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Original Research

Psychological Stress in Patients Undergoing Intrauterine Insemination With Husband's Sperm: Prevalence, Influencing Factors, and Impact on Conception Success—A Retrospective Cohort Study

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Abstract

Background: Psychological stress in infertile individuals undergoing artificial insemination with their husband's sperm (AIH) remains understudied, despite its potential impact on reproductive outcomes. The current study aimed to evaluate the prevalence, influencing factors, and effects of psychological stress on conception success in a population undergoing AIH. **Methods**: This retrospective cohort study analyzed data from 976 patients treated between June 2020 and January 2024. Standardized psychological assessments were used to evaluate anxiety, depression, somatic symptoms, and sleep quality. These included generalized anxiety disorder 7-item (GAD-7), patient health questionnaire 9-item (PHQ-9), patient health questionnaire 15-item (PHQ-15), and the Pittsburgh Sleep Quality Index. Logistic regression analysis was performed to identify predictors of stress and their association with clinical pregnancy rates. **Results**: Younger age (<30 years) was significantly correlated with higher anxiety (odds ratio (OR) = 1.801, $p = 0.012$). Whilst, unemployment ($OR_{adjusted} = 2.183$, $p = 0.002$) and prolonged duration (3–5 years) of infertility ($OR_{adjusted} = 1.445$, $p = 0.014$) were significantly correlated with somatic symptoms. Moreover, unemployment ($OR_{adjusted} = 2.020$, $p = 0.008$) and prolonged duration (≥5 years) of infertility ($OR_{adjusted} = 1.780$, $p = 0.008$) were also significantly correlated with sleep disorders. However, no direct links were found between anxiety, depression, somatic symptoms or sleep quality and conception outcomes. **Conclusion**: Our findings highlight the need to target psychological interventions for specific populations, including younger individuals, unemployed persons, and patients experiencing prolonged infertility.

Keywords: psychological stress; artificial insemination; conception success; cohort study

1. Introduction

Artificial insemination with the husband's sperm (AIH) is a fundamental assisted reproductive technology (ART) involving transuterine deposition of processed spermatozoa during the ovulatory window [1,2]. This technique preserves genetic parenthood, distinguishing it from donor insemination, and circumvents cervical factors to achieve clinical pregnancy rates (CPR) of 8%–15% per cycle in unexplained infertility [1]. Population-specific data from China demonstrate an overall CPR of 13.0% across 3015 AIH cycles [3], consistent with global estimates. Published evidence has established that ovarian stimulation combined with intrauterine insemination (IUI-OS) significantly increases live birth rates (LBR) and CPR up to 3-fold compared to expectant management, thus supporting its role as a first-line therapeutic strategy for unexplained infertility [4]. Current evidence-based guidelines recommend age-stratified treatment algorithms, with IUI-OS being indicated for women aged <38 years with favorable prognoses, and *in vitro* fertilization (IVF) for patients aged ≥38 years [2]. This stratification framework may influence patient expectations and treatment-related anxiety. Notwithstanding the clinical benefits of AIH, the psychosocial implications remain a critically underexplored area of care delivery.

Accumulating evidence confirms that psychological stress adversely impacts AIH outcomes [5]. Elevated depressive symptoms (center for epidemiological studies depression scale (CES-D) ≥16) affect 59.1% of women [6], while the prevalence of anxiety can reach up to 75.9% in infertile females [7]. Pathophysiological mechanisms involve activation of the hypothalamic-pituitary-adrenal (HPA) axis, thereby increasing cortisol levels and inducing reproductive dysfunction [8]. Clinically, pretreatment anxiety has been associated with a 29% reduction in ovarian response and a 31% suppression of luteinizing hormone (LH) pulsatility, thereby impairing folliculogenesis. Stress-mediated increases in β-endorphin have been associated with a 42% decrease in tubal motility, while dysregulation of ghrelin doubles endometrial natural killer (NK) cell activity [8], compromising implantation. Multimodal interventions aimed at improving adverse psychological stress have demonstrated clinically significant efficacy. For in-

stance, mindfulness-based therapies can increase cumulative pregnancy rates, while cognitive behavioral therapy (CBT) has been reported to reduce the rate of treatment discontinuation by 37% and improve patient-clinician communication dynamics [9]. Concurrently, structured stress management protocols combined with Mediterranean dietary interventions were shown to attenuate oxidative stress biomarkers, leading to increased CPR in ART populations [7]. Collectively, these findings indicate that infertility is a chronic stressor [10], necessitating the integration of biopsychosocial frameworks within AIH care paradigms.

The psychosocial burden associated with AIH stems from multifactorial stressors encompassing socioeconomic constraints, interpersonal discord, and cultural expectations. A cross-sectional analysis of 175 AIH patients revealed an inverse correlation between the severity of anxiety and the magnitude of perceived social support ($\beta = -0.41$, $p < 0.01$) [11]. Furthermore, a household income $\leq$200% of the federal poverty level (FPL) was found to be an independent predictor of worse anxiety symptomatology (odds ratio (OR) = 2.3, 95% confidence interval (CI): 1.1–4.8). These findings establish socioeconomic status as a significant effect modifier of psychological distress, with robust social support networks conferring protective benefits. Transcultural psychiatric epidemiology studies have reported a high prevalence of affective disorders among infertility cohorts, including major depressive disorder (23.7%), illness anxiety (18.2%), and persecutory ideation (14.9%), with comorbid adoption of nutritionally suboptimal dietary patterns [7]. However, a prospective cohort study of 102 couples undergoing IVF found no statistically significant association between women's anxiety/depression levels and oocyte count [12].

A prospective study combined psychological stress assessments with the analysis of salivary biomarkers (α-amylase and cortisol) in 114 women aged $\leq$42 years who underwent ART [10]. No significant differences in stress scores (general health questionnaire-28 item: 5.0 $\pm$ 3.7 vs. 5.1 $\pm$ 4.9; Self-Rating Depression Scale: 37.2 $\pm$ 6.3 vs. 36.7 $\pm$ 6.8) or biomarker levels (α-amylase: 196.0 $\pm$ 144.6 vs. 202.0 $\pm$ 133.2 µg/dL; cortisol: 0.16 $\pm$ 0.10 vs. 0.15 $\pm$ 0.02 IU/mL) were observed between pregnant and non-pregnant groups, suggesting that combined psychological stress measures lack predictive utility for ART outcomes. Despite these insights, critical research gaps persist. To isolate psychological impacts, earlier studies included only couples with unexplained infertility, while systematically excluding confounding factors that could affect pregnancy outcomes [12]. Moreover, previous studies have often overlooked confounding biological variables, relied on static psychological assessment, ignored periodic stress fluctuations, and failed to adequately address the impact of male factors on the psychological burden of infertile women.

The present study aimed to address these gaps by evaluating the prevalence and severity of psychological stress in AIH patients, identifying modifiable psychosocial and biological predictors of stress, and measuring how stress affects pregnancy outcomes.

2. Materials and Methods

2.1 Study Design and Participants

This single-center cohort study evaluated psychological stress levels in patients undergoing IUI with their husband's sperm. In addition, we identified associated factors and assessed the impact of stress on clinical pregnancy outcomes. This retrospective cohort study utilized data that were collected prospectively within the electronic medical records database of the Center of Reproductive Medicine, West China Second University Hospital, Sichuan University.

The study population comprised of patients who initiated IUI cycles using their partner's sperm between June 2020 and January 2024. Initial screening identified 1946 patients who had undergone psychological assessment during their treatment period (Fig. 1). To increase internal validity and mitigate confounding factors, stringent exclusion criteria were applied: (1) the use of donor sperm (n = 566); (2) treatment discontinuation (n = 127); and (3) started IUI treatment more than two months after psychological assessment (n = 229). Following these exclusions, 1024 participants were eligible for inclusion in the study. Subsequent analysis revealed that 48 treatment cycles were cancelled for various clinical reasons, resulting in a final analytical cohort of 976 completed IUI cycles.

2.2 Psychological Assessment Tools

The severity of anxiety symptoms was assessed using the generalized anxiety disorder 7-item scale (GAD-7), initially developed by Spitzer *et al*. [13] and subsequently translated and introduced to China by China by He XY *et al*. [14]. GAD-7 is a self-rating scale for anxiety-related symptoms experienced in the 2 weeks prior. Each item is scored on a four-point Likert scale of 0–3, with 0 indicating "not at all" and 3 indicating "almost every day". The reliability and validity of GAD-7 were confirmed in previous studies [14,15]. The Cronbach's α coefficient for GAD-7 in the current study was 0.861. Anxiety was examined as a dichotomous variable, with a score of >4 indicating an abnormal anxiety level in this study.

The patient health questionnaire 9-item (PHQ-9) initially developed by Kroenke *et al*. [16] was used to assess the severity of the depression-related symptoms. PHQ-9 is a self-rating scale for symptoms related to depression which have been experienced in the past 2 weeks. Each item is scored on a four-point Likert scale of 0–3, with 0 indicating "not at all" and 3 indicating "almost every day". PHQ-9 is widely used in both clinic and community settings, and was introduced to China in 2007 [17]. The reliability and

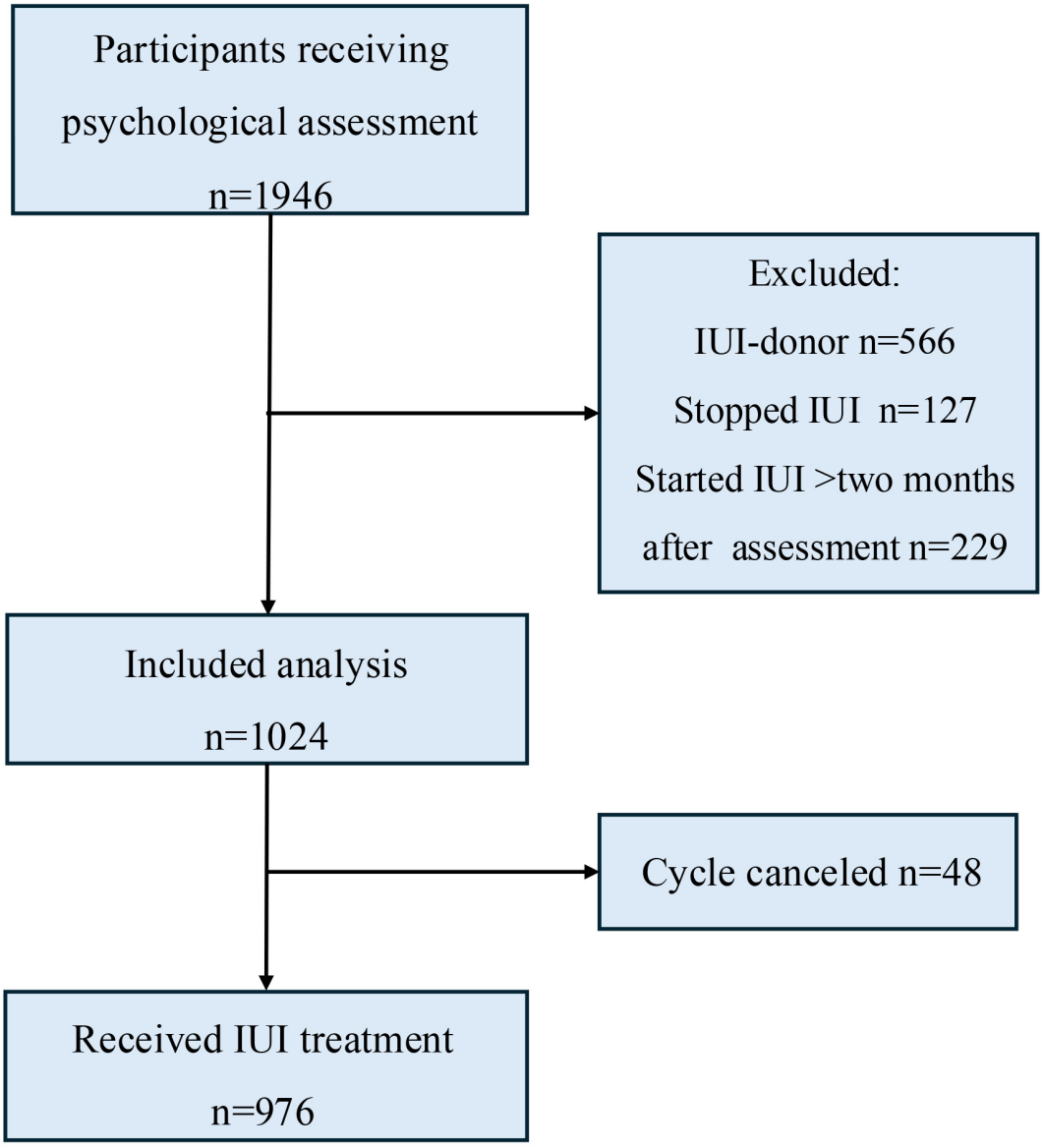

Fig. 1. Flow chart of the study (IUI, intrauterine insemination).

validity of PHQ-9 have been demonstrated in infertile populations in mainland China [18]. The Cronbach's α coefficient of PHQ-9 was 0.817 in the current study. Depression was examined as a dichotomous variable, with a score of >4 indicating an abnormal anxiety level.

The patient health questionnaire 15-item (PHQ-15) used in this study to evaluate the patient's somatic symptoms was initially developed by Kroenke *et al*. [19]. PHQ-15 is a self-rating scale for the severity of somatic symptoms experienced during the past 2 weeks. Each item is scored on a four-point Likert scale of 0–2, with 0 indicating "no influence at all" and 2 indicating "significant influence". PHQ-15 is widely used in both clinical and community settings, and its reliability and validity have been demonstrated in infertile populations in mainland China [18]. The Cronbach's α coefficient of PHQ-15 in this study was 0.783. Somatic symptoms were examined as a dichotomous variable, with a score of >4 identifying abnormal somatic symptoms.

Patient sleep quality was evaluated using the Pittsburgh Sleep Quality Index (PSQI), which is a self-rating scale for sleep quality and disturbances over a 1-month time interval. The PSQI evaluates subjective sleep quality, latency, duration, efficiency, disturbances, use of sleep medication, and daytime dysfunction. The score for each part is between 0–3 points, and the global score (sum of these 7 components) ranges from 0 to 21. The reliability and validity of PSQI have been demonstrated in mainland China [20]. The Cronbach's α coefficient for the PSQI was 0.724 in this study. Subjective sleep quality was examined as a dichotomous variable, with a score of >7 indicating poor sleep quality.

Table 1. Demographic and fertility characteristics of participants (n = 1024).

Characteristics	n (%)/median (IQR)
Female	
Age (years)	
<30	300 (29.30)
30–34	575 (56.20)
≥35	149 (14.50)
Ethnicity	
Han	986 (96.30)
Minority	38 (3.70)
Marital status	
First marriage	961 (93.80)
Digamy	63 (6.20)
Occupational status	
Employed	950 (92.80)
Not working	74 (7.20)
Educational degree	
Junior college and below	420 (41.02)
Bachelor	462 (45.12)
Master and above	142 (13.86)
Preconception BMI	
Low (<18.5 kg/m^2)	126 (12.30)
Normal (>18.5 kg/m^2, <24.0 kg/m^2)	780 (76.20)
Overweight/obesity (>24.0 kg/m^2)	117 (11.40)
Missing data	1 (0.10)
Duration of infertility	2.61 (1.83)
Previous pregnancy	269 (26.30)
Gravida (time), median (IQR)	0 (1.00)
Parity (time), median (IQR)	0 (0)
Spontaneous abortion (time), median (IQR)	0 (0)
Induced abortion (time), median (IQR)	0 (0)
Male	
Age (years)	
<30	206 (20.12)
30–34	540 (52.73)
≥35	278 (27.15)
Ethnicity	
Han	986 (96.30)
Minority	36 (3.50)
Other	1 (0.10)
Missing data	1 (0.10)
Marital status	
First marriage	942 (92.00)
Digamy	82 (8.00)
Occupational status	
Employed	1010 (98.60)
Not working	14 (1.40)
Educational degree	
Junior college and below	385 (37.60)
Bachelor	480 (46.90)
Master and above	159 (15.50)

IQR, interquartile range; BMI, body mass index.

2.3 Data Collection

Psychological assessments were part of standard clinical data collection in our department, used to identify individuals with severe negative emotions. Before a patient entered the artificial insemination cycle, trained nurses guided them through the psychological assessment. The patient was informed of the result at the completion of the assessment. Patients with no or only mild symptoms received psychological guidance from the department's counselors. Those evaluated as having moderate or severe symptoms were referred for psychological counseling in the outpatient department. Data collection was performed through the hospital's electronic medical records system. All clinical data was prospectively collected. Primary data was collected for demographic characteristics such as age, body mass index (BMI), whether the patient was undergoing IUI for the first time, the health status of the partner, and the patient's fertility history (e.g., duration of infertility, prior pregnancies). In addition to psychological assessment data, information related to treatment was also collected, including the treatment regimen (e.g., the use of ovulation-stimulating drugs), the number of treatment cycles, the number of IUI attempts, and the final treatment outcome (i.e., whether the patient became pregnant).

2.4 Data Analysis

Data analysis was performed using SPSS 26.0 (IBM Corp., Armonk, NY, USA), with a significance level set at $p < 0.05$ for all analyses. Continuous variables with normal distribution were presented as the mean $\pm$ standard deviation (SD), while those with non-normal distribution were presented as the median and interquartile range. Categorical variables were presented as frequencies and percentages. Univariate analyses using chi-square tests were performed to assess the relationship between demographic characteristics and psychological outcomes. The Cochran-Armitage trend method was used to test the linear relationship between ordered categorical variables (e.g., female age, female educational degree, infertility duration, male age, male educational degree) and binary categorical outcomes. Multivariate logistic regression analysis was used to identify the influencing factors for psychological outcomes and their association with the pregnancy rate.

3. Results

3.1 Characteristics of Participants

The demographic and fertility characteristics of the 1024 participants included in this study were examined in detail (Table 1). Analysis of the age distribution showed that 29.30% of participants were <30 years of age, 56.20% were between 30 and 34 years, and 14.50% were 35 years or older. Most participants were of Han ethnicity (96.30%), and a large majority (93.80%) were in their first marriage. In terms of fertility characteristics, BMI was classified as

Table 2. Prevalence of anxiety, depression, somatic disorders and sleep disorders according to GAD-7, PHQ-9, PHQ-15 and PSQI (n = 1024).

Classification	n (%)
GAD-7	
Normal (0–4)	726 (70.90)
Abnormal (5–21)	298 (29.10)
PHQ-9	
Normal (0–4)	674 (65.80)
Abnormal (5–27)	350 (34.20)
PHQ-15	
Normal (0–4)	587 (57.30)
Abnormal (5–30)	437 (42.70)
PSQI	
Good (0–6)	815 (79.60)
Poor (7–21)	209 (20.40)

Note: GAD-7, generalized anxiety disorder 7-item; PHQ-9, patient health questionnaire 9-item; PHQ-15, patient health questionnaire 15-item; PSQI, pittsburgh sleep quality index.

"low" in 12.30% of participants, "normal" in 76.20%, and "overweight or obese" in 11.40%. In relation to the duration of infertility, 76.20% of participants had been infertile for <5 years. Furthermore, 70.90% had primary infertility, while 26.20% experienced secondary infertility. The male participants were similarly mostly of Han ethnicity (96.30%), with 92% in their first marriage. Their age distribution mirrored that of the female participants, with the majority in the 30–34 years age group.

3.2 Prevalence of Psychological Stress

Descriptive data on psychological symptoms, including anxiety, depression, somatic symptoms, and sleep disorders, were collected using the standardized scales GAD-7, PHQ-9, PHQ-15, and PSQI (Table 2). Abnormal anxiety levels were seen in 29.10% of participants and abnormal depression levels in 34.20%, while 57.30% of participants reported no somatic symptoms and 79.60% had good sleep quality.

3.3 Univariate Analyses of Psychological Stress and Characteristics

Table 3 shows the relationships between anxiety, depression, somatic symptoms, and sleep quality with various demographic and fertility characteristics. A linear relationship was found between age and anxiety ($\chi^2 = 6.03$, $p < 0.05$). The younger the age, the higher the incidence of anxiety, although the correlation was weak ($r = –0.077$, $p = 0.014$). A linear relationship was also observed between the duration of infertility and sleep quality ($\chi^2 = 6.53$, $p < 0.05$). The longer the duration of infertility, the higher the incidence of sleep disorders, but again the correlation was weak ($r = –0.080$, $p = 0.011$). Additionally, occupational status was significantly associated with somatic symptoms ($\chi^2 = 11.54$, $p < 0.001$) and sleep quality ($\chi^2 = 7.92$, $p < 0.05$).

3.4 Multivariate Logistic Regression Analysis of Factors Related to Psychological Stress

Logistic regression analysis identified the key factors influencing anxiety, depression, somatic symptoms, and sleep quality (Table 4). Age was found to be significantly associated with anxiety, with participants aged <30 years being more likely to experience anxiety compared to older participants (OR = 1.801, 95% CI: 1.138–2.850, $p = 0.012$). Occupational status was a significant predictor of somatic symptoms, and participants who were not working were more likely to report such symptoms ($OR_{adjusted} = 2.183$, 95% CI: 1.323–3.603, $p = 0.002$). The duration of infertility was significantly associated with sleep disorders, as participants who had been infertile for >5 years were more likely to experience poor sleep quality ($OR_{adjusted} = 1.780$, 95% CI: 1.161–2.728, $p = 0.008$).

3.5 Relationship Between Psychological Stress and Conception Success

We next examined the relationship between successful conception and psychological symptoms. Following adjustment for age, employment status, duration of infertility and other characteristics, no significant associations were observed between successful conception and the factors of anxiety, depressive symptoms, somatic symptoms, or poor sleep quality (Table 5).

4. Discussion

This study provides insights into the psychological stress experienced by women undergoing AIH, as well as the impact of this stress on the rate of pregnancy success. The findings highlight the significant role of demographic factors such as age, occupational status, and duration of infertility in predicting psychological issues like anxiety, somatic symptoms, and sleep disorders. These factors can influence the overall wellbeing of patients, and hence may indirectly affect the success of fertility treatments.

The prevalence of mental health disorders, including anxiety, depression, somatic symptoms and sleep disorder, was found to be high among women undergoing AIH. This finding concurs with the results of a systematic review of 32 studies conducted by Bagade and coworkers [21]. These authors found the prevalence of mental health disorders, including anxiety, depression, psychological distress, and stress, was higher among women with infertility compared to fertile women. Furthermore, we found that social determinants influenced the severity of anxiety, depression, somatic symptoms and sleep disorder. Women undergoing AIH experienced worse mental health and sleep quality if they were young (<30 years), had a low education level, were unemployed, and had a long duration of infertility.

Table 3. Univariate analyses of psychological distress and participant characteristics.

Variables	Total, n (%)	Anxiety symptom			Depressive symptom			Somatic symptom			Sleep quality		
		yes	no	χ^2	yes	no	χ^2	yes	no	χ^2	poor	good	χ^2
Female													
Age (years) [a]				6.03*[b]			1.87			2.03			0.21
<30	300 (29.30)	99 (33.00)	201 (67.00)		112 (37.30)	188 (62.70)		137 (45.70)	163 (54.30)		57 (19.00)	243 (29.80)	
30–34	575 (56.20)	167 (29.00)	408 (71.00)		191 (33.20)	384 (66.80)		242 (42.10)	333 (57.90)		122 (21.20)	453 (78.80)	
≥35	149 (14.50)	32 (21.50)	117 (78.50)		47 (31.50)	674 (65.80)		58 (38.90)	91 (61.10)		30 (20.10)	119 (79.90)	
Ethnicity				0.04			0.77			0.06			0.09
Han	986 (96.30)	288 (29.20)	698 (70.80)		334 (33.90)	652 (66.10)		422 (42.80)	564 (57.20)		200 (20.30)	786 (79.70)	
Minority	38 (3.70)	10 (26.30)	28 (73.70)		16 (42.10)	22 (57.90)		15 (39.50)	23 (60.50)		9 (23.70)	29 (76.30)	
Marital status				0.66			2.74			<0.001			0.19
First marriage	961 (93.80)	283 (29.40)	678 (70.60)		335 (34.90)	626 (65.10)		410 (42.70)	551 (57.30)		198 (20.60)	763 (79.40)	
Digamy	63 (6.20)	15 (23.80)	48 (76.20)		15 (23.80)	48 (76.20)		27 (42.90)	36 (57.10)		11 (17.50)	52 (82.50)	
Occupational status				<0.001			1.76			11.54**			7.92*
Employed	950 (92.80)	276 (29.10)	674 (70.90)		319 (33.60)	631 (66.40)		391 (41.20)	559 (58.80)		184 (19.40)	766 (80.60)	
Not working	74 (7.20)	22 (29.70)	52 (70.30)		31 (41.90)	43 (58.10)		46 (62.20)	28 (37.80)		25 (33.80)	49 (66.20)	
Educational degree [a]				0.65			0.04			1.08			1.60
Junior college and below	420 (41.00)	126 (30.00)	294 (70.00)		149 (35.50)	271 (64.50)		191 (45.50)	229 (54.50)		94 (22.40)	326 (77.60)	
Bachelor	462 (45.10)	135 (29.20)	327 (70.80)		145 (31.40)	317 (68.60)		185 (40.00)	277 (60.00)		89 (19.30)	373 (80.70)	
Master and above	142 (13.90)	37 (26.10)	105 (73.90)		56 (39.40)	86 (60.60)		61 (43.00)	81 (57.00)		26 (18.30)	116 (81.70)	
Duration of infertility (years) [a]				1.00			3.80			5.27*[c]			6.53*[d]
≤2	607 (59.30)	173 (28.50)	434 (71.50)		193 (31.80)	414 (68.20)		237 (39.00)	370 (61.00)		112 (18.50)	495 (81.50)	
3–5	27 (27.20)	78 (28.00)	201 (72.00)		103 (36.90)	176 (63.10)		137 (49.10)	142 (50.90)		57 (20.40)	222 (79.60)	
≥5	138 (13.50)	47 (34.10)	91 (65.90)		54 (39.10)	84 (60.90)		63 (45.70)	75 (54.30)		40 (29.00)	98 (71.00)	
Previous pregnancy				<0.001			0.31			0.20			2.99
Yes	754 (73.60)	219 (29.00)	535 (71.00)		253 (33.60)	501 (66.40)		325 (43.10)	429 (56.90)		143 (19.00)	611 (81.00)	
No	269 (26.30)	78 (29.00)	535 (71.00)		96 (35.70)	173 (64.30)		111 (41.30)	158 (58.70)		65 (24.20)	204 (75.80)	
Male													
Age (years) [a]				1.97			0.12			0.28			0.01
<30	206 (20.12)	67 (32.50)	139 (67.50)		71 (34.50)	135 (65.50)		89 (43.20)	117 (56.80)		38 (18.40)	168 (81.60)	
30–34	540 (52.73)	157 (29.10)	383 (70.90)		187 (34.60)	353 (65.40)		234 (43.30)	306 (56.70)		119 (22.00)	421 (78.00)	
≥35	278 (27.15)	74 (26.60)	204 (73.40)		92 (33.10)	186 (66.90)		114 (41.00)	164 (59.00)		52 (18.70)	226 (81.30)	

Table 3. Continued.

Variables	Total, n (%)	Anxiety symptom			Depressive symptom			Somatic symptom			Sleep quality		
		yes	no	χ^2	yes	no	χ^2	yes	no	χ^2	poor	good	χ^2
Marital status				0.17			0.02			<0.001			<0.001
First marriage	942 (92.00)	272 (28.90)	670 (71.10)		323 (34.30)	619 (65.70)		402 (42.70)	540 (57.30)		192 (20.40)	750 (79.60)	
Digamy	82 (8.00)	26 (31.70)	56 (68.30)		27 (32.90)	55 (67.10)		35 (42.70)	47 (57.30)		17 (20.70)	65 (79.30)	
Educational degree (male) [a]				3.62			0.13			3.84			2.40
Junior college and below	385 (37.60)	123 (31.90)	262 (68.10)		138 (35.80)	247 (64.20)		186 (48.30)	199 (51.70)		89 (23.10)	296 (76.90)	
Bachelor	480 (46.90)	137 (28.50)	343 (71.50)		155 (32.30)	325 (67.70)		183 (38.10)	297 (61.90)		91 (19.00)	389 (81.00)	
Master and above	159 (15.50)	38 (23.90)	121 (76.10)		57 (35.80)	102 (64.20)		68 (42.80)	91 (57.20)		29 (18.20)	130 (81.80)	

Note: [a]The Cochran-Armitage trend method was used to test the linear relationship between ordered categorical variables (female age, female educational degree, infertility duration, male age, male educational degree) and binary categorical outcomes. [b]Pearson test: $r = –0.077$, $p = 0.014$, suggesting a weak negative correlation between female age and anxiety. [c]Pearson test: $r = –0.072$, $p = 0.022$, suggesting a weak positive correlation between duration of infertility and somatic symptoms. [d]Pearson test: $r = –0.080$, $p = 0.011$, suggesting a weak positive correlation between duration of infertility and sleep quality. The remaining associations were all non-significant ($p > 0.05$). $^{**}p < 0.001$; $^{*}p < 0.05$.

Table 4. Multivariate logistic regression analysis of factors related to anxiety, depression, somatic symptoms and sleep quality.

Variables	Crude			Model 1		
	Beta	OR (95% CI)	*p* value	*Beta*	OR (95% CI)	*p* value
Anxiety						
Age (years)						
<30	0.588	1.801 (1.138–2.850)	0.012	-	-	-
30–34	0.403	1.497 (0.973–2.302)	0.066	-	-	-
≥35	Ref.	Ref.	Ref.	-	-	-
Somatic symptom						
Occupational status (not working)	0.701	2.015 (1.222–3.324)	0.006	0.781	2.183 (1.323–3.603)	0.002
Duration of infertility (years)						
≤2	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
3–5	0.336	1.399 (1.045–1.873)	0.024	0.368	1.445 (1.078–1.937)	0.014
≥5	0.260	1.297 (0.881–1.910)	0.188	0.311	1.365 (0.926–2.013)	0.116
Educational degree (male)						
Junior college and below	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Bachelor	–0.246	0.782 (0.586–1.044)	0.782	–0.034	0.967 (0.726–1.287)	0.817
Master and above	–0.020	0.980 (0.660–1.457)	0.922	0.184	1.202 (0.796–1.815)	0.382
Sleep quality						
Occupational status (not working)	0.700	2.014 (1.200–3.379)	0.008	0.703	2.020 (1.202–3.396)	0.008
Duration of infertility (years)						
≤2	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
3–5	0.101	1.106 (0.770–1.587)	0.586	0.102	1.108 (0.771–1.591)	0.580
≥5	0.580	1.787 (1.169–2.731)	0.007	0.576	1.780 (1.161–2.728)	0.008
Previous pregnancy (yes)	0.265	1.303 (0.929–1.829)	0.125	0.260	1.297 (0.920–1.830)	0.138

Model 1: adjusted for age; OR, odds ratio; CI, confidence interval; Ref, reference.

Age is a critical factor in the success of ART, including AIH. Age-specific disparities are quite pronounced, with women aged <30 years and 30–39 years exhibiting 3-fold higher pregnancy rates than those aged ≥40 years (13.7% and 13.0% vs. 4.8%, $p < 0.05$), thus reinforcing age as a critical prognostic factor [3]. Age-specific outcomes have shown that women aged ≥38 years achieve significantly higher live birth rates with IVF than IUI-OS (risk ratio (RR) = 2.15, 95% CI: 1.16–4.00), a disparity that may amplify stress in older patients navigating prolonged IUI cycles before transitioning to IVF [4]. However, we found that younger women (<30 years) were more prone to anxiety. This result is inconsistent with the findings of several other studies. Teklemicheal *et al.* [22] found that older women (35 years and older) had more infertility-related stress, while Ogawa *et al.* [23] and Alhassan *et al.* [24] both reported that increasing age was correlated with higher depression scores. A possible reason for the discordant results may stem from variations in the study populations. Our study only included patients who underwent AIH for the first time. Younger infertile women face greater social pressures and uncertainties in career development, suggesting they may require additional psychological support during fertility treatment. Unemployment was significantly associated with somatic symptoms and sleep disorders in the present study. This result aligns with previous studies by Alhassan *et al.* [24] and Honarvar and Taghavi [25], who found that employed women had lower anxiety, depression and stress levels. However, Ikemoto *et al.* [26] found that perceived difficulties to continue working during fertility treatment, and infertility-related harassment in the workplace, were associated with higher rates of psychological distress. The duration of infertility was also positively associated with somatic symptoms and sleep disorders in the current study. This concurs with the finding by Teklemicheal *et al.* [22] that women with 4–6 years of infertility experienced more severe infertility-related stress. Because such high-risk groups are prone to psychological stress, methods such as cognitive behavioral therapy (CBT) [27], stress-management [28], acupuncture [29], mindfulness-based group counselling, and expressive writing intervention [30] are recommended before entering the treatment cycle. Moreover, it is crucial that both the husband and wife receive psychological intervention. A study of 83 AIH patients demonstrated that psychological interventions centered around the couples, significantly enhanced emotional regulation, adaptive coping strategies, and marital quality compared to standard care, with improved treatment literacy in both the patients and their spouses [31].

Our study found no significant associations between psychological factors (anxiety, depression, somatic symptoms, sleep disorders) and conception success, even after adjustment for covariates such as age, occupational

Table 5. Associations between successful conception and the factors of anxiety, depression, somatic symptoms and sleep quality.

Variables	Successful conception, n (%)	Crude		Model 1		Model 2	
		OR (95% CI)	*p* value	OR (95% CI)	*p* value	OR (95% CI)	*p* value
Anxiety symptoms							
Yes	74 (10.8)	0.936 (0.639–1.370)	0.733	0.933 (0.636–1.367)	0.721	0.706 (0.430–1.159)	0.169
No	23 (7.9)	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Depressive symptoms							
Yes	65 (10.2)	0.927 (0.593–1.446)	0.737	0.925 (0.592–1.444)	0.732	0.955 (0.607–1.504)	0.843
No	32 (9.5)	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Somatic symptom							
Yes	55 (9.9)	1.022 (0.669–1.560)	0.921	1.019 (0.666–1.557)	0.932	1.029 (0.668–1.584)	0.897
No	42 (10.0)	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Sleep disorder							
Yes	76 (9.8)	1.066 (0.640–1.775)	0.807	1.067 (0.640–1.776)	0.805	1.087 (0.645–1.831)	0.753
No	21 (10.4)	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.

Crude: unadjusted; Model 1: adjusted for age; Model 2: adjusted for ethnicity, marital status, BMI, occupational status, educational level, infertility duration, previous pregnancy, follicle-stimulation hormone (basic), progesterone (basic), testosterone (basic), prolactin (basic), estrogen (basic) and anti-mullerian hormone.

status, and sex hormones. However, some studies have demonstrated an association between psychological stress and pregnancy rate. A systematic review conducted by Matthiesen *et al.* [32] found that stress, trait anxiety, and state anxiety were negatively associated with clinical pregnancy rates. This inconsistency may be due to dynamic changes in the psychological stress of infertile women across treatment cycles, as well as differences between study populations (AIH vs. *in vitro* fertilization-embryo transfer). Psychological stress can impact reproductive outcomes through various mechanisms, including neuroendocrine changes and immune system dysfunction. For example, chronic stress can suppress LH pulsatility and reduce tubal motility, both of which can hinder the reproductive process. While cumulative clinical pregnancy rates reach 37.4% over three IUI-OS cycles, the live birth success rate declines by 25% per additional cycle ($OR_{adjusted}$ = 0.75, 95% CI: 0.62–0.93), potentially exacerbating the psychological distress of couples as they undergo repeated unsuccessful attempts. Symptom Checklist-90 assessments revealed that recurrent AIH failures exhibited higher anxiety, hostility, phobic anxiety, and total scores compared to first-time patients ($p < 0.05$), with the psychological distress increasing with each treatment cycle ($p < 0.05$) [33]. Randomized trials have shown that preoperative psychological interventions can improve psychological wellbeing and pregnancy rates [34]. However, adjunctive psychological care has non-significant impacts on clinical conception rates, despite enhancing patient adherence and satisfaction [35]. Conversely, cumulative stressors and maladaptive traits predict conception failure [36], suggesting that psychological factors may operate indirectly through pathways such as treatment persistence or neuroendocrine modulation. Collectively, these studies highlight that psychological variables are likely to influence AIH outcomes via intermediary mechanisms rather than direct biological causality, reinforcing the need for holistic care models to address both mental health and reproductive goals.

Limitation

Our study had several limitations. First, data analysis was not controlled for biological factors such as sperm DNA fragmentation and the psychological assessment of men, which could confound the results. Secondly, psychological assessments only measure baseline stress levels, and assessments were not conducted throughout the treatment cycle. The 2024–2028 National Institutes of Health Strategic Plan advocates interdisciplinary approaches, including artificial intelligence, to disentangle cyclical stress fluctuations and confounders [37]. Such methodologies could address limitations due to static psychological assessments, as highlighted by NIH studies linking AIH failure to unmeasured biological variables. Future research should focus on longitudinal studies that track psychological stress levels throughout the treatment cycle, as well as controlling for biological factors, socioeconomic status and lifestyle to provide a more comprehensive understanding of the relationship between psychological stress and fertility outcomes.

5. Conclusion

This study examined associations between demographic characteristics and mental health disorders. Notwithstanding the methodological limitations, the findings of our study underscore the need for targeted psychological interventions among specific populations, including younger individuals, unemployed persons, and patients experiencing prolonged infertility. Although no statistically significant direct relationship was observed between mental health disorders and conception success, the amelioration of psychological wellbeing may enhance

quality of life and overall health outcomes. Future research should further deconstruct the complex interplay between mental health and reproductive health to develop evidence-based interventions for vulnerable groups.

Our results support integration of the biopsychosocial model into treatment protocols for AIH, wherein psychological wellbeing constitutes an essential component of holistic patient care. By addressing psychological comorbidities—particularly anxiety, somatic symptom disorders, and sleep disturbances—this could not only optimize patient quality of life, but potentially improve the success rates of ART. Evidence-based multidisciplinary frameworks should engage both partners throughout therapeutic consultations and procedures, thereby enhancing coping mechanisms and treatment adherence while mitigating perceptions of isolation or unilateral responsibility [38]. Future investigations should aim to further delineate psychoreproductive interactions, thereby developing more effective interventions to support dyadic wellbeing during fertility treatment.

Availability of Data and Materials

The datasets used and analyzed during the current study available from the corresponding author on reasonable request.

Author Contributions

MJR: design of the work, write the main manuscript; YYW: acquisition, analysis of data for the work, write the main manuscript; YP: study conception, design, data analysis. All authors contributed to editorial changes in the manuscript. All authors read and approved the final manuscript. All authors have participated sufficiently in the work and agreed to be accountable for all aspects of the work.

Ethics Approval and Consent to Participate

This study was approved by Ethics Committee of West China Second University Hospital, Sichuan University (No.2024248). We abided research process by the ethical principle of informed consent, voluntary, harmless. All study procedures were strictly followed the Declaration of Helsinki.

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Conflict of Interest

The authors declare no conflict of interest.

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