frontiers in Public Health

ORIGINAL RESEARCH
published: 25 May 2021
doi: 10.3389/fpubh.2021.645421

Changes in Mental Health of Women Undergoing Assisted Reproductive Technology Treatment During the COVID-19 Pandemic Outbreak in Xi'an, China

Pengfei Qu[1,2,3†], *Doudou Zhao*[1†], *Peng Jia*[4,5], *Shaonong Dang*[6], *Wenhao Shi*[1,2*], *Min Wang*[2*] and *Juanzi Shi*[1,2*]

[1] Translational Medicine Center, Northwest Women's and Children's Hospital, Xi'an, China, [2] Assisted Reproduction Center, Northwest Women's and Children's Hospital, Xi'an, China, [3] Departments of Pediatrics and Neonatology, Children's Hospital of Fudan University, Shanghai, China, [4] Department of Land Surveying and Geo-Informatics, The Hong Kong Polytechnic University, Hong Kong, China, [5] International Institute of Spatial Lifecourse Epidemiology (ISLE), Hong Kong, China, [6] Department of Epidemiology and Health Statistics, School of Public Health, Xi'an Jiaotong University Health Science Center, Xi'an, China

OPEN ACCESS

Edited by:
Wulf Rössler,
Charité – Universitätsmedizin Berlin, Germany

Reviewed by:
Chung-Ying Lin,
National Cheng Kung University, Taiwan
Judy E. Stern,
Dartmouth–Hitchcock Medical Center, United States

***Correspondence:**
Wenhao Shi
swihao@yeah.net
Min Wang
wangmin307158@163.com
Juanzi Shi
shijuanzi123@126.com

† These authors have contributed equally to this work

Specialty section:
This article was submitted to Public Mental Health, a section of the journal Frontiers in Public Health

Received: 23 December 2020
Accepted: 19 April 2021
Published: 25 May 2021

Citation:
Qu P, Zhao D, Jia P, Dang S, Shi W, Wang M and Shi J (2021) Changes in Mental Health of Women Undergoing Assisted Reproductive Technology Treatment During the COVID-19 Pandemic Outbreak in Xi'an, China. Front. Public Health 9:645421. doi: 10.3389/fpubh.2021.645421

Objective: To investigate the mental health of women undergoing assisted reproductive technology (ART) treatment during the novel coronavirus pneumonia (COVID-19) pandemic outbreak in Xi'an, China.

Methods: A repeated cross-sectional study was administered to women undergoing ART treatment during the outbreak period (599 women in February 2020) and the control period (892 women in May 2020) at the Northwest Women's and Children's Hospital, Xi'an, China.

Results: Both the ART-treated women surveyed during the outbreak period and those surveyed during the control period had high scores on the fear dimension (0.88, 0.51). The total scores for mental health among the participants during the control period were lower than those during the outbreak period (difference = −0.22; 95% CI = −0.25, −0.18). Lower scores were also seen during the control period, compared to those in the outbreak period, for depression (difference = −0.18; 95% CI = −0.23, −0.13), neurasthenia (difference = −0.31; 95% CI = −0.36, −0.25), fear (difference = −0.37; 95% CI = −0.43, −0.31), compulsion anxiety (difference = −0.13; 95% CI = −0.16, −0.09), and hypochondriasis (difference = −0.09; 95% CI = −0.12, −0.06).

Conclusions: During the COVID-19 global pandemic, the mental health of women undergoing ART treatment in Xi'an, China, was primarily manifested as fear. As the pandemic was brought under control, the mental health of ART-treated women improved. As evidenced by these results, the COVID-19 pandemic influences the mental health of women undergoing ART treatment, and clinicians should be aware of this for similar future situations.

Keywords: mental health, assisted reproductive technology, COVID-19, cross-sectional study, women

INTRODUCTION

A novel coronavirus pneumonia (COVID-19) outbreak occurred in Wuhan, Hubei, China, at the end of 2019 (1). Since February 2020, the COVID-19 pandemic has shown rapid global escalation, and the cumulative number of confirmed cases has exploded (2). On March 11, the World Health Organization (WHO) officially declared COVID-19 a pandemic. Difficulties in fighting this global public health issue have been increasing (3). At present, although the pandemic shows fluctuations in China, such as the recent local resurgences in Heilongjiang, Beijing, and Xinjiang, the overall situation has been under control.

However, this raging pandemic may have had a heavy impact on the mental health of people around the world. As in the cases of the outbreak of severe acute respiratory syndrome (SARS) in 2003 and Ebola in 2014, the public has generally felt fear and anxiety and has thus overreacted due to the uncertainty of the virus during the incubation period and its possible transmission by asymptomatic infections (4, 5). After its outbreak, different levels of strict control strategies have been undertaken to curb the pandemic, including a city closure in Wuhan and community-based prevention and control in other regions, which may have adverse socio-psychological effects on citizens (6). Social media platforms, such as Weibo, WeChat, and We-Media, have been delivering exhaustive information about the pandemic. Such an information overload may inconspicuously exert further psychological pressure on citizens, such as in the form of depression, anxiety, or post-traumatic stress disorder (7, 8), particularly among high-risk populations (e.g., survivors, front-line medical staff) (9).

Most of the current studies on the impact of COVID-19 or SARS on mental health have also shown that women are more likely to experience anxiety or depression and post-traumatic stress due to the pandemic (10–13). The increased difficulty in accessing antenatal care during the pandemic has led pregnant women to feel more concerned about the healthy development of their fetuses (14–16). With the development of reproductive medicine, an increasing number of infertile couples become pregnant through assisted reproductive technology (ART) [including *in vitro* fertilization (IVF) and intracytoplasmic sperm injection (ICSI)] around the world. However, undergoing ART treatment is psychologically and emotionally stressful for most patients and involves the possibility of perceived fear, distress, depression, or anxiety (17–20). Due to the complexity, long treatment cycle, and high costs associated with ART treatment, the mental health of women undergoing such treatment is vulnerable and necessitates closer attention. A cohort study in Taiwan prior to COVID-19 showed that ART-treated women's mental health status was worst in the first trimester and within 2 months following delivery (21). However, no relevant research has been conducted on the mental health of ART-treated women during the COVID-19 pandemic. To fill this gap, this study investigated changes in the mental health of ART-treated women during the COVID-19 pandemic in Xi'an, Shaanxi Province, China.

MATERIALS AND METHODS

Study Design and Population

Using an online psychological questionnaire, we conducted a repeated cross-sectional study during the outbreak period (February 2020) and the control period (May 2020) at the Assisted Reproduction Center of Northwest Women's and Children's Hospital in Xi'an, Shaanxi Province in northwestern China. In February 2020, 608 ART-treated women were invited to participate in the study, and nine refused, leaving 599 complete questionnaires. In May 2020, 909 ART-treated women were invited, and 17 refused. Therefore, a total of 1,491 complete questionnaires, 599 in February and 892 in May, were included in the final analysis.

Mental Health Assessment

The Psychological Questionnaire for Public Health Emergencies was used to assess the mental health of the ART-treated women recruited (22). There are 27 items in the questionnaire, which are divided into five dimensions: depression, neurasthenia, fear, compulsive anxiety, and hypochondria; each item corresponded to a specific question. For each item, the participant scored 0, 1, 2, or 3 based on the degree (no, mild, moderate, severe) and frequency (occasionally, sometimes, often, always) of the emotional reaction that occurred at the time of survey. The total score in each dimension was divided by the number of items in that dimension to calculate that dimension's score. The higher the score of a particular dimension, the more severe the emotional reaction in that dimension.

Covariates

Sociodemographic characteristics were also collected in the study. These characteristics include the participants' age ($<$30, 30–34.99, $\geq$35 years old), educational level (junior high school and below, high school/secondary school, college, or University and above), occupation (professional and technical personnel, administrative staff, workers/service staff, other, or unemployed), residence (city, town, or rural), family monthly income level ($<$2,500 yuan, 2,500–4,999 yuan, 5,000–9,999 yuan, or $\geq$10,000 yuan), number of children in the family (0 or $\geq$1), and phase of ART treatment (before IVF treatment, first cycle of IVF, second cycle of IVF, or third and later cycle of IVF).

Statistical Analysis

The participants' sociodemographic characteristics were summarized using counts and proportions for categorical variables. Chi-squared tests were performed to compare the categorical variables. Mental health scores were described using mean and standard deviation for continuous variables, and analysis of covariance as well as a Wilcoxon rank test or Kruskal-Wallis test were performed to compare continuous variables. The univariate and multivariate generalized linear

model was used to analyze the difference in mental health scores between the two waves. Additionally, a generalized linear model was used for subgroup analysis. Statistical analyses were executed with the SAS software package (version 9.4, SAS Institute Inc., Cary, NC, USA). All *P*-values were two-sided with a significance level of <0.05.

RESULTS

Sociodemographic Characteristics

Forty women participated in both participant groups. The majority of participants were between 30 and 35 years old (50.58% for the outbreak period and 46.08% for the control period). The educational level accounting for the largest proportion of participants was University and above (33.89, 31.84%), and the occupation accounting for the largest proportion was unemployed (35.89, 30.61%). Most participants resided in rural areas (54.92, 58.07%), the most common monthly household income level 2,055–4,999 yuan (37.73, 36.32%), and the majority of couples had no children (91.32, 88.79%). The most common phase of ART treatment was the second cycle of IVF in the outbreak period (37.06%), but in the control period, most participants had not yet begun IVF treatment (40.81%). There was a statistically significant difference in occupation and phase of ART treatment ($P = 0.026$; $P < 0.001$); the distributions of other sociodemographic characteristics between the two waves were well-balanced (**Table 1**).

TABLE 1 | Baseline characteristics of the study subjects (%).

Variables	Outbreak period (*n* = 599)	Control period (*n* = 892)	χ^2 value	*P*-value
Women's age (year), *n* (%)				
<30	170 (28.38)	294 (32.96)		
30–34.99	303 (50.58)	411 (46.08)	3.936	0.140
≥35	126 (20.04)	187 (20.96)		
Education level, *n* (%)				
Junior high school and below	130 (21.70)	199 (22.31)	0.706	0.872
High school/secondary school	112 (18.70)	170 (19.06)		
College	154 (25.71)	239 (26.79)		
University and above	203 (33.89)	284 (31.84)		
Occupation, *n* (%)				
Professional and technical personnel	114 (19.03)	140 (15.70)		
Administrative staff	65 (10.85)	125 (14.01)		
Workers/service staff	89 (14.86)	154 (17.26)	11.067	0.026
Other	116 (19.37)	200 (22.42)		
Unemployed	215 (35.89)	273 (30.61)		
Residence, *n* (%)				
City	163 (27.21)	241 (27.02)		
Town	107 (17.86)	133 (14.91)	2.571	0.277
Rural	329 (54.92)	518 (58.07)		
Family monthly income level (yuan*), *n* (%)				
<2,500	103 (17.20)	139 (15.58)	6.448	0.092
2,055–4,999	226 (37.73)	324 (36.32)		
5,000–9,999	173 (28.88)	238 (26.68)		
≥10,000	97 (16.19)	191 (21.41)		
Number of family children				
0	547 (91.32)	792 (88.79)	2.505	0.114
≥1	52 (8.68)	100 (11.21)		
Phases of ART treatment				
Before IVF treatment	164 (27.38)	364 (40.81)	195.102	<0.001
First cycle of IVF	100 (16.69)	338 (37.89)		
Second cycle of IVF	222 (37.06)	127 (14.24)		
Third and later cycle of IVF	113 (18.86)	63 (7.06)		

IVF, in vitro fertilization.
**Exchange rate of USD to RMB 1–7.*

The Psychological State of ART-treated Women

The ART-treated women surveyed during the outbreak period and those surveyed during the control period both had the highest scores for the fear dimension (0.88, 0.51), high scores for the neurasthenia dimension (0.60, 0.26) and depression dimension (0.41, 0.21), low scores for the compulsive-anxiety dimension (0.23, 0.09), and the lowest scores for the hypochondria dimension (0.14, 0.04). Moreover, we found that the fear dimension scores for different education levels, residence locations, and family monthly income levels were statistically different during the outbreak period ($P < 0.001$, $P = 0.008$, $P = 0.003$). Women who had a higher education level and higher family income and who lived in cities had higher scores for the fear dimension (see **Table 2** for details).

Change in the Psychological State and Subgroup Analysis

Table 3 and **Figure 1** illustrate that the ART-treated women's scores for all psychological dimensions during the control period showed a decline compared to the outbreak period with the most significant decline in the scores for the fear dimension (adjusted difference = −0.37; 95% CI = −0.43, −0.31), followed by those for the neurasthenia dimension (difference = −0.31; 95% CI: −0.36, −0.25), the depression dimension (difference = −0.18; 95% CI: −0.23, −0.13), the compulsive-anxiety dimension (difference = −0.13; 95% CI: −0.16, −0.09), and the hypochondria dimension (difference = −0.09; 95% CI: −0.12, −0.06).

Following subgroup analysis of the change in the psychological dimension scores from the first to the second wave, we found that the scores for all psychological dimensions during the control period decreased among all subgroups, and the differences in the scores were statistically significant (see **Supplementary Table 1** for details).

DISCUSSION

This study investigated the mental health status of ART-treated women during the COVID-19 pandemic for the first time. It

TABLE 2 | The psychological state of ART-treated women during the outbreak period and during the control period (Mean ± SD).

Variables	Outbreak period						Control period					
	Depression score	Neurasthenia score	Fear score	Compulsive-anxiety score	Hypochondria score	Total score	Depression score	Neurasthenia score	Fear score	Compulsive-anxiety score	Hypochondria score	Total score
Total	0.41 ± 0.52	0.60 ± 0.59	0.88 ± 0.55	0.23 ± 0.39	0.14 ± 0.34	0.47 ± 0.40	0.21 ± 0.35	0.26 ± 0.39	0.51 ± 0.45	0.09 ± 0.22	0.04 ± 0.17	0.24 ± 0.26
Women's age (year)												
<30	0.35 ± 0.48	0.58 ± 0.60	0.85 ± 0.53	0.20 ± 0.39	0.12 ± 0.31	0.44 ± 0.39	0.20 ± 0.36	0.26 ± 0.39	0.51 ± 0.46	0.09 ± 0.23	0.03 ± 0.13	0.23 ± 0.27
30–34.99	0.43 ± 0.52	0.59 ± 0.58	0.87 ± 0.57	0.24 ± 0.38	0.15 ± 0.37	0.48 ± 0.41	0.20 ± 0.34	0.24 ± 0.38	0.49 ± 0.44	0.09 ± 0.22	0.04 ± 0.19	0.23 ± 0.25
≥35	0.42 ± 0.55	0.63 ± 0.59	0.94 ± 0.53	0.24 ± 0.41	0.13 ± 0.33	0.50 ± 0.41	0.20 ± 0.36	0.31 ± 0.40	0.55 ± 0.46	0.10 ± 0.23	0.06 ± 0.17	0.27 ± 0.26
P-value	0.258	0.767	0.298	0.519	0.579	0.397	0.388	0.093	0.297	0.987	0.150*	0.166
Education level												
Junior high school and below	0.42 ± 0.55	0.59 ± 0.62	0.78 ± 0.59	0.25 ± 0.40	0.10 ± 0.25	0.46 ± 0.42	0.22 ± 0.38	0.27 ± 0.41	0.53 ± 0.53	0.12 ± 0.27	0.05 ± 0.19	0.26 ± 0.30
High school/secondary school	0.34 ± 0.52	0.51 ± 0.59	0.77 ± 0.60	0.22 ± 0.46	0.11 ± 0.33	0.41 ± 0.44	0.22 ± 0.37	0.23 ± 0.34	0.50 ± 0.46	0.09 ± 0.23	0.05 ± 0.17	0.24 ± 0.27
College	0.38 ± 0.49	0.60 ± 0.59	0.89 ± 0.50	0.20 ± 0.37	0.13 ± 0.31	0.45 ± 0.37	0.22 ± 0.36	0.25 ± 0.39	0.48 ± 0.43	0.10 ± 0.22	0.03 ± 0.16	0.24 ± 0.26
University and above	0.46 ± 0.51	0.63 ± 0.55	1.00 ± 0.52	0.25 ± 0.36	0.19 ± 0.42	0.53 ± 0.38	0.19 ± 0.31	0.28 ± 0.40	0.53 ± 0.40	0.08 ± 0.17	0.04 ± 0.16	0.24 ± 0.21
P-value	0.198	0.379	<0.001	0.694	0.086	0.073	0.817	0.574	0.345*	0.207*	0.235*	0.474*
Occupation												
Professional and technical personnel	0.44 ± 0.52	0.59 ± 0.54	0.98 ± 0.54	0.27 ± 0.41	0.19 ± 0.40	0.52 ± 0.39	0.20 ± 0.31	0.25 ± 0.30	0.50 ± 0.40	0.07 ± 0.16	0.06 ± 0.21	0.24 ± 0.21
Administrative staff	0.41 ± 0.46	0.61 ± 0.59	0.93 ± 0.50	0.21 ± 0.31	0.16 ± 0.40	0.48 ± 0.35	0.18 ± 0.31	0.24 ± 0.34	0.49 ± 0.38	0.07 ± 0.16	0.05 ± 0.16	0.22 ± 0.21
Workers/service staff	0.44 ± 0.54	0.65 ± 0.59	0.88 ± 0.55	0.24 ± 0.43	0.20 ± 0.47	0.50 ± 0.44	0.22 ± 0.32	0.22 ± 0.30	0.49 ± 0.42	0.08 ± 0.22	0.03 ± 0.12	0.23 ± 0.21
Other	0.32 ± 0.46	0.48 ± 0.52	0.82 ± 0.52	0.15 ± 0.26	0.10 ± 0.24	0.39 ± 0.33	0.21 ± 0.38	0.26 ± 0.44	0.48 ± 0.46	0.11 ± 0.27	0.03 ± 0.15	0.24 ± 0.28
Unemployed	0.43 ± 0.55	0.63 ± 0.64	0.85 ± 0.59	0.25 ± 0.44	0.10 ± 0.27	0.48 ± 0.44	0.23 ± 0.39	0.30 ± 0.45	0.56 ± 0.51	0.11 ± 0.24	0.04 ± 0.18	0.27 ± 0.31
P-value	0.358	0.206	0.165	0.205*	0.051*	0.152	0.810	0.730*	0.665*	0.429*	0.626*	0.721*
Residence, *n* (%)												
City	0.40 ± 0.51	0.62 ± 0.56	0.99 ± 0.51	0.20 ± 0.35	0.19 ± 0.47	0.50 ± 0.39	0.22 ± 0.35	0.27 ± 0.40	0.49 ± 0.42	0.08 ± 0.20	0.04 ± 0.15	0.24 ± 0.23
Town	0.45 ± 0.42	0.62 ± 0.52	0.85 ± 0.51	0.24 ± 0.31	0.15 ± 0.32	0.48 ± 0.32	0.20 ± 0.32	0.21 ± 0.29	0.49 ± 0.39	0.08 ± 0.16	0.04 ± 0.13	0.22 ± 0.20
Rural	0.40 ± 0.55	0.57 ± 0.62	0.83 ± 0.58	0.24 ± 0.43	0.11 ± 0.27	0.46 ± 0.43	0.21 ± 0.36	0.53 ± 0.48	0.53 ± 0.48	0.11 ± 0.24	0.05 ± 0.18	0.25 ± 0.28
P-value	0.712	0.596	0.008	0.598	0.197*	0.535	0.750	0.498*	0.845*	0.594*	0.789	0.822*
Family monthly income level (yuan)												
<2,500	0.41 ± 0.57	0.63 ± 0.61	0.74 ± 0.58	0.24 ± 0.42	0.13 ± 0.26	0.45 ± 0.42	0.24 ± 0.41	0.26 ± 0.38	0.50 ± 0.50	0.13 ± 0.30	0.05 ± 0.22	0.26 ± 0.32
2,055–4,999	0.39 ± 0.51	0.57 ± 0.6	0.85 ± 0.55	0.21 ± 0.39	0.11 ± 0.31	0.45 ± 0.40	0.21 ± 0.35	0.25 ± 0.42	0.49 ± 0.45	0.10 ± 0.22	0.04 ± 0.17	0.24 ± 0.27
5,000–9,999	0.47 ± 0.38	0.66 ± 0.6	0.94 ± 0.57	0.28 ± 0.43	0.20 ± 0.47	0.53 ± 0.45	0.20 ± 0.33	0.26 ± 0.37	0.54 ± 0.43	0.06 ± 0.15	0.03 ± 0.12	0.24 ± 0.22
≥10,000	0.33 ± 0.4	0.50 ± 0.48	1.00 ± 0.48	0.18 ± 0.25	0.12 ± 0.24	0.45 ± 0.27	0.21 ± 0.33	0.27 ± 0.36	0.52 ± 0.45	0.10 ± 0.23	0.06 ± 0.18	0.25 ± 0.24
P-value	0.170	0.170	0.003	0.200*	0.126*	0.064*	0.639	0.970	0.430*	0.096	0.124*	0.598*
Number of family children												
0	0.41 ± 0.51	0.59 ± 0.59	0.87 ± 0.55	0.22 ± 0.39	0.13 ± 0.33	0.47 ± 0.40	0.20 ± 0.34	0.25 ± 0.38	0.51 ± 0.44	0.09 ± 0.21	0.04 ± 0.17	0.24 ± 0.25
≥1	0.43 ± 0.53	0.62 ± 0.55	0.95 ± 0.57	0.28 ± 0.39	0.18 ± 0.44	0.52 ± 0.40	0.30 ± 0.44	0.34 ± 0.43	0.55 ± 0.50	0.14 ± 0.31	0.06 ± 0.17	0.30 ± 0.31
P-value	0.792	0.758	0.330	0.292	0.968**	0.418	0.095**	0.072*	0.620**	0.072*	0.151	0.080**
Phases of ART treatment												
Before IVF treatment	0.35 ± 0.47	0.56 ± 0.52	0.93 ± 0.53	0.22 ± 0.34	0.12 ± 0.26	0.46 ± 0.35	0.20 ± 0.35	0.25 ± 0.42	0.49 ± 0.46	0.09 ± 0.22	0.05 ± 0.21	0.23 ± 0.27
First cycle of IVF	0.36 ± 0.49	0.55 ± 0.57	0.83 ± 0.51	0.17 ± 0.32	0.12 ± 0.34	0.42 ± 0.36	0.23 ± 0.37	0.26 ± 0.35	0.53 ± 0.44	0.10 ± 0.23	0.04 ± 0.14	0.25 ± 0.26
Second cycle of IVF	0.43 ± 0.55	0.61 ± 0.61	0.85 ± 0.56	0.25 ± 0.42	0.15 ± 0.36	0.48 ± 0.43	0.21 ± 0.31	0.33 ± 0.41	0.57 ± 0.48	0.10 ± 0.21	0.03 ± 0.12	0.27 ± 0.25
Third and later cycle of IVF	0.50 ± 0.53	0.67 ± 0.63	0.91 ± 0.60	0.27 ± 0.44	0.17 ± 0.42	0.53 ± 0.44	0.17 ± 0.30	0.24 ± 0.32	0.44 ± 0.36	0.08 ± 0.24	0.05 ± 0.15	0.21 ± 0.21
P-value	0.065	0.354	0.346	0.280	0.565	0.385	0.679	0.227	0.148	0.833	0.761	0.359

**Kruskal-Wallis test.*

***Wilcoxon rank test.*

IVF, in vitro fertilization.

TABLE 3 | Changes in psychological questionnaire scores between the outbreak period and the control period.

Variables	Outbreak period	Control period	Difference (95% CI), *P*-value	Adjusted difference (95% CI)*, *P*-value
Depression score	0.41 ± 0.52	0.21 ± 0.35	−0.20 (−0.24, −0.15), <0.001	−0.18 (−0.23, −0.13), <0.001
Neurasthenia score	0.60 ± 0.59	0.26 ± 0.39	−0.33 (−0.38, −0.28), <0.001	−0.31 (−0.36, −0.25), <0.001
Fear score	0.88 ± 0.55	0.51 ± 0.45	−0.37 (−0.42, −0.32), <0.001	−0.37 (−0.43, −0.31), <0.001
Compulsive-anxiety score	0.23 ± 0.39	0.09 ± 0.22	−0.14 (−0.17, −0.11), <0.001	−0.13 (−0.16, −0.09), <0.001
Hypochondria score	0.14 ± 0.34	0.04 ± 0.17	−0.10 (−0.12, −0.07), <0.001	−0.09 (−0.12, −0.06), <0.001
Total score	0.47 ± 0.40	0.24 ± 0.26	−0.23 (−0.26, −0.20), <0.001	−0.22 (−0.25, −0.18), <0.001

**Adjusted for women's age, education level, occupation, residence location, family monthly income level, number of children in the family, and phase of ART treatment.*

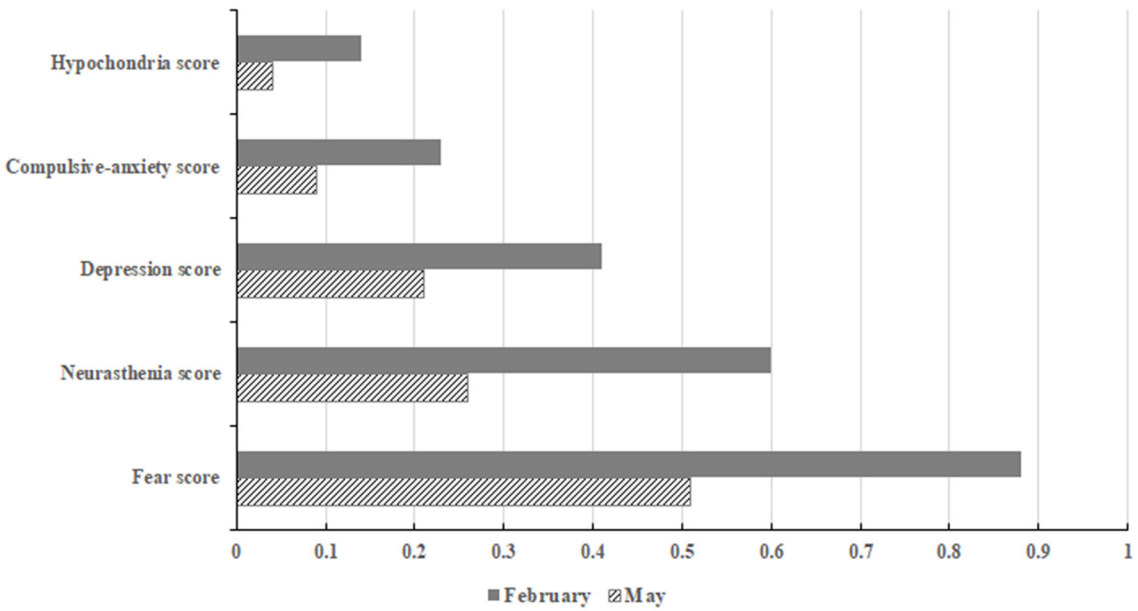

FIGURE 1 | Comparison of psychological scores between ART-treated women during the outbreak period and those during the control period.

assessed the changes in their mental health after the pandemic stabilized in China. A poor psychological state is more likely to occur under the ART process's interruption during the COVID-19 pandemic. Our study found that the mental health of women undergoing ART treatment was mainly manifested as fear during the COVID-19 pandemic in Xi'an, and as the pandemic was brought under control, the mental health of ART-treated women improved.

Following the onset of the pandemic, several studies on pregnant women's mental health reported that the main manifestations were anxiety and depression (23–25). In our study, ART-treated women's psychological state was primarily fearful. After the Zika virus began to spread, Yang observed the mental health of women of childbearing age in the United States and found that women who were pregnant or planning to become pregnant showed a higher sense of fear than women who did not meet these two conditions (26). After the COVID-19 pandemic began in Italy, pregnant women's fear was as high as 49%. Pregnant women who had psychological disorders before the pandemic experienced more severe levels of fear (27). A study in Japan found that the COVID-19 pandemic has had a significant impact on the economy and residents' happiness. High levels of fear and panic behavior were observed in the general population as was a phenomenon of hoarding numerous living materials (28). People's fear and anxiety were often aggravated under the raging pandemic (29, 30). Ahorsu et al. used the Fear of COVID-19 Scale (FCV-19S) to assess pregnant women' fear of COVID-19 and analyze the associations among fear of COVID-19, mental health, and preventive behaviors. They found that fear of COVID-19 among pregnant women was significantly and positively associated with their psychological problems and their preventive COVID-19 behaviors. The fear of COVID-19 among pregnant women was significantly and negatively associated with their mental quality of life (31). In our study, the majority of women treated with ART had begun their first IVF cycle. According to Xi'an's pandemic prevention policies, all non-emergency medical treatments were restricted at the Northwest Women's and Children's Hospital in February 2020, including ART treatment. The restriction of ART treatment during the COVID-19 pandemic led to fear of the decreased odds

of conception. Therefore, it was necessary to increase healthcare professionals' sensitivity to ART-treated women's psychological fears and adopt tailor-made intervention measures to provide appropriate psychological support in unusual times.

This study found that ART-treated women's mental health during the control period improved to varying degrees, and their fear and neurasthenia were significantly relieved. As of the control period, the domestic pandemic was in a stable state, and most areas of China resumed work, schooling, and production. Additionally, ART treatment and other non-emergency medical treatment were re-initiated at the Northwest Women's and Children's Hospital in Xi'an in May 2020. The strain on people's mental health has thus been considerably eased. Research by Wu found that pregnant women under the age of 35 were at increased risk of depression and anxiety symptoms during the outbreak of the COVID-19 (25). Guo's study found that the negative impact of the COVID-19 pandemic on livelihoods was particularly severe in regard to mental health problems (β = 0.15; 95% CI: 0.10, 0.19) (32). Therefore, after the pandemic stabilized, the city's blockade was lifted, full-time and middle-income workers resumed their normal life rhythm, economic pressure was relieved, and people's mental state improved.

Epidemiological and zoological studies have also shown that psychological stress was considered a potential cofactor in the pathogenesis of infectious diseases, which can change animals' and humans' sensitivity to sources of infection, thereby affecting the onset, process, and pathology results of certain infectious diseases (33). Therefore, special attention should be paid to the mental health level of populations undergoing ART treatment. Most reproductive societies recommend that, except in a small number of cases, the current cycle of embryo transfer should be postponed, and a new IVF cycle should not be initiated (34). The severity of the COVID-19 outbreak could indirectly impact negative emotions by affecting sleep quality; maintaining an appropriate amount of daily physical exercise and adequate sleep may improve mental health (35). In countries or regions with severe pandemic, remote health care could be implemented and tailored for high-risk prenatal patients (36). Maternal and infant health care institutions should understand pregnant women's needs, optimize prenatal care services, and provide targeted and easily accessible health education and services to ensure mothers and infants (37).

In our study, there is no non-pandemic control group because of the sudden outbreak of the COVID-19. The same questionnaire, the Psychological Questionnaire for Public Health Emergencies, was used in a study on the status of mental health in college students during the SARS pandemic period. Their study included 1,019 college students, 702 of whom were boys, with a mean age of 20.63. Their scores for the depression, neurasthenia, fear, compulsive anxiety, and hypochondria dimensions were 0.33, 0.37, 0.64, 0.24, and 0.20, respectively (22). Compared to that study, the participants in this study were older, and the psychological dimension scores were higher during the outbreak period.

This study has several limitations. First, this is a repeated cross-sectional study rather than a cohort study. A longitudinal cohort study could more accurately assess changes in mental health. Second, although we used multivariable regression to control for potential confounders, the findings may be confounded by unmeasured covariates. Additionally, the interpretation of this study's results may be restricted by time, geography, and socio-cultural background. Finally, instruments designed specifically for COVID-19, such as the Fear of COVID-19 Scale (FCV-19S), were not used in our study, which may affect the accuracy of the psychological assessment in relation to COVID-19. These limitations should be considered when comparing our results with other relevant research results.

CONCLUSION

This study found that ART-treated women's mental health during the COVID-19 pandemic was mainly manifested as fear. With the effective control of the COVID-19 pandemic in China, the mental health of ART-treated women improved in all dimensions. The COVID-19 pandemic undoubtedly influences the mental health of women undergoing ART treatment, and clinicians should be aware of this for similar situations in the future.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the Human Research Ethics Committee of the Northwest Women's and Children's Hospital (No. 2020001). The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

PQ, MW, WS, and JS conceived and designed the study. PQ, DZ, PJ, SD, WS, MW, and JS drafted and revised the manuscript. PQ and DZ analyzed and interpreted the data. PQ, DZ, and MW collected and cleared the data. All authors have read and approved the final version of the manuscript.

FUNDING

This work was financially supported by the Fundamental Research Funds for the Central Universities (China) (No. xzy012019116), the Key Research and Development Program of Shaanxi Province (No. 2020SF-031), and the National Natural Science Foundation of China (No. 81771657).

ACKNOWLEDGMENTS

We thank the staff from Northwest Women's and Children's Hospital for their assistance with the data collection. We thank all participants in this study.

SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpubh.2021.645421/full#supplementary-material

REFERENCES

1. Huang C, Wang Y, Li X, Ren L, Zhao J, Hu Y, et al. Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. *Lancet.* (2020) 395:497–506. doi: 10.1016/S0140-6736(20)30183-5
2. Zhu N, Zhang D, Wang W, Li X, Yang B, Song J, et al. A novel coronavirus from patients with pneumonia in China, 2019. *N Engl J Med.* (2020) 382:727–33. doi: 10.1056/NEJMoa2001017
3. Li H, Liu SM, Yu XH, Tang SL, Tang CK. Coronavirus disease 2019 (COVID-19): current status and future perspectives. *Int J Antimicrob Agents.* (2020) 55:105951. doi: 10.1016/j.ijantimicag.2020.105951
4. Person B, Sy F, Holton K, Govert B, Liang A, National Center for Inectious Diseases, et al. Fear and stigma: the epidemic within the SARS outbreak. *Emerg Infect Dis.* (2004) 10:358–63. doi: 10.3201/eid1002.030750
5. Shultz JM, Cooper JL, Baingana F, Oquendo MA, Espinel Z, Althouse BM, et al. The role of fear-related behaviors in the 2013-2016 West Africa Ebola virus disease outbreak. *Curr Psychiatry Rep.* (2016) 18:104. doi: 10.1007/s11920-016-0741-y
6. 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) 395:912–20. doi: 10.1016/S0140-6736(20)30460-8
7. Gao J, Zheng P, Jia Y, Chen H, Mao Y, Chen S, et al. Mental health problems and social media exposure during COVID-19 outbreak. *PLoS ONE.* (2020) 15:e0231924. doi: 10.1371/journal.pone.0231924
8. Kolliakou A, Bakolis I, Chandran D, Derczynski L, Werbeloff N, Osborn DPJ, et al. Mental health-related conversations on social media and crisis episodes: a time-series regression analysis. *Sci Rep.* (2020) 10:1342. doi: 10.1038/s41598-020-57835-9
9. Mak IW, Chu CM, Pan PC, Yiu MG, Chan VL. Long-term psychiatric morbidities among SARS survivors. *Gen Hosp Psychiatry.* (2009) 31:318–26. doi: 10.1016/j.genhosppsych.2009.03.001
10. Leung GM, Lam TH, Ho LM, Ho SY, Chan BH, Wong IO, et al. The impact of community psychological responses on outbreak control for severe acute respiratory syndrome in Hong Kong. *J Epidemiol Community Health.* (2003) 57:857–63. doi: 10.1136/jech.57.11.857
11. Liu N, Zhang F, Wei C, Jia Y, Shang Z, Sun L, et al. Prevalence and predictors of PTSS during COVID-19 outbreak in China hardest-hit areas: gender differences matter. *Psychiatry Res.* (2020) 287:112921. doi: 10.1016/j.psychres.2020.112921
12. Özdin S, Bayrak Özdin S. Levels and predictors of anxiety, depression and health anxiety during COVID-19 pandemic in Turkish society: The importance of gender. *Int J Soc Psychiatry.* (2020) 66:504–11. doi: 10.1177/0020764020927051
13. Wang C, Pan R, Wan X, Tan Y, Xu L, Ho CS, et al. Immediate psychological responses and associated factors during the initial stage of the 2019 coronavirus disease (COVID-19) epidemic among the general population in China. *Int J Environ Res Public Health.* (2020) 17:1729. doi: 10.3390/ijerph17051729
14. Durankuş F, Aksu E. Effects of the COVID-19 pandemic on anxiety and depressive symptoms in pregnant women: a preliminary study. *J Matern Fetal Neonatal Med.* (2020) 1–7. doi: 10.1080/14767058.2020.1763946. [Epub ahead of print].
15. Liu X, Chen M, Wang Y, Sun L, Zhang J, Shi Y, et al. Prenatal anxiety and obstetric decisions among pregnant women in Wuhan and Chongqing during the COVID-19 outbreak: a cross-sectional study. *BJOG.* (2020) 127:1229–40. doi: 10.1111/1471-0528.16381
16. Taubman-Ben-Ari O, Chasson M, Abu Sharkia S, Weiss E. Distress and anxiety associated with COVID-19 among Jewish and Arab pregnant women in Israel. *J Reprod Infant Psychol.* (2020) 38:340–8. doi: 10.1080/02646838.2020.1786037
17. Darwiche J, Lawrence C, Vial Y, Wunder D, Stiefel F, Germond M, et al. Anxiety and psychological stress before prenatal screening in first-time mothers who conceived through IVF/ICSI or spontaneously. *Women Health.* (2014) 54:474–85. doi: 10.1080/03630242.2014.897677
18. Rooney KL, Domar AD. The impact of stress on fertility treatment. *Curr Opin Obstet Gynecol.* (2016) 28:198–201. doi: 10.1097/GCO.0000000000000261
19. Gourounti K. Psychological stress and adjustment in pregnancy following assisted reproductive technology and spontaneous conception: a systematic review. *Women Health.* (2016) 56:98–118. doi: 10.1080/03630242.2015.1074642
20. Wu MH, Su PF, Chu WY, Huey NG, Lin CW, Ou HT, et al. Quality of life and pregnancy outcomes among women undergoing in vitro fertilization treatment: a longitudinal cohort study. *J Formos Med Assoc.* (2020) 119 (1 Pt 3):471–9. doi: 10.1016/j.jfma.2019.06.015
21. Huang MZ, Kao CH, Lin KC, Hwang JL, Puthussery S, Gau ML. Psychological health of women who have conceived using assisted reproductive technology in Taiwan: findings from a longitudinal study. *BMC Womens Health.* (2019) 19:97. doi: 10.1186/s12905-019-0801-7
22. Yan G, Yu-Feng Y, Yan-Sheng M, Kai-Nan Y. Research on the status of emotion response in college students during the epidemic period of SARS. *Chin J Behav Med Sci.* (2004) 13:62–4.
23. Berthelot N, Lemieux R, Garon-Bissonnette J, Drouin-Maziade C, Martel É, Maziade M. Uptrend in distress and psychiatric symptomatology in pregnant women during the coronavirus disease 2019 pandemic. *Acta Obstet Gynecol Scand.* (2020) 99:848–55. doi: 10.1111/aogs.13925
24. Kotabagi P, Fortune L, Essien S, Nauta M, Yoong W. Anxiety and depression levels among pregnant women with COVID-19. *Acta Obstet Gynecol Scand.* (2020) 99:953–4. doi: 10.1111/aogs.13928
25. Wu Y, Zhang C, Liu H, Duan C, Li C, Fan J, et al. Perinatal depressive and anxiety symptoms of pregnant women during the coronavirus disease 2019 outbreak in China. *Am J Obstet Gynecol.* (2020) 223:240.e1–9. doi: 10.1016/j.ajog.2020.05.009
26. Yang C, Dillard JP, Li R. Understanding fear of Zika: personal, interpersonal, and media influences. *Risk Anal.* (2018) 38:2535–45. doi: 10.1111/risa.12973
27. Ravaldi C, Wilson A, Ricca V, Homer C, Vannacci A. Pregnant women voice their concerns and birth expectations during the COVID-19 pandemic in Italy. *Women Birth.* (2020). doi: 10.1016/j.wombi.2020.07.002. [Epub ahead of print].
28. Shigemura J, Ursano RJ, Morganstein JC, Kurosawa M, Benedek DM. Public responses to the novel 2019 coronavirus (2019-nCoV) in Japan: mental health consequences and target populations. *Psychiatry Clin Neurosci.* (2020) 74:281–2. doi: 10.1111/pcn.12988
29. Shuja KH, Aqeel M, Jaffar A, Ahmed A. COVID-19 pandemic and impending global mental health implications. *Psychiatr Danub.* (2020) 32:32–5. doi: 10.24869/psyd.2020.32
30. Zhang Y, Ma ZF. Impact of the COVID-19 pandemic on mental health and quality of life among local residents in Liaoning Province, China: a cross-sectional study. *Int J Environ Res Public Health.* (2020) 17:2381. doi: 10.3390/ijerph17072381
31. Ahorsu DK, Imani V, Lin CY, Timpka T, Brostrom A, Updegraff JA, et al. Associations between fear of COVID-19, mental health, and preventive behaviours across pregnant women and husbands: an actor-partner interdependence modelling. *Int J Ment Health Addict.* (2020) 1–15. doi: 10.1007/s11469-020-00340-x. [Epub ahead of print].
32. Guo J, Feng XL, Wang XH, van IMH. Coping with COVID-19: exposure to COVID-19 and negative impact on livelihood predict elevated mental health

problems in Chinese adults. *Int J Environ Res Public Health.* (2020) 17:3857. doi: 10.3390/ijerph17113857
33. Biondi M, Zannino LG. Psychological stress, neuroimmunomodulation, and susceptibility to infectious diseases in animals and man: a review. *Psychother Psychosom.* (1997) 66:3–26. doi: 10.1159/000289101
34. Monteleone PA, Nakano M, Lazar V, Gomes AP, de HM, Bonetti TC. A review of initial data on pregnancy during the COVID-19 outbreak: implications for assisted reproductive treatments. *JBRA Assist Reprod.* (2020) 24:219–25. doi: 10.5935/1518-0557.20200030
35. Zhang Y, Zhang H, Ma X, Di Q. Mental health problems during the COVID-19 pandemics and the mitigation effects of exercise: a longitudinal study of college students in China. *Int J Environ Res Public Health.* (2020) 17:3722. doi: 10.3390/ijerph17103722
36. Aziz A, Zork N, Aubey JJ, Baptiste CD, D'Alton ME, Emeruwa UN, et al. Telehealth for high-risk pregnancies in the setting of the COVID-19 pandemic. *Am J Perinatol.* (2020) 37:800–8. doi: 10.1055/s-0040-1712121
37. Du L, Gu YB, Cui MQ, Li WX, Wang J, Zhu LP, et al. Investigation on demands for antenatal care services among 2 002 pregnant women during the epidemic of COVID-19 in Shanghai. *Zhonghua Fu Chan Ke Za Zhi.* (2020) 55:160–5. doi: 10.3760/cma.j.cn112141-20200218-00112

Conflict of Interest: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.