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ORIGINAL ARTICLE

Severe COVID-19 has low testosterone, estrogen levels, and impaired sexuality

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Serum estradiol and total testosterone

Summary For assessing whether women with and without COVID-19 differed with regard to female genital self-image, sexual function and hormonal profile. Female genital self-image being assessed with the female genital self-image scale (FGSIS) and Female Sexual Function Index (FSFI) and laboratory investigations. The study had revealed significant differences in all domains of the FSFI except pain between the cases and the controls. The study had demonstrated significant differences in all domains of the FGSIS between the cases and the controls. The study had shown significant decline in the post-COVID-19 serum levels of total testosterone (TT), free testosterone (FT) and estradiol (E) between the two groups ($P < 0.05$). Positive correlations between serum TT, FT, E and FGSIS domains and total score of FGSIS in the cases were observed.

Introduction

The World Health Organization (WHO) demonstrates that Coronavirus 2019 (COVID-19) causes severe acute respiratory syndrome with severe acute respiratory coronavirus 2 (SARS-CoV-2) from humans to humans, worldwide (Park, 2020; Wang et al., 2020). The disease of SARS-CoV-2 infection was considered as a pandemic on 11th March 2020, due to rapid spread and deaths in many countries (Park, 2020). This highly contagious disease characterized with fever, dry cough, muscle aches, fatigue and shortness of breath. Currently, measure available for managing COVID-19 is covering the mouth and nose with mask, hand washing and maintaining social distance, can decrease burden of disease, stay-at-home and even a mandatory quarantine (Considerations Relating to Social Distancing Measures in Response to COVID-19 — Second Update, 2020; Wilder-Smith & Freedman, 2020).

Female Sexual dysfunction is a common distressing disorder that affects the quality of lives. This affects female sexual interest/arousal disorder, hypoactive sexual desire disorder, genito-pelvic pain/penetration disorder and female orgasm disorder (The Impacts of Isolation Measures Against SARS-CoV-2 Infection on Sexual Health, n.d.). COVID-19 can affect sexual health and function (Shaeer et al., 2020).

Female genital self-image is an imperative pillar of sexual esteem, satisfaction, behavior, performance and psychoso-

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cial health (Mori et al., 2020; Pampati et al., 2020). Because sexual health is an imperative pillar of people's well-being, it is thought that sexual contact will be affected negatively (Anis et al., 2011). Social measures taken in facing this contagious disease will change the social interactions and sexual life behaviors (Schiavi et al., 2020). Being contacting with COVID-19 also raised the negative effects on the sexual function and genital self-image of women. Therefore, sexual and reproductive health should also be involved in the pillar of COVID-19 management. Universal health coverage should include women. Thus, we aimed in the current prospective cohort study to investigate the effect of COVID-19 on female sexual function and female genital self-image as well as serum levels of total testosterone (TT), free testosterone (FT) and estradiol (E).

Material and methods

The current prospective study was conducted on women who contracted COVID-19 and admitted to a tertiary hospital from January (2021) to March (2021). The study was conducted in accordance with the Helsinki Declaration guidelines (1964) after receiving institutional review board approval. All participants provided written informed consent and were between 18—60 years old. Any case invited to join the present study was diagnosed of having COVID 19 after the results of the reverse transcription polymerase chain reaction (RT-PCR) test of pharyngeal and nasal swabs performed due to suspected COVID-19 infection. The criteria of the COVID-19 guidelines in determining the severity of COVID-19 stated by Xu et al. (2020) were strictly followed up. The guidelines of strengthening of observational studies in epidemiology (STROBE) were adhered to (Fig. 1).

Inclusion criteria of the patients

Sexually active women who had finalized the management protocol, discharged and had no past history of sexual dysfunction.

Exclusion criteria of the patients

Any patient who had a history of incontinence, being pregnant, on a current management protocol for COVID-19, having a history of pelvic organ prolapses, being on hormonal contraception or intrauterine devices or contraception implants, antidepressant medication or having a chronic illness that impairs sexual performance or hormones as (PCOS or any other form of hyperandrogenism) were excluded. All psychological elements were excluded using the Diagnostic and Statistical Manual of Mental Disorders, 4th Edition, published by the American Psychiatric Association.

Inclusion criteria of the controls

They were age matched healthy sexually active females in a committed relationship not on hormonal contraception and not on any long-term medications for any chronic illness. After computer-based randomization, as controls, 100 healthy volunteer women were used. Controls were selected from close associates of the cases, such as friends and relatives who were attending with the patients or healthy escorts of dermatology patients attending the dermatology outpatient clinic.

Between the specified time intervals, 462 women were admitted to the hospital. Following the exclusion criteria, the remaining cases totaled 250, with only 135 completed the study (Fig. 1). All of them hospitalized for two weeks and completed the treatment protocol. On hundred healthy volunteer women served as controls. The structured interview took place for the patients at the isolation hospitals and compared with medical reports. One month later; the patients were contacted via telephone to attend the second structured interview. All the participants were subjected to: Detailed history taking, clinical examination, the Arabic version of the Female Sexual Function Index (ArFSFI) (Anis et al., 2011) and Arabic version of Female Genital Self-Image Scale (ArFGSIS) (Mohammed and Hassan, 2014) were used to evaluate the sexual function and the genital self-image for the participants & laboratory investigations.

All participants filled in the questionnaires by themselves and results were where compared to medical records. In the ovulatory period (D8 to D15) a blood sample of 5 mL was obtained from each participant in order to assess sex hormone binding globulin (SHBG), TT, FT and E.

Measurement of TT, FT and E was done by (VIDAS®, BIOMERIEUX SA, Marcy-l'Étoile, France). Normal range for TT 0.06—0.82 ng/mL, for FT 0.04—4.0 pg/mL, and for E (Follicular) 12.5—166.0 pg/mL. Periovulatory (± 3 days) 43.8—166 pg/mL Luteal 1.7—27.0 pg/mL. SHBG analysis was determined by immunoassay (DPC, Los Angeles) with a normal range of 18—114 nmol/L.

The sensitivity of the assays was expressed as a minimal amount of the hormones distinguishable from the zero sample with 95% probability and the intra-assay and inter-assay coefficients of variation for TT, FT, E and SHBG.

All individuals had performed blood tests in the same laboratory, using the same technique, at the same (approximate) time. This was carried out in the middle of the menstrual cycle (days 8—15). Blood was drawn from all women between 0800 and 1200 and stored at −20 °C for a period of 1—30 days until assayed.

Statistical analysis

For data analysis, SPSS software system version 25 (SPSS Inc, Chicago, IL, USA) was used. The quantitative data were presented as mean, standard deviation (SD), while the qualitative data were presented as percentages and frequency. The Kolmogorov—Smirnov was used to verify the normality of the variables distribution. The paired *t*-test was used to compare data with a normal distribution, while the Wilcoxon signed ranks test was used to compare data that did not have a normal distribution. ANOVA test was used to compare data means of two or more groups. A median (minimum—maximum) was used for data that did not show the normal distribution. $P < 0.050$ was considered significant. The Mann—Whitney test was used to compare continuous data. The Kruskal—Wallis test was used to assess the independent effects of multiple categorical variables because

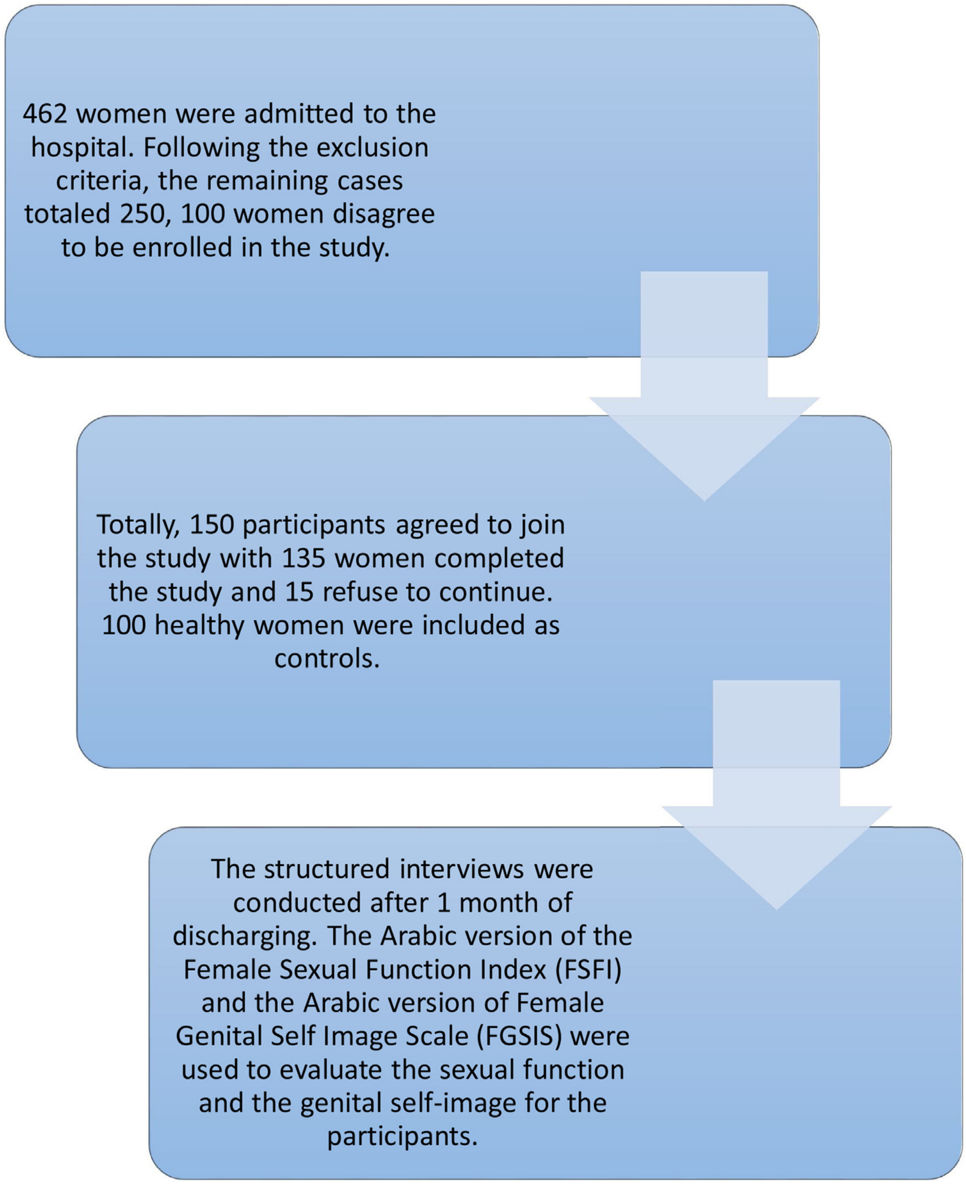

Figure 1 Shows the flowchart of the study.

a standard distribution of the data could not be assumed. Testing mean 1 = mean 2 (versus $\neq$), Calculating power for mean 1 = mean 2 + difference $\alpha = 0.05$ Assumed standard deviation = 4. Target power is 0.9. Actual power 0.910232.

Results

The biographic, anthropometric, hematological and basic biochemical characteristics of the study population summarized in Tables 1 and 2. The groups were matched for age, BMI, smoking and duration of marriage without significant differences. Interestingly, the study had shown a significant decline in the frequency of sexual intercourse/week in the cases compared to the controls $P < 0.05$ (Table 1).

There were significantly lower mean values of WBC, lymphocytic count, total protein and albumin (3.9 ± 1.3, 0.91 ± 0.2, 5.9 ± 0.5 and 2.5 ± 0.1, respectively) among study group than control group (6.1 ± 1.1, 1.12 ± 0.5, 7.1 ± 0.2, and 2.9 ± 0.2), $P < 0.05$ (Table 2).

Additionally, there were significantly higher mean values of CRP, ESR, ferritin, ALT and AST among patients in the study group (99 ± 56, 79.7 ± 23.3, 389 ± 87.5, 36 ± 5.2, and 41 ± 1.2, respectively) when compared with controls (42 ± 11, 12.7 ± 11.3, 246 ± 36.8, 22 ± 1.8, and 24 ± 2.1, respectively), $P < 0.05$ (Table 2). All of the patients' and controls' SHBG levels were within normal ranges (33—97 nmol/L). Also, post-COVID-19 serum levels of TT, FT and E showed significant decreasing differences versus controls ($P < 0.05$) (Table 3).

Furthermore, the study had revealed significant differences in desire (4.5 ± 1.74; 3.21 ± 2.22; 4.4 ± 1.51; $P = 0.011$), arousal (4.14 ± 2.48; 3.51 ± 2.14; 5.14 ± 2.14; $P = 0.045$), lubrication (5.23 ± 1.18; 2.11 ± 1.13; 5.11 ± 2.14;

Table 1 Distribution of women's demographic characteristics.

	Study group		Control group		Significance test
	Frequency (*n*)	Percent (%)	Frequency (*n*)	Percent (%)	
Age	41.6 ± 5.6		37.5 ± 5.6		399.296
BMI					
Underweight < 18.5	0	–	0	–	653.116
Normal 18.5–24.9	130	96.3	95	95	
Over weight 25–29.9	5	3.7	5	5	
Obese 30–34.9	0	–	0	–	
Extremely obese 35 <	0	–	0	–	
Smoking					
Yes	98	72.6	89	89	453.116
No	37	27.4	11	11	
Residence					
Rural	99	73.3	60	60	469.286
Urban	36	26.7	40	40	
Religion					
Muslim	105	77.8	77	77	789.254
Non-Muslim	30	22.2	23	23	
Sexual orientation					
Heterosexual	134	99.3	100	100	269.366[a]
Lesbian	0	–	0	–	
Bisexual	1	0.7	0	–	
Other	0	–	0	–	
Living together in a stable relationship					
Yes	135	100	100	100	729.526[a]
No	0	–	0	–	
Duration of marriage (years)					
< 15	70	51.9	46	46	549.231
≥ 15	65	48.1	54	54	
Sexual intercourse frequency					
1–2 times a week	112	83	3	3	659.243[a]
3–4 times a week	20	14.8	30	30	
> 4 times a week	3	2.2	67	67	
Education					
Middle school	36	26.6	30	30	349.126
High school	30	22.2	9	9	
Associate degree	45	33.3	38	38	
University	24	17.9	23	23	
Profession					
Civil servant	59	43.7	25	25	289.436
Worker	33	24.4	29	29	
Housewife	30	22.2	26	26	
Other	13	9.7	20	20	
Chronic illness					
No	135	135	100	100	249.351
Other	0	–	0	–	
Complaint					
Cough	88	65.1	–	–	
Diarrhoea	33	24.4	–	–	
Fever	88	65.1	–	–	
Muscle pain	52	38.5	–	–	
Loss of smell	45	33.3	–	–	
Vomiting	23	17.03	–	–	
Loss of taste	28	20.7	–	–	
Sore throat	29	21.4	–	–	
Mild headache	31	22.9	–	–	
Fatigue/weakness	34	25.1	–	–	

[a] Statistically significant at $P < 0.05$.

Table 2 Hematological and Biochemical characteristics of women at admission.

Variables	Study group (Mean ± SD)	Control group (Mean ± SD)	Significance test
Hb (g/dL)	12.5 ± 0.8	12.8 ± 1.2	532.554
WBC (×103 mm^{-3})	3.9 ± 1.3	6.1 ± 1.1	332.214[a]
Lymphocytic count (×103 mm^{-3})	0.91 ± 0.2	1.12 ± 0.5	461.232[a]
CRP (mg/dL)	99 ± 56	42 ± 11	363.563[a]
ESR	79.7 ± 23.3	12.7 ± 11.3	592.114[a]
Ferritin (ng/mL)	389 ± 87.5	246 ± 36.8	132.994[a]
Serum creatinine (mg/dL)	1.13 ± 0.8	0.6 ± 0.3	132.511[a]
Total protein (g/dL)	5.9 ± 0.5	7.1 ± 0.2	192.724[a]
Albumin (g/dL)	2.5 ± 0.1	2.9 ± 0.2	422.511[a]
ALT (IU/L)	36 ± 5.2	22 ± 1.8	589.717[a]
AST (IU/L)	41 ± 1.2	24 ± 2.1	313.545[a]

SD: standard deviation; Hb: hemoglobin; WBC: white blood cell count; CRP: C-reactive protein; ESR: erythrocyte sedimentation rate; ALT: alanine aminotransferase; AST: aspartate aminotransferase.
[a] Statistically significant at $P < 0.05$.

Table 3 Comparison of hormonal characteristics in the study and control groups.

Hormonal profile	Min.	Mean ± SD	Max.	*P*
Free testosterone				
pg/dL				
1st measure COVID-19 group	0.23	0.22 ± 0.11	0.35	< 0.001[a]
2nd measure COVID-19 group	0.11	0.12 ± 0.31	0.26	
Control group	0.19	0.24 ± 0.13	0.42	
Total testosterone				
ng/dL				
1st measure COVID-19 group	0.06	0.71 ± 1.1	0.65	< 0.001[a]
2nd measure COVID-19 group	0.08	0.39 ± 4.5	0.55	
Control group	0.07	0.73 ± 2.1	0.69	
Estradiol				
pg/mL				
1st measure COVID-19 group	52	89.8 ± 77.1	140	< 0.001[a]
2nd measure COVID-19 group	41	75.1 ± 17.6	147	
Control group	40	87.4 ± 75.4	150	

P: *P*-value for comparing between the studied group.
[a] Statistically significant at $P \leq 0.05$.

$P = 0.004$), orgasm (5.25 ± 2.13; 1.23 ± 1.12; 5.23 ± 1.21; $P = 0.001$), satisfaction (4.12 ± 1.42; 2.23 ± 2.11; 5.11 ± 2.15; $P = 0.010$) except pain (5.45 ± 2.32; 4.10 ± 2.12; 5.12 ± 2.42; $P = 0.303$) between the cases and the controls (Fig. 2). Additionally, the study had demonstrated significant differences in all domains of the FGSIS; satisfaction with the appearance of their genitals (3.5 ± 0.4; 2.8 ± 0.76; 4.0 ± 0.2; $P = 0.047$), feeling comfortable letting a sexual partner look at their genitals (3.7 ± 0.5; 2.5 ± 0.3; 3.9 ± 0.2; $P = 0.001$), thinking that their genitals smell fine (3.7 ± 0.4; 2.2 ± 0.3; 4.0 ± 0.5; $P = 0.002$), and being not embarrassed about their genitals (3.8 ± 0.7; 3.2 ± 0.3; 4.0 ± 0.5; $P = 0.025$) between the cases and the controls (Fig. 3). Interestingly, our study had shown positive correlations between serum FT, TT and E and both FGSIS domains and its total score in the patients group ($P < 0.05$) (Table 4). There was a gradient decline in the mean serum TT level according to the severity of COVID-19 (0.60 ± 4.11; 0.41 ± 3.41; 0.25 ± 3.35, respectively), which showed a significant statistical difference ($P = 0.01$) (Table 5). As well as there was also a gradient decline in the mean serum FT level according to the severity of COVID-19 (0.17 ± 5.11; 0.11 ± 4.11; 0.07 ± 2.12, respectively), which showed a significant statistical difference ($P = 0.01$) (Table 4). Also, there was a gradient decline in the mean serum E level according to the severity of COVID-19 (72.1 ± 22.2; 56.1 ± 22.7; 47.5 ± 76.1, respectively), which also showed a significant statistical difference ($P = 0.03$) (Tables 4 and 5). Moreover, there were significant differences in the mean desire (4.11 ± 2.51; 3.10 ± 1.01; 1.23 ± 1.25, $P = 0.001$), arousal (5.12 ± 1.15; 3.45 ± 1.25; 2.12 ± 1.12, $P = 0.041$), lubrication (4.83 ± 1.11; 3.17 ± 1.82; 3.51 ± 1.11, $P = 0.050$), orgasm (4.98 ± 1.11; 3.82 ± 1.78;

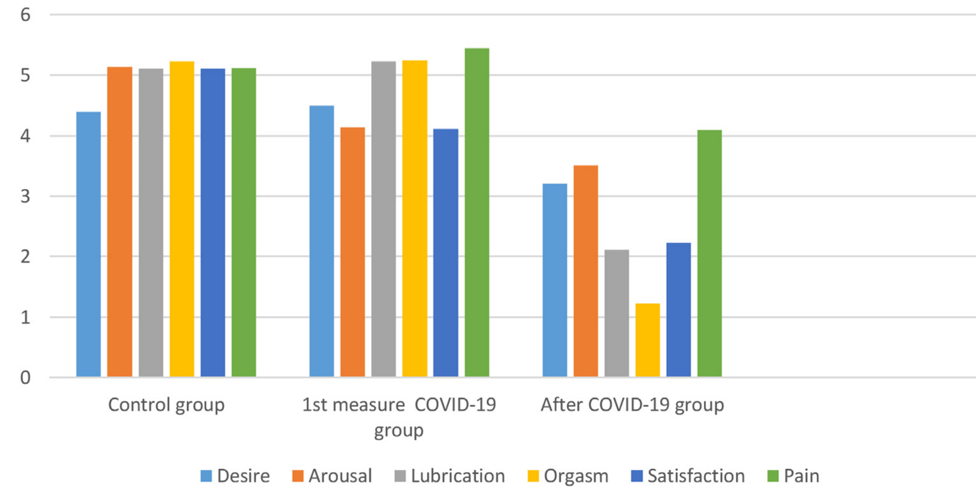

Figure 2 Comparison of the female sexual function index (FSFI) between groups.

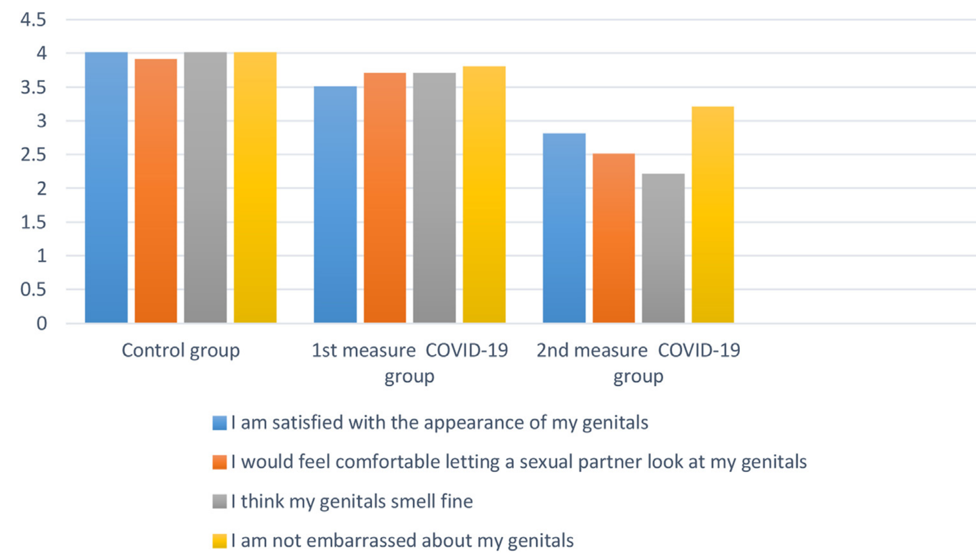

Figure 3 Comparison of the female genital self-image scale (FGSIS) between control and study groups.

Table 4 Correlation between FGSIS domains and hormonal profile in control and study groups.

FGSIS domains	Hormonal profile [free testosterone, total testosterone and estradiol]		Sign. test	*P*-value
	Study group	Control group		
I am satisfied with the appearance of my genitals	2.3 ± 0.41	3.8 ± 0.30	0.451[a]	0.02*
I would feel comfortable letting a sexual partner look at my genitals	2.1 ± 0.2	3.7 ± 0.56	0.763[a]	0.01*
I think my genitals smell fine	2.3 ± 1.3	3.9 ± 0.64	0.254[a]	0.03*
I am not embarrassed about my genitals	2.7 ± 0.5	4.0 ± 0.40	0.421[a]	0.03*
Total	6.8 ± 0.5	13.1 ± 0.8	0.435[b]	0.04*

FGSIS: Female genital self-image scale.

* Statistically significant at $P \leq 0.05$.
[a] Kruskal–Wallis Test.
[b] Mann–Whitney U Test.

Table 5 Relationship between disease severity classification system for COVID-19 and hormonal profile in study groups.

Variables	Disease severity classification system for COVID-19			Test statistics	*P*-value
	Mild	Moderate	Severe		
Hormonal profile					
Total testosterone ng/dL	0.60 ± 4.11	0.41 ± 3.41	0.25 ± 3.35	0.651	0.01[a]
Free testosterone pg/dL	0.17 ± 5.11	0.11 ± 4.11	0.07 ± 2.12	0.843	0.01[a]
Estradiol pg/mL	72.1 ± 22.2	56.1 ± 22.7	47.5 ± 76.1	0.484	0.03[a]
Female sexual function scale					
Desire	4.11 ± 2.51	3.10 ± 1.01	1.23 ± 1.25	2.105	0.001[a]
Arousal	5.12 ± 1.15	3.45 ± 1.25	2.12 ± 1.12	3.559	0.041[a]
Lubrication	4.83 ± 1.11	3.17 ± 1.82	3.51 ± 1.11	2.016	0.050[a]
Orgasm	4.98 ± 1.11	3.82 ± 1.78	1.21 ± 1.23	1.201	0.001[a]
Satisfaction	3.54 ± 2.13	2.48 ± 2.12	2.23 ± 1.71	1.001	0.011[a]
Pain	4.41 ± 2.12	3.46 ± 1.12	3.51 ± 2.51	3.988	0.073
Total	24.81 ± 4.51	20.01 ± 6.51	17.41 ± 5.51	2.574	0.040[a]
FGSIS					
I am satisfied with the appearance of my genitals	3.4 ± 0.20	3.8 ± 0.76	2.4 ± 0.46	3.011	0.050[a]
I would feel comfortable letting a sexual partner look at my genitals	3.4 ± 0.20	4.0 ± 0.20	2.5 ± 0.3	2.751	0.001[a]
I think my genitals smell fine	3.8 ± 0.50	4.0 ± 0.30	2.2 ± 0.3	2.729	0.003[a]
I am not embarrassed about my genitals	4.0 ± 0.50	3.6 ± 0.30	2.6 ± 0.3	2.334	0.043[a]
Total	11.1 ± 0.7	9.2 ± 0.5	6.4 ± 0.3	4.254	0.02[a]

[a] Significant values ($P \leq 0.05$).

1.21 ± 1.23, $P = 0.001$), satisfaction (3.54 ± 2.13; 2.48 ± 2.12; 2.23 ± 1.71, $P = 0.011$) domains and total score (24.81 ± 4.51, 20.01 ± 6.51, 17.41 ± 5.51, $P = 0.040$) of the FSFI according to the severity of COVID-19 (Table 5).

Finally, there were significant differences in the mean satisfaction with the appearance of their genitals (3.4 ± 0.20, 3.8 ± 0.76, 2.4 ± 0.46, $P = 0.050$), feeling comfortable letting a sexual partner look at their genitals (3.4 ± 0.20, 4.0 ± 0.20, 2.5 ± 0.3, $P = 0.001$), thinking that their genitals smell fine (3.8 ± 0.50, 4.0 ± 0.30, 2.2 ± 0.3, $P = 0.003$), being not embarrassed about their genitals (4.0 ± 0.50, 3.6 ± 0.30, 2.6 ± 0.3, $P = 0.043$) and total score (11.1 ± 0.7, 9.2 ± 0.5, 6.4 ± 0.3, $P = 0.02$) according to the severity of COVID-19 (Table 5).

FGSIS and FSFI

Correlation of different FSFI domains with the total score on the FGSIS revealed a significant correlation with desire, lubrication, orgasm, and satisfaction domain (*P*-values < 0.05); desire ($r = 0.015$), arousal ($r = 0.505$), lubrication ($r = 0.021$), orgasm ($r = 0.012$), satisfaction ($r = 0.041$), and pain ($r = 0.202$). So, the genital self-image was significantly as affected as sexual function.

Discussion

In the current study, women who contracted COVID-19 had a significant decrease in the frequency of sexual intercourse, as well as a significant decrease in all domains of the FSFI except the pain domain, when compared to the controls. This significant decline can be attributed to significant declines in the serum levels of TT, FT and E as well as the negative impact of the lock down measures imposed by the pandemic situation. Also, this may be attributed to the cytokine storm and multiple organ failure induced by COVID-19 (Tang et al., 2020; Mehta et al., 2020; Jose & Manuel, 2020; Wright, 2020; Iba et al., 2020). In the same context, Li et al. (2020) and Panzeri et al. (2020) and Omar et al. (2021) have shown similar results. On the contrary, Yuksel and Ozgor (2020) found an increase in the frequency of sexual intercourse. However, in the aforementioned study (Yuksel and Ozgor, 2020) the quality of sexual life decreased during the pandemic. Our study had shown significant decline in desire, and arousal in the cases post-COVID-19 compared to baseline and was significantly lower than that in the controls.

Additionally, Feng et al. (2020) had demonstrated a decline in the sexual frequency of subjects during confinement compared with those before the COVID-19 outbreak that could be seen similar to our finding (Feng et al., 2021). Even non-infected sexually active women during the COVID-19 pandemic had shown similar findings (Schiavi et al., 2020). Quietly the reverse, Yuksel and Ozgor (2020) had shown increased frequency of sexual intercourse (Yuksel and Ozgor, 2020). However, the quality of sexual life during the pandemic decreased in the aforementioned study (Yuksel and Ozgor, 2020). Living together in stable relationship help is spreading infection. Although our study had shown a significant decline in desire, yet, decline in arousal was insignificant. Moreover, it should be noted that arousal declined in cases post-COVID-19 compared to the baseline and was lower than that in the controls. The discrepancy in the results of desire and arousal in our cases can raise the debate and substantial confusion in literature between either merging desire and arousal in a single entity (Meston et al., 2020) or dealing with them as distinct disorders (Meston et al., 2020; Parish et al., 2019; Reed et al., 2016). In contrast, Yuksel and Ozgor (2020) and Micelli et al. (2020) had shown an increase in the sexual desire between men and women during the COVID-19 outbreak. However, Feng et al. (2020) demonstrated unchanged desire and satisfaction in the majority of their target population (Feng et al., 2021). Furthermore, the mean score of pain reduced in our affected cases post-COVID-19 and was lower than that in the controls, yet, this difference was insignificant. This finding can be explained by the following facts. Firstly, a clinical cutoff score has not yet been determined for the pain domain (Meston et al., 2020). Secondly, we do not precisely have the pre-COVID-19 clinical cutoff score of pain in our cases. Even though the current study had demonstrated significant decline in the remaining domains of sexual function in the cases that can be attributed to significant declines in the serum levels of TT, FT and E (Motta-Mena and Puts, 2017). Moreover, James and Zachary (2013) found that estradiol positively affected the sexual desire especially during mid-cycle peak (Roney and Simmons, 2013). The present study is one of a few studies that had demonstrated a potential impact of COVID-19 on serum levels of TT, FT and E in females affected by COVID-19 and their correlations with the severity of COVID-19. On the one hand, an early Chinese study demonstrated similar finding as it revealed that women with low estrogen levels had more severe infection with COVID-19 (Ding et al., 2020). This can be explained by the fact that ovarian injury may be induced directly by COVID-19 binding to the angiotensin converting enzyme 2 (ACE2) receptor and entering the cell through transmembrane serine protease 2 (TMPRSS2), leading to a cytopathic effect mediated by local replication of the COVID-19 (Jing et al., 2020). This may also be induced by the severe illness in the form of multiple organ failure and cytokine storm theory that may happen during COVID-19 infection (Tang et al., 2020; Mehta et al., 2020; Jose & Manuel, 2020; Wright, 2020; Iba et al., 2020).

On the other hand, the current study had shown that mild and moderate cases of COVID-19 had higher levels of E compared to the severe cases which supports the theory that E plays a crucial role in protecting cells against infection through estrogen receptors that are present on all cells that fight infections (Ghosh and Klein, 2017). Additionally, estrogen improves the number, genetic programming and lifespan of all immune cells (Ghosh and Klein, 2017). Moreover, estrogen prevents the detrimental effect of the cytokines storm, which occurs in some people with severe COVID-19 infections by blocking the production of interleukin-6 (Trenti et al., 2018).

Waltner proposed the concept of genital identity in 1986, defining it as ''those self-definitions, self-attitudes, and subsequent feelings that arise from specific interactions and experiences that either indirectly or directly involve the genitals'' (Waltner, 1986). He proposed that genital identity could emerge from and be influenced by sexual interactions. Reinholtz and Muehlenhard discovered in 1995 that positive genital perceptions were associated with increased sexual engagement and enjoyment. Women's genital feelings and beliefs may be a particularly sensitive subject for some, given that women's genitals have traditionally been shrouded in secrecy and taboo (Braun and Wilkinson, 2001).

The perception of one's own genital appearance is a fundamental self-perception that influences one's ability to have meaningful sexual experiences (Amos and McCabe, 2016). There is a link between positive genital self-image and positive sexual function, according to research. Furthermore, genital self-image was considered as a tool for predicting a woman's behavior as her genital system was examined (Pakpour et al., 2014). Solati et al. (2005), on the other hand, concluded that infertile women's lack of self-confidence could lead to lower sexual satisfaction and, as a result, lower scores on the Genital Self-image Scale (Solati et al., 2006).

We found that women after COVID-19 has lower total FGSIS scores than normal healthy women (8.4 ± 0.4, and 14.1 ± 0.9; respectively), which were statistically and clinically different. It is an important concern, however, because women with COVID-19 have an increased risk of sexual complications, which may be due to hormonal imbalance (Berg and Denison, 2012). And Female sexual function is found to be strongly related to female genital self-image (Mohammed and Hassan, 2014). According to research, women with higher levels of genital satisfaction are more sexually active and engage in more sexual activity than women with lower levels of satisfaction (Rowen et al., 2018). This research has some limitations. Because this was an exploratory cross-sectional study, no conclusions about causation could be drawn. We, on the other hand, used a validated, reliability-tested scale, trained clinic staff, multivariate analyses, and a large sample size.

Conclusion

There is a potential link between COVID-19 and total testosterone, free testosterone and estradiol through which it negatively impacts sexual function together with the severe stress associated with COVID-19 as a result of the restrictions and lockdown measures imposed on the citizens because of the pandemic.

Disclosure of interest

The authors declare that they have no competing interest.

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