g., sildenafil, $p = 0.0002$; tadalafil $p = 0.0016$), then reverted to pre-lockdown levels (e.g., sildenafil, $p < 0.0001$; tadalafil $p < 0.0001$), mirroring a concomitant sales decrement ($p = 0.0292$). A subsequent recovery to previous levels at the end of the social confinement was also found (e.g., after vs. before lockdown, sildenafil, $p = 0.8459$; tadalafil $p = 0.1166$). During lockdown, interest towards pornography significantly increased during restrictions ($p = 0.0053$) and remained high (after vs. before lockdown, $p = 0.0004$), whereas interest towards paid and casual sex declined ($p = 0.0015$ and $p = 0.049$, respectively), then reverted to previous levels (after vs. before lockdown, $p = 0.3969$ and 0.8373 , respectively). During the first Italian lockdown, we observed a transient but measurable decrease of sexual health-seeking behaviors and changes in sexual behaviors, with unknown impact for sexual medicine and public health.

Keywords: erectile dysfunction; phosphodiesterase type 5 inhibitors; premature ejaculation; dapoxetine; google trends; COVID-19; lockdown; sexual behavior; pornography

1. Introduction

Italy was the first Western country to be struck by COVID-19, with the first cases being reported since February, 2020 [1]. From these initial cases, the pandemic quickly spread throughout all of the country [2], and a lockdown, i.e., a nationwide community containment restricting the population from moving except for well-defined reasons [3], was therefore enforced between 9 March and 3 May 2020.

However, while potentially able to minimize potential exposure, lockdowns bear negative consequences on a personal and social level. The pandemic itself, with the fear for the new infection; the constriction in small apartments; the feeling of isolation; the

obligation to reside with some relatives or, vice-versa, the impossibility of meeting partners, friends, and relatives; the economic and political uncertainties [4,5]; and the absence of a defined end in the restrictions did contribute to the onset of disturbances on a psychological and relational level [6,7]. At the same time, strict lockdown carries high economical costs, with temporary shutdown of many activities and selected work categories being put indefinitely on hold or with citizens being forced to work remotely with difficulties in the family management [8]. Without a shade of doubt, the COVID-19 pandemic and the related containment measures have been identified as traumatic events [9–11] that contributed to generate anxiety and stress, conditions having a well-known, negative effect on overall health and well-being [12], and possibly associated with worse outcomes in terms of obesity, cognition, cardiovascular disease, and cancer [13–15].

In this scenario, COVID-19 and lockdown have also taken their toll on sexual and reproductive health [16], with potential effects on reproduction being a particularly perceived issue [17–20]. The burden of COVID-19 on sexual health, on the other hand, has been less investigated. Psychological stress also affects both the quality and quantity of sexual activity [16,21], and indeed sexual activity can act as a mechanism to cope with exogenous sources of stress, as proven during the COVID-19 lockdown [22]. However, besides the presence of potentially psychosocial risk factors, several organic, COVID-related mechanisms leading to the onset of sexual dysfunctions have also been investigated. Being an endothelial disease, COVID-19 has severe consequences on endothelium-dependent sexual functions, such as erection, which is further impaired by the concomitant subclinical hypogonadism, anosmia, local hypoxia, and psychological distress [23]. Indeed, there is preliminary evidence that COVID-19 patients might develop erectile dysfunction as a consequence of SARS-CoV-2 infection [24,25].

However, sexual health, as stated by the WHO, is “fundamental to the overall health and well-being of individuals, couples, and families”; therefore, addressing the potential effects of COVID-19 on sexual health becomes a socially relevant issue also in consideration of the increasing numbers of COVID long-haulers [26] with persistent symptoms following discharge [27].

The Web—including activity on social media and queries from search engines—can be used in order to investigate to what extent diseases and condition are perceived in the general population [28,29], with male sexual dysfunctions being no exception [30,31]. Higher awareness of a certain condition or symptom is usually reflected in an increased prevalence of online searches [32], as also proven for COVID-19, with an increase in public interest being observed before the start of the pandemic [33] and in its first months [34]. Similarly, and based on these grounds, it can be assumed that, among the several possible causes, the decrease in search volume may be not a sign of reduced prevalence of any given disease or condition but rather an index of reduced interest and/or awareness. Therefore, a decline in the search volume for male sexual dysfunctions or pro-erectile treatments during lockdown would suggest a similar decrease in interest or awareness for these topics, meaning a worse social sexual health for the general population. Similar reduced health-seeking behaviors have been reported worldwide [35–37]. At the same time, it is also likely that, during lockdown, most subjects would be searching online for information concerning the spread of the pandemic or possible treatments rather than being concerned with their sexual health.

We therefore investigated the search volume provided by Google Trends of several topics pertaining to male sexual function and dysfunction in Italy during 2020 in order to assess to what extent real-life perception of male sexual health, also measured by queries for treatments, changed during and after lockdown.

Additionally, and for the same purpose, we also investigated sales data for various phosphodiesterase type 5 inhibitors (PDE5i), comparing market data from 2019 and 2020 as a further surrogate marker of the sexual health of the population during the forced quarantine.

2. Materials and Methods

2.1. Analysis of Google Trends Search Volume

Google Trends (GT) is a freely available tool that provides worldwide search volume information for any given search string, with the possibility of measuring changes over a selected time frame and in a specified country or region [38]. GT provides results as relative search volume, i.e., a 0–100 scale in which 100 represents the time of peak popularity in the selected time frame [38]. For the present study, we selected to investigate only data from Italy, from 1 January to 31 December 2020. Search terms were generated for the four approved PDE5i (*sildenafil*; *vardenafil*; *tadalafil*; *avanafil*) and their most used brand names as well as the two terms for erectile dysfunction (*disfunzione erettile*) and premature ejaculation (*ejaculazione precoce*). Analysis was conducted by measuring the search volume provided by GT before, during, and after the lockdown period in Italy (weeks 10 to 18 of 2020), obtained by investigating each keyword separately. Additionally, by using the same strategy, we investigated three other search terms aimed to provide further insight on sexual behaviors of Italian male heterosexual subjects in 2020, namely *Pornhub*, *escort*, and *Tinder*, each one acting as a surrogate of specific sexual behaviors—pornography use, sex work, and use of dating apps.

2.2. Analysis of Sales Data for PDE5 Inhibitors

Sales data were provided by IQVIA Italy (Third Party Access Limited License Agreement Number: TPA-74911) regarding the raw sales volume of all commercially available, approved PDE5i between January and September of both 2019 and 2020. IQVIA is a world leader in using data, technology, advanced analytics, and human expertise related to healthcare and human health.

2.3. Statistical Analysis

Pairwise Wilcoxon rank sum tests with Holm correction were used to measure changes in the relative search volume provided by GT. Paired Wilcoxon rank sum test was used to measure the change in sales data between 2019 and 2020; linear regression models were also used to measure the interaction of lockdown measures on year-based changes. Correlation was measured using Spearman's rho (ρ). Statistical significance was set at $p < 0.05$. All statistical analysis were performed using the R software (R Core Team, version 4.0.3, Vienna, Austria), with the use of the *reshape2*, *tidyverse*, and *ggsignif* packages for data restructuring and plotting [39,40].

3. Results

3.1. Analysis of Google Trends Search Volume for Male Sexual Dysfunctions and Treatments

The median volume of google queries for both erectile dysfunction and premature ejaculation was not different during lockdown compared to before ($p = 0.96$ and $p = 1$, respectively) and after ($p = 1$ and $p = 0.79$) the end of restriction measures. However, queries for both sildenafil and its most common brand names decreased significantly during lockdown ($p = 0.0069$ and $p = 0.0002$, respectively) and increased again following the end of lockdown ($p = 0.0011$, $p < 0.0001$), returning to similar levels as before lockdown ($p = 0.7988$, $p = 0.8459$). The same findings were confirmed by using tadalafil and its most common brand name as keywords: queries during lockdown were decreased compared to before ($p = 0.0007$ and $p = 0.0016$, respectively) and after lockdown ($p = 0.0012$, $p < 0.0001$), but no significant change was found comparing search volume from before lockdown and after lockdown ($p = 0.1004$ and $p = 0.1166$). No significant changes were observed ($p > 0.05$ for all pairwise comparisons), on the contrary, using the keywords vardenafil, avanafil, or their most common brand names (Figure 1).

For the treatments for premature ejaculation, no significant trends were observed concerning the queries for the unique approved oral treatment for premature ejaculation, dapoxetine, nor for its brand name ($p > 0.05$ for all pairwise comparisons).

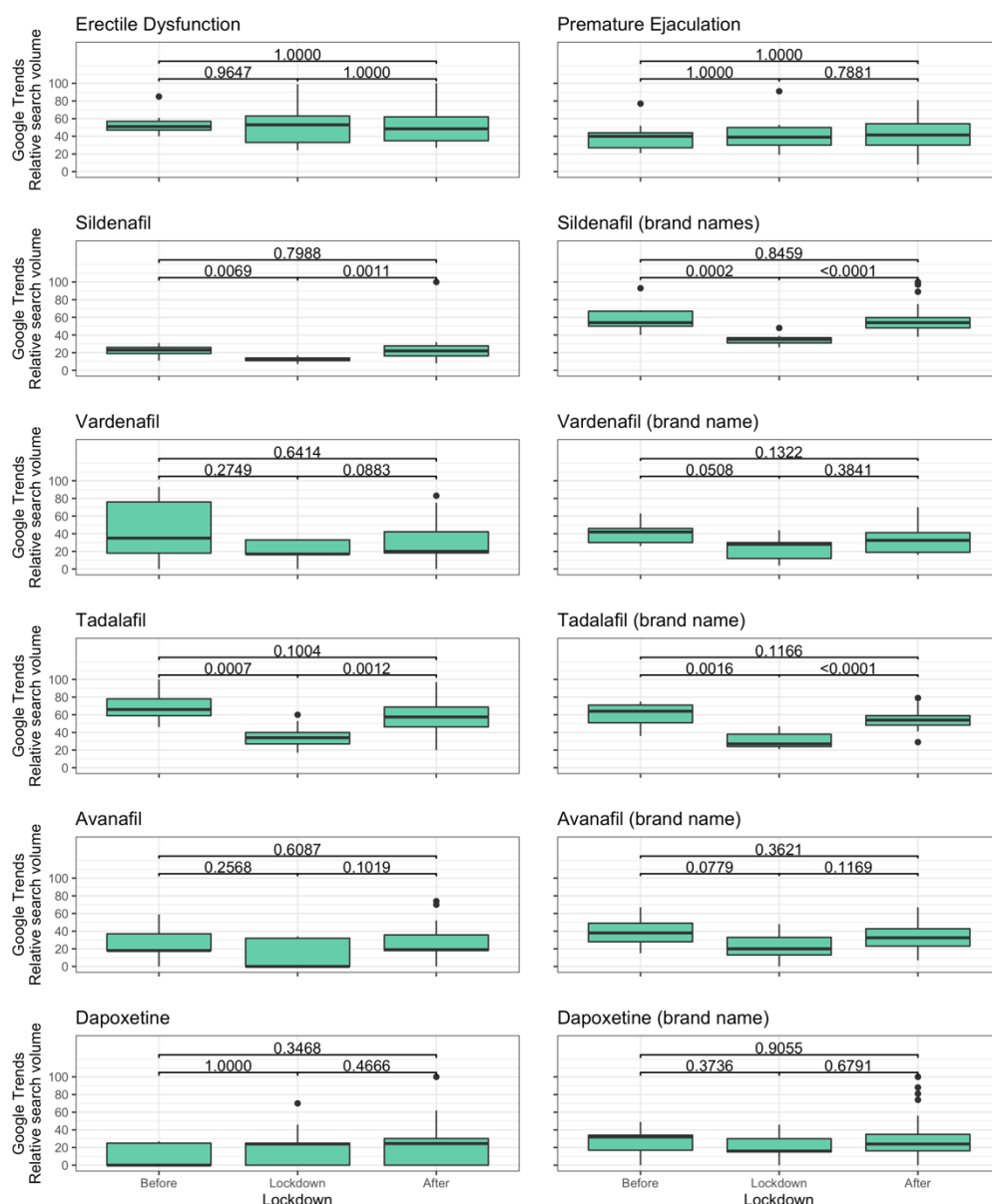


Figure 1. Changes in Google Trends relative search volume for the different keywords pertaining to male sexual health.

3.2. Analysis of GT Search Volume for Other Keywords Pertaining to Sexual Behavior

A significant increase in the relative search volume for Pornhub was found during lockdown ($p = 0.0053$); following the end of lockdown, the interest significantly decreased ($p = 0.039$) although it was still greater than before ($p = 0.0004$). Interest for the term escort decreased significantly following the onset of restriction measures ($p = 0.0015$) and increased again immediately after their end ($p = 0.0001$), with a non-significant difference between before and after lockdown ($p = 0.3970$); the same findings applied for Tinder, with an initial significant decline in search volume ($p = 0.049$), which then significantly increased ($p = 0.0029$), reaching pre-lockdown levels ($p = 0.8373$) (Figure 2). Correlation analysis showed a significant association between search volume for the escort and Tinder keywords and queries for PDE5i (Table 1). More in detail, brand names of all PDE5i showed statistically significant, moderate-to-high degree correlation with both keywords, ranging between 0.39 and 0.52 for Tinder and between 0.32 and 0.58 for escort. Given the different curve for Pornhub trends (reverse, mirrored J-shape), we did not investigate the correlation between queries for this keyword and for PDE5i.

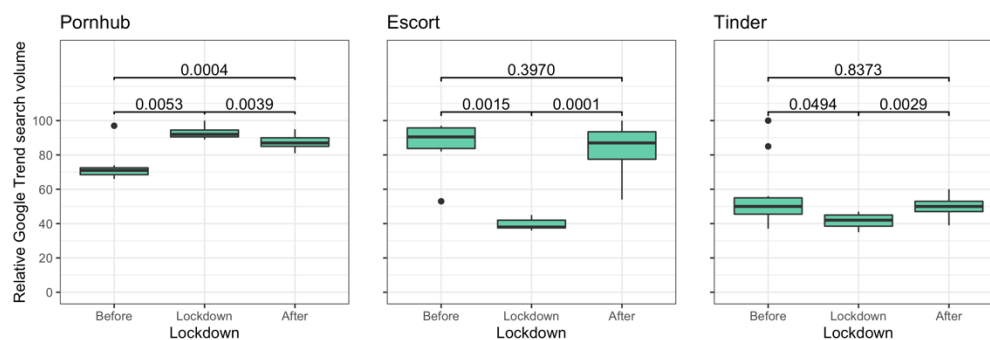


Figure 2. Changes in Google Trends relative search volume for three different keywords (Pornhub, escort, and Tinder) mostly pertaining to male heterosexual behaviors.

Table 1. Correlation analysis of keywords pertaining to sexual behaviors and sexual health.

Keyword	Tinder		Escort	
	Spearman’s ρ	p	Spearman’s ρ	p
Sildenafil	0.51	<0.0001	0.43	0.001
Sildenafil (brand names)	0.48	<0.0001	0.48	0.0003
Vardenafil	0.18	0.190	0.37	0.007
Vardenafil (brand name)	0.39	0.004	0.37	0.007
Tadalafil	0.14	0.335	0.39	0.004
Tadalafil (brand name)	0.52	<0.0001	0.58	<0.0001
Avanafil	0.15	0.272	0.24	0.087
Avanafil (brand name)	0.40	0.003	0.32	0.022

3.3. Results of Marketing Analysis of Pde5i Sales

Regression analysis on PDE5i sales data between January and September of both 2019 and 2020 highlighted a significant negative effect of lockdown on the sales of PDE5i (Figure 3; Table 2), mirroring the overall reduced interest in PDE5i appreciated by GT analysis. Analysis of the raw sales data showed a marked decline in sales in April and May, with a -27.9% and -47.5% reduction, respectively (Table 3).

Table 2. Regression analysis for the overall change in phosphodiesterase type 5 inhibitors in 2020.

Term	Estimate	Std. Error	p
(Intercept)	469,233.53	31,746.06	0.0001
Before vs. Lockdown	-104,304.97	49,022.9	0.0387
Lockdown vs. After	19,115.22	41,298.05	0.3299

Adjusted R^2 : 0.434.

Table 3. Decline in sales between 2020 and 2019 for PDE5 inhibitors.

Month	Sales Difference (%)
January	+2.8%
February	+7.5%
March	+0.6%
April	-27.9%
May	-47.5%
June	-9.00%
July	+0.90%
August	+2.50%
September	+7.50%

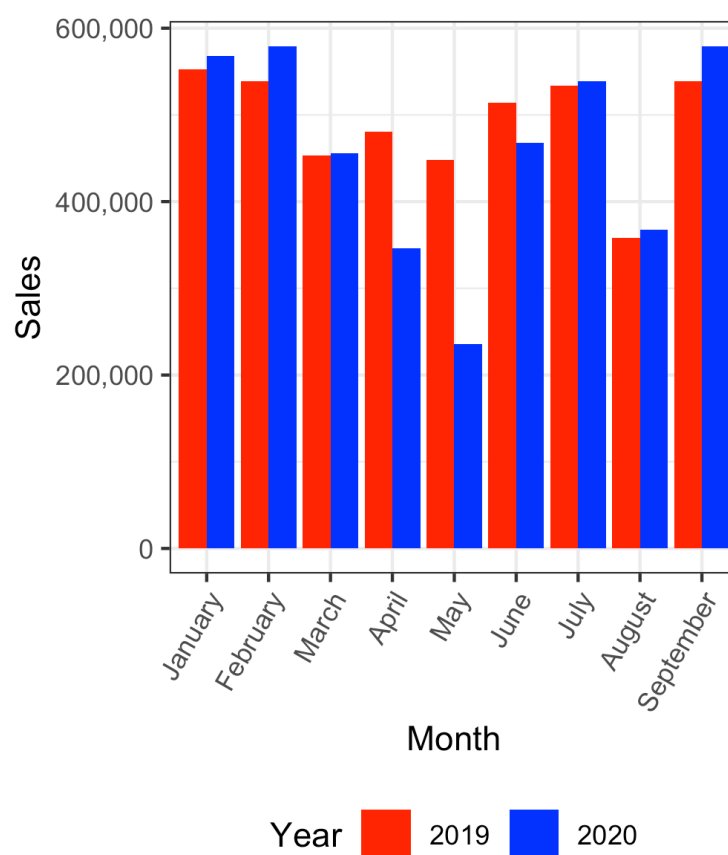


Figure 3. Changes in the overall sales volume for phosphodiesterase type 5 inhibitors between 2019 and 2020 (January–September for both years).

Overall, sales of PDE5i were not significantly reduced between 2019 and 2020 ($p = 0.453$). However, when correcting the effect of lockdown based on sales from 2019, a significant effect of lockdown was found ($p = 0.0292$), showing a dramatic and unique decrease in PDE5i sales (Table 4).

Table 4. Regression analysis for the overall change in phosphodiesterase type 5 inhibitors between 2019 and 2020.

Term	Estimate	Std. Error	p
(Intercept)	−21,547.22	213,126.30	0.0092
Lockdown	−122,479.73	52,528.88	0.0292
2019 Sales	1.06	0.42	0.0218

Adjusted R^2 : 0.434.

4. Discussion

We report that general interest towards erectile dysfunction (ED) and premature ejaculation (PE) did not change during lockdown, but a significant, U-shaped trend was found for queries for sildenafil and tadalafil, using either the molecule or the most common brand name. Sildenafil and tadalafil are the most frequently preferred treatments for ED, possibly owing to the higher efficacy and lower rate of adverse events for these drugs [41,42]; however, several other factors should be considered, such as the brand name recognition, the possibility of once-daily tadalafil administration [43], or the availability of the discrete, intimacy-sparing orodispersible film sildenafil formulation [44,45]. PDE5i have also been considered as candidate treatments for COVID-19 [46,47], owing to the effects on endothelial function. Interestingly, while the absence of changes in searches for vardenafil corresponds to the long and current lack of availability in the Italian market of its

brand name, indirectly proving the sensitivity of the method we used, the similar profile of the avanafil could be better explained by the peculiar characteristics of this drug. Avanafil is a second-generation PDE5i with a peculiarly good balance between efficacy and tolerability profile [48,49]; however, compared to other PDE5i, Avanafil is more rarely sought after by patients and is instead more frequently prescribed by physicians [50]. Similarly, another drug largely prescribed in the andrological context, i.e., dapoxetine, the unique, approved oral treatment for PE [51], was not affected by the lockdown and by the social and personal anxiety generated by the pandemic. Additionally, another possible explanation for this comes from the presence of several off-label treatments for PE, including selective serotonin reuptake inhibitors (SSRIs) and local anesthetics [51].

The lack of any significant trend on ED and PE is not surprising: indeed, in several fields of healthcare, a significant increase in queries for self-medication was observed [52,53] despite no significant change in search volume for the underlying conditions. Likewise, it has often been mentioned that the overall quality of information pertaining to andrological health is generally poor [54,55]. Additionally, we also hypothesize that PDE5i have become so widespread that most subjects self-diagnosing ED would look online for treatments rather than for confirmation of their diagnosis: this is partly confirmed by the increasing prevalence of counterfeit PDE5i being sold online [56–58]. Therefore, the declining trend observed for sildenafil and tadalafil queries during lockdown acts as a surrogate marker of reduced interest in treatment of sexual dysfunctions and, therefore, also a further proof of the worsening of the overall sexual health we demonstrated in the Italian population during confinement [22]. While the prevalence of sexual dysfunctions remained stable (or possibly increased even more among the young [21,22,59,60]), at the same time, people were not actively looking for treatments: the decrease in total PDE5i units being sold in this same time frame further proves this hypothesis. In these regards, it is also possible that fewer sexual intercourse occasions due to restriction measures reduced the sense of bother experienced by subjects with sexual dysfunctions [61]. However, as sexual health provides invaluable information concerning the well-being of individuals [62,63], failing to identify such dysfunctions could possibly contribute to worse overall health.

The effects of lockdown on sexual health can also be assessed by investigating other sexual behaviors. In this regard, the trend for Pornhub queries is a surrogate marker of pornography use. Our findings suggest that, during lockdown, interest for sexually explicit material rose abruptly, further strengthening claims of increased use of sexually explicit contents by the popular media and other researchers [64]. During the COVID-19 outbreak, Pornhub offered free premium subscription to users—first in selected countries, then worldwide: this policy, aimed to ease the burden of isolation for all those who could not have sex due to containment measures, is undoubtedly one of the main drivers for the increase in search volume during lockdown [65]. However, despite a significant decline in the following weeks, interest for pornography remained high, with only a minimum decline compared to lockdown, suggesting that, in fact, the free premium policy could not be considered the unique reason for increased search volume. Statistical data provided by Pornhub also suggest that a moderate increase in website traffic was present since at least the beginning of March [66]. In our opinion, pornography and masturbation (another parameter which has been found increased during the Italian quarantine) might be acting as coping mechanisms during isolation [22,67–70] although the potential for an increased prevalence of problematic pornography use should also be considered [65,71,72]. Additionally, confinement is associated with boredom [73], which has been associated in turn with greater pornography use [74]: it is therefore likely that even following the end of lockdown, subjects who were self-isolating and/or working remotely could have had found a way to escape boredom by using pornography. This was also found for other lifestyles often associated with lack of social contacts: loneliness and apathy, such as smoking, inappropriate dietary habits, and physical inactivity [75–78].

The hypothesis that pornography and masturbation are acting as coping mechanisms during lockdown [67–70] fits well with our findings on searches for female sex workers

and dating apps in the time frame immediately after the end of restriction measures. The initial decrease for both conditions can be undoubtedly associated with the restrictions of movement promoted by the government. While the interest towards pornography soared during lockdown, as there was no way to meet in person, the interest towards both escorts and partners met through dating apps declined; however, it increased once again following the end of lockdown. This phenomenon is worrying for public health, considering that while lockdown measures were lifted, the risk of contracting SARS-CoV-2 during sex was still present; therefore, the increased interest towards casual or paid sex is suggestive of a decreased perception of the risk of contagion. Additionally, as proven by correlation analysis, we found that the increased interest for the Tinder and escort keywords was mirrored by a similar increase in the search volume for some PDE5i, suggesting a common mechanism. Once again, it is likely that people look for a coping mechanism to reduce anxiety and likely depression symptoms [22] either by pornography and masturbation during lockdown or by casual or paid sex during the post-lockdown phase. However, to some extent, it can also be hypothesized that this lust for sex may reach, in some subjects, the traits of hypersexual behavior characterized by compulsivity and obsession towards sex [79,80] in spite of the potential risks to one's own health; since hypersexuality is a known reaction to trauma [81], this finding would be in agreement with the assumption of COVID-19 as a traumatic event [9–11]. Overall, these findings would also explain the return to pre-lockdown levels for queries pertaining to casual or paid sex or for search volume for proerectile treatments following the end of restriction measures.

The present study is, to our best knowledge, the first one to investigate peculiar aspects of the sexual behavior of the population of the first Western nation exposed to severe lockdown. The findings are fitting with current evidence on the consequences of COVID-19 lockdown and social distancing measures on sexual function and highlight an overall decline in social sexual health, with potential repercussions on psychological health and relational status.

However, this investigation also has some limitations: data provided from GT are expressed as relative search volume rather than absolute and are anonymous and, therefore, not allowing analysis based on subgroups, e.g., according to gender, sexual orientation, or location. This limitation is due to how GT provides data to the end-user: in order to obtain more adequately tailored results, it would be necessary to use other pieces of software if available or surveys on distinct sub-populations, which could be influenced by recall bias, selection bias, and Hawthorne effect. Additionally, age and socioeconomic status might influence the results, as younger and wealthier individuals might have better access to the Internet, and more tech-savvy users might instead use private browsing. Another limitation comes from the impossibility to discern the intended use for Tinder: it has been reported that many users look for stable relationships on Tinder [82] rather than casual sex. Likewise, also based on current literature [83,84], we assume that escort is a keyword pertaining to male heterosexual behavior although we cannot exclude that females or non-heterosexual subjects used the same search queries. A further study on the female and non-heterosexual people is warranted: e.g., investigating data from GT on the consumption of oral contraceptives and vaginal lubricants could provide much needed data concerning female sexuality. Additionally, investigating the same findings on a larger scale could possibly improve our knowledge on the topic.

5. Conclusions

In conclusion, by investigating the trends for online queries concerning PDE5i, we were able to prove that during lockdown the overall social sexual health of Italian men declined and that, as soon as lockdown restrictions were lifted, their interest for sexual health was swiftly rekindled. The decrease in Google queries for pro-erectile medications together with the sales reduction is a clear sign of reduced health-seeking behaviors in Italy, possibly because of lockdown rather than of a reduced prevalence of sexual dysfunctions that indeed have been found to be significantly increased [22] in the same

context. Several factors could contribute to a decreasing interest in sexual activity, including other Coronavirus-related worries, such as unemployment, isolation, constriction, and fear; however, this phenomenon might further contribute to an overall worse psychological status, as sexual activity can act as a coping mechanism towards depression and anxiety.

Additionally, our findings are relevant not only for sexual medicine but also for public health, considering the association between specific sexual behaviors and SARS-CoV-2 spread. The increase in public interest towards casual and paid sex suggests that people started looking for potential hookups and dates immediately after lockdown measures were lifted despite the possible risks of contracting COVID-19. In a nod towards the 1987 music scene, we believe that our results are more along the lines of REM's "it's the end of the world, and I feel fine" rather than Madonna's "Italians do it better".

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