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Over one-third of professionals in French ART centers experience job strain

Lucie Delaroche[1,2,3]✉, Fabienne Bazin[4] & Nathalie Sermondade[3,5]

This study aimed to evaluate the level of strain experienced by professionals across 104 French assisted reproductive technology (ART) centers. A cross-sectional survey was conducted from November 2023 to January 2024, using an online questionnaire based on Karasek's and Siegrist's models to assess psychological demands, decision latitude, social support, and the balance between efforts and rewards. Additional questions collected personal and professional details. Job strain was defined by high demands and low decision latitude, while iso-strain also included low social support. Effort-reward imbalance (ERI) referred to a situation where individuals experience high effort in their work but perceive the rewards as insufficient. The study included 464 participants (13% participation rate), comprising biologists (*n* = 124, 26.7%), gynecologists (*n* = 129, 27.8%), technicians (*n* = 107, 23.1%), secretaries (*n* = 51, 11.0%), midwives (*n* = 31, 6.7%), and other professions (*n* = 22, 4.7%). We found that 35.7% of professionals in French ART centers experienced job strain, with 20.9% in an iso-strain situation and 14.9% showing an imbalance between efforts and rewards. Multivariate logistic regression analysis revealed a significant impact of occupational roles on job strain, with secretaries (OR 9.76 [3.70; 25.78]) and technicians (OR 8.62 [3.45; 21.53]) facing a higher risk compared to gynecologists. A strong correlation was found between perceived work stress or job satisfaction and the risk of job strain, iso-strain, and ERI. In conclusion, our study revealed that over a third of French ART professionals experienced job strain, a condition linked to increased risks of stress, burnout, and health concerns. Secretaries and technicians appeared particularly vulnerable, highlighting the need for targeted interventions. Future research should aim to identify specific stressors and protective factors to help create tailored support programs that promote staff well-being.

Keywords Job strain, Stress, Psychosocial care, Karasek, Siegrist, ART centre, Occupational

Workplace stress is a growing issue in modern societies, affecting millions of workers around the world. A staggering one in six European employees report chronic stress-related health problems[1]. According to the cognitive model of stress and coping, occupational stress arises from a perceived imbalance between job demands and the individual's resources to manage them[2]. Health professionals are particularly vulnerable due to long working hours, high workloads, shift work, emotional demands from confronting suffering and death, as well as various physical challenges[3].

The consequences of workplace stress are multifaceted, affecting both physical health (e.g., headaches, digestive issues, sleep disturbances, cardiovascular problems) and mental health (e.g., anxiety, depression, irritability, reduced concentration). Stress can negatively impact job satisfaction and decrease performance[4,5]and may contribute to increased absenteeism and employee turnover, leading to significant costs for businesses[6].

To assess occupational stress, various methods are available, which can be grouped into three main approaches: the use of instruments for self-reported measures (such as the Perceived Stress Scale (PSS)[7]Patient Health Questionnaire (PHQ-15)[8]and Maslach Burnout Inventory General Survey (MBI-GS)[9]); objective observational measures of job stressors (including physiological responses to stress, such as heart rate, blood pressure, cortisol levels, etc.); and behavioural measures (focusing on external manifestations of stress, such as absenteeism, productivity, and social behaviours)[10]. The Job Content Questionnaire (JCQ) is a well-known example of a self-reported psychological questionnaire created and validated by Karasek in 1979 [11–13]. It

[1]Ramsay Santé, Hôpital Privé de Parly 2, Le Chesnay Rocquencourt, France. [2]Centre de Biologie Médicale - Biogroup, Le Chesnay-Rocquencourt, France. [3]Fédération Nationale des Biologistes des Laboratoires d'Étude de la Fécondation et de la Conservation de l'OEuf (BLEFCO), Labège, France. [4]Horiana, Bordeaux, France. [5]Service de Biologie de la Reproduction CECOS, Hôpital Tenon, Assistance Publique-Hôpitaux de Paris, Hôpitaux Universitaires Est Parisien, Paris, France. ✉email: lucie.delaroche@biogroup.fr

assesses job demands, including the mental burden of completing tasks, encompassing time constraints and interruptions, while also measuring decision latitude which reflects the level of control employees have over their work, and the social support at work from both superiors and colleagues[14]. On the other hand, the Effort-Reward Imbalance (ERI) model from Siegrist evaluates stress based on the balance between effort (time, energy, responsibility) and rewards (salary, recognition, career advancement), as well as personal coping strategies[15]. For example, overcommitted workers driven by a fear of losing control and a strong desire for appreciation may set unrealistic expectations and invest excessive effort, leading to sustained stress and strain[16].

Numerous studies have been made of the mental and physical health of healthcare professionals[17,18]. However, research on the well-being of diverse Assisted Reproductive Technologies (ART) teams is scarce. Previous studies focused on burnout risk among embryologists in the United States[19]Spain[20–22]and in the United Kingdom[23]showing high levels of mental health issues and stress. A wider understanding of the psychosocial dynamics within ART centres is crucial for promoting a supportive work environment and limiting stress-related challenges among professionals.

The objective of this study was to assess the level of strain experienced by professionals working in French ART centres, using the questionnaires developed by Karasek[11] and Siegrist[15].

Materials and methods

Ethics committee

The study was approved by the Ramsay Santé group Ethics Committee (IRB00010835, approval number COS-RGDS-2024-11-004-DELAROCHE-L) and was declared compliant with the reference methodology MR-004 (CNIL, Commission Nationale de l'Informatique et des Libertés, reference 2233812 v 0). All procedures adhered to relevant guidelines and regulations. Participants received an email invitation that explained the study's purpose, assured anonymity, and clarified that participation was voluntary. Informed consent was obtained from all participants. All data were collected anonymously, with no identifying information. Only individuals aged 18 or older were eligible to participate.

Questionnaire

From November 21th, 2023, to January 21st, 2024, an online survey was emailed to healthcare professionals across all French ART centres. The questionnaire was distributed by the Professional associations FFER (Fédération Française des Etablissements de Reproduction), BLEFCO (Fédération nationale des biologistes des laboratoires d'étude de la fécondation et de la conservation de l'œuf), and SMR (Société de la Médecine de la Reproduction) through their mailing lists, with several reminder emails sent. Centre managers were specifically contacted and asked to raise awareness among their teams and share the questionnaire link with professionals outside these associations, such as secretaries and psychologists. The survey link was also posted on the respective websites of these associations and shared on social media platforms, including LinkedIn and WhatsApp.

The questionnaire included a total of 58 questions, based on the validated models by Karasek[11] and Siegrist[15]as well as 7 demographic questions and 2 Visual Analog Scales (VAS).

Demographic questions

Professionals selected their profession: gynaecologist, biologist, technician, secretary, midwife or other. In France, the term "biologist" refers to medical biologists or pharmacist biologists who participate in the supervision of the ART laboratory and the team of technicians. The term "technicians" encompasses embryologists who perform the technical procedures of ART. Participants also specified their gender, age category, ART centre type and years of experience in ART. Workload was categorized based on number of days worked *per* week and the number of hours worked *per* day.

Karasek's model

The Karasek model assessed psychological demands (scale ranging from 9 to 36), decision latitude (scale ranging from 24 to 96), and social support using 26 questions rated on a four-point Likert scale. Professionals were categorized into four job profiles based on the combination of psychological demand and latitude scores: passive, relaxed, active, or stressed (job strain). Job strain combines high psychological demands (score > 21) with low decision latitude (score < 70). Additionally, social support (scale ranging from 8 to 32) was evaluated separately for managers (scale ranging from 4 to 16) and colleagues (scale ranging from 4 to 16). Iso-strain, a more severe form of job strain, was defined by the co-occurrence of job strain and low social support (score < 24).

Siegrist's model

Siegrist's model evaluated extrinsic effort (scale ranging from 6 to 30), rewards (scale ranging from 11 to 55), and overcommitment (on a scale of 6 to 24) with 23 questions on a five-point Likert scale. The effort-reward imbalance (ERI) was calculated to identify individuals experiencing high extrinsic effort with low rewards (ratio effort/reward > 1).

Visual analog scales (VAS)

The questionnaire incorporated two visual analog scales (VAS) to evaluate perceived work stress and job satisfaction, both measured on a 1–10 scale. Work stress was categorized into three levels based on VAS scores: low work pressure (1–4), moderate work pressure (5–7), and high work pressure (8–10). Similarly, job satisfaction was classified into three groups: low job fulfilment (1–4), moderate job fulfilment (5–7), and high job fulfilment (8–10). Further details on the specific scoring methods and complete item formulation are provided in the Supplementary Material.

Statistical methodologies

Analyses were performed using SAS® software (version 9.4 or higher), with significance set at $p < 0.05$. Quantitative variables were described by the number of observed values, mean and standard deviation. The comparison of quantitative variables between groups was performed using a Wilcoxon test (comparison between 2 groups) or a Kruskal-Wallis test (comparison of more than 2 groups).

Qualitative variables were described by the number of observed values and frequencies for each class. Patients with missing data were not included in the calculation of percentages. The comparison of qualitative variables between groups was performed using a Chi-square test.

Multivariate analyses were conducted using logistic regression models to identify factors associated with Job Strain, Iso-Strain, and ERI Imbalance. The models included age, gender, type of ART centre, years of experience in ART, weekly workload, job category, work stress, and job satisfaction. All variables were retained in the models regardless of their statistical significance to assess the independent effect of each factor while controlling for potential confounders. This approach ensured that the observed associations accurately reflect the specific contribution of each variable, holding all other factors constant.

Additionally, interaction terms were tested to determine whether the effect of each factor on the outcomes varied by job category. These interaction terms, representing the relationship between job category and each independent variable, were incorporated into the models. The results indicated that none of these interactions were statistically significant, suggesting that the impact of the factors on the studied outcomes remained consistent across job categories. As a result, stratified analyses by job category were not deemed necessary. Instead, job category was included as an adjustment variable in the models to account for its influence while preserving sample size and statistical power.

Results

Participants

Out of a total population of professionals working in the 104 French ART centres, 483 participated in the survey, representing a response rate of approximately 13%.

Nineteen (3.9%) questionnaires were excluded: 5 questionnaires were completed before the official survey launch date and 9 participants were from centres that either did not perform ART or were located outside of France. Additionally, 5 questionnaires from medical residents were excluded.

This resulted in a final sample of 464 participants. The distribution of functions among the participants was as follows: 124 (26.7%) biologists, 129 (27.8%) gynaecologists, 107 (23.1%) technicians, 51 (11.0%) secretaries, 31 (6.7%) midwifes and 22 (4.7%) other functions: 6 nurses, 6 psychologists, 4 healthcare managers, 3 engineers, 2 urologists and one centre manager. One participant "endocrinologist" was included in the "gynaecologist" group and one participant "embryologist" was included in the "technician" group (Fig. 1).

Demographic characteristics of the participants

The majority of participants were employed at public institutions (59.1%). Most professionals were female (81.5%). The remaining were male (18.1%), primarily biologists and gynaecologists, and non-binary (0.4%). Participants were drawn from across all age groups, with slightly fewer professionals over the age of 60 (3.9%). Participants represented a wide range of experience levels. The most common work schedule among participants was five days a week (64.9%). However, work patterns varied, with 18.5% completing their tasks in 4 days and 12.9% taking 6 days. A 7 to 8-hour workday was the norm for most professionals (42.0%). A medium workload per week was the most common experience among participants (36.6%). All demographic characteristics of the participants are presented in (Supplementary Table S1).

Results from karasek's model

A total of 76.1% of professionals experienced high psychological demand (score > 21), while 39.0% reported low decision latitude (score < 70). The distribution of professionals based on their psychological demand and decision latitude scores identified four distinct profiles: 8.9% passive, 14.8% relaxed, 35.7% stressed (job strain), and 40.5% active. These profiles varied significantly across job functions ($p < 0.001$). Gynaecologists and biologists were predominantly classified as active professionals, whereas technicians and secretaries were mostly categorized as stressed (Table 1; Fig. 1).

While a large majority of professionals (87.7%) felt supported by their colleagues, nearly half (45.1%) reported a lack of managerial support. Overall, more than a third (35.3%) had a low global social support score (< 24). The association between job strain and low social support (termed iso-strain) was observed in 20.9% of professionals, with significant differences across occupations ($p = 0.0011$), ranging from 6.7% of midwives to 34.6% of technicians. Furthermore, the prevalence of iso-strain among professionals experiencing job strain varied significantly by occupation, reaching a peak of 66.7% among biologists ($p = 0.0182$).

The figure illustrates the distribution of professionals across four categories (passive, active, relaxed, or stressed) based on their decision latitude and psychological demand scores. Each point represents an individual professional's profile, with shapes denoting different professional categories. Overlapping points indicate identical scores. Blue symbols denote isotrain profiles.

Results from siegrist's model

Across all professionals, the mean reported extrinsic effort was 15.8 ± 5.0 and the mean reported rewards score was 21.6 ± 7.9 with significative differences between functions ($p < 0.0001$) (Table 1). A total of 14.9% of professionals experienced imbalance between high extrinsic effort and low rewards (ratio > 1). The ERI was found to be more prevalent among professionals in other functions (27.3%) and technicians (19.2%), although

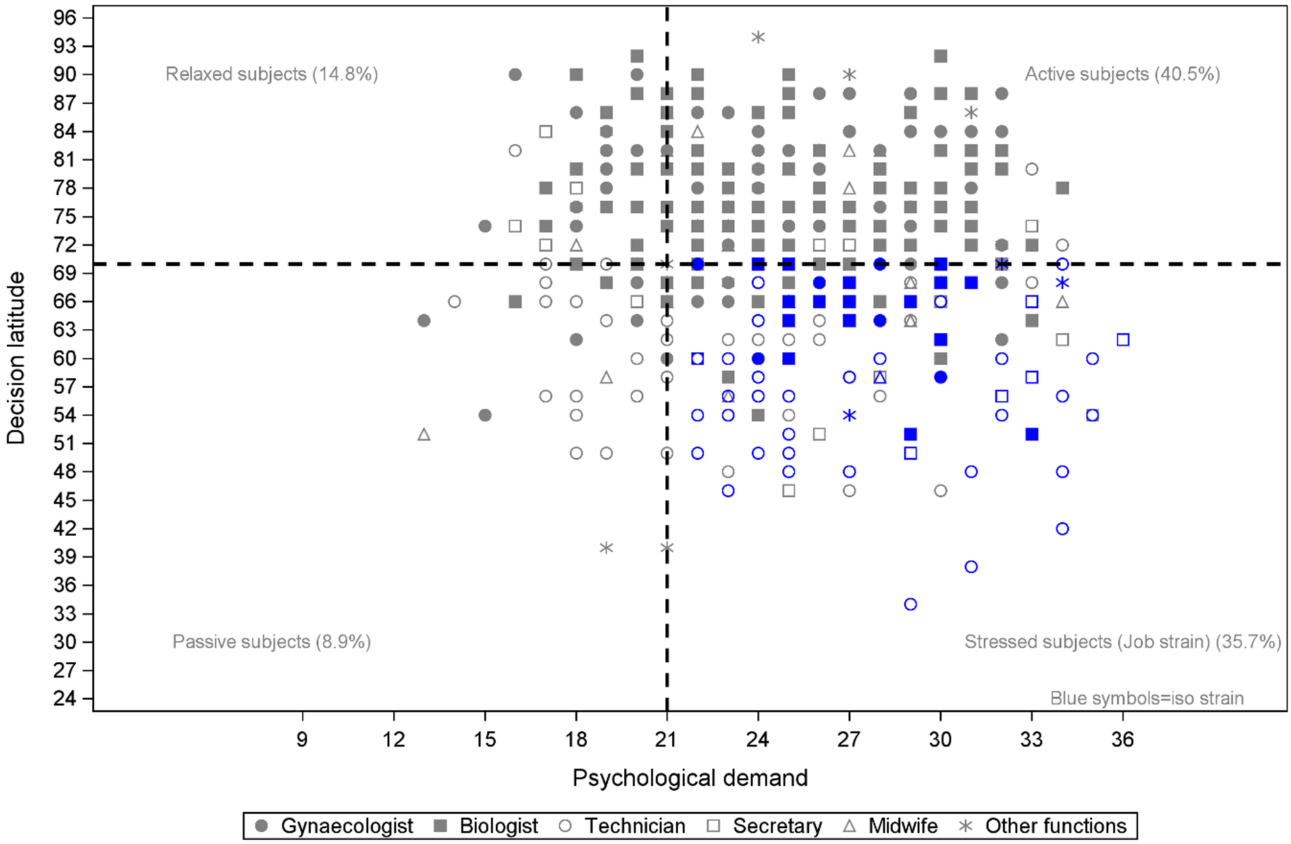

Fig. 1. Distribution of professionals by function according to the four profiles defined by Karasek psychological demand and latitude scores.

the statistical difference between groups was not significant. The mean score for overcommitment was 15.9 ± 4.1, with significant differences observed between professional functions ($p < 0.0001$).

Visual analog scales analysis

The overall mean work stress score for all professionals was 5.9 ± 2.0, with significant differences observed across job functions ($p = 0.0005$). A high work stress score (8 to 10) was reported by 26.2% of technicians and 25.2% of biologists (Table 2).

The mean job satisfaction score was 6.8 ± 1.9, with significant variations between functions ($p = 0.0158$). Notably, 17.9% of technicians reported a low job satisfaction score (1 to 4).

Factors associated with job strain

Multivariable logistic regression showed that professionals from public centres had a higher job strain risk (OR = 2.06 [95% CI: 1.17; 3.63]) compared to those from for-profit private centres. Furthermore, technicians and secretaries were respectively significantly more likely to experience job strain compared to gynaecologists (OR 8.62 [95% CI 3.45; 21.53]; OR 9.76 [95% CI 3.70; 25.78]). Similarly, midwives experienced a higher job strain risk compared to gynaecologists (OR 3.47 [95% CI 1.19; 10.17]). Increased perceived work stress and decreased job satisfaction are both associated with a higher risk of job strain, with odds ratios of 5.25 [95% CI 2.28; 12.10] and 7.19 [95% CI 3.17; 16.30], respectively (Fig. 2A).

Factors associated with iso strain

Multivariate analysis revealed that the risk of iso strain was higher for female professionals compared to males (OR 4.41 [95% CI 1.41; 13.82]). Furthermore, the higher the work pressure and the lower the job fulfilment, the greater was the risk of iso-strain, with OR = 2.66 [95% CI 1.40; 5.06] and OR 2.71 [95% CI 1.31; 5.64], respectively (Fig. 2B).

Factors associated with ERI

High work pressure (OR 9.73[4.84; 19.54]), along with low job fulfilment (OR 3.96 [1.66; 9.40]) were significantly associated with a risk of ERI (Fig. 2C).

These figures display adjusted odds ratios (OR) with 95% confidence intervals (CI) for Job strain, Iso-strain, and Effort-Reward Imbalance (ERI) among ART professionals (respectively, $n = 455$, 379 and 398). The analysis considers factors such as gender, age, ART centre type, years of ART experience, weekly workload, profession,

	All participants (*n* = 464)*	Gynaecologist (*n* = 129)	Biologist (*n* = 124)	Technician (*n* = 107)	Secretary (*n* = 51)	Midwife (*n* = 31)	Other functions (*n* = 22)	*p*-value
KARASEK								
Psychological demand >21, n (%)	353 (76.1)	93 (72.1)	98 (79.0)	82 (76.6)	41 (80.4)	23 (74.2)	16 (72.7)	0.7831[a]
Decision latitude < 70, n (%)	179 (39.0)	22 (17.1)	30 (24.2)	81 (77.1)	27 (54.0)	13 (43.3)	6 (28.6)	**< 0.0001[a]**
Social support at work, n (%)								
Manager support < 12	175 (45.1)	24 (30.8)	52 (48.6)	63 (59.4)	17 (36.2)	10 (32.3)	9 (47.4)	**0.0016[a]**
Colleague support <12	57 (12.3)	13 (10.1)	15 (12.1)	19 (17.8)	4 (7.8)	0 (0.0)	6 (27.3)	**0.0197[a]**
Global social support <24	137 (35.3)	20 (25.6)	45 (42.1)	46 (43.4)	10 (21.3)	7 (22.6)	9 (47.4)	**0.0074[a]**
Profiles								
Professional profile, n (%)*								
Passive profile	41 (8.9)	8 (6.2)	5 (4.0)	18 (17.1)	3 (6.0)	4 (13.3)	3 (14.3)	**< 0.0001[a]**
Relaxed profile	68 (14.8)	28 (21.7)	21 (16.9)	5 (4.8)	7 (14.0)	4 (13.3)	3 (14.3)	
Stressed profile (Job strain)	164 (35.7)	21 (16.3)	34 (27.4)	66 (62.9)	28 (56.0)	10 (33.3)	5 (23.8)	
Active profile	186 (40.5)	72 (55.8)	64 (51.6)	16 (15.2)	12 (24.0)	12 (40.0)	10 (47.6)	
Iso-strain profile, n (%)**	80 (20.9)	9 (11.5)	22 (20.6)	36 (34.6)	8 (17.4)	2 (6.7)	3 (16.7)	**0.0011[a]**
Iso-strain profile among Job strain profile, n (%)**	80 (50.3)	9 (52.9)	22 (66.7)	36 (54.5)	8 (28.6)	2 (20.0)	3 (60.0)	**0.0182[b]**
SIEGRIST								
Extrinsic effort (score 6 to 30) mean (SD)	15.8 (5.0)	15.8 (4.9)	16.9 (5.3)	14.7 (4.9)	15.7 (4.9)	15.0 (4.0)	15.8 (5.6)	0.0812[c]
Rewards (score 11 to 51) mean (SD)	21.6 (7.9)	19.2 (6.8)	20.5 (7.3)	24.7 (8.3)	20.9 (7.8)	19.4 (5.2)	26.4 (9.6)	**< 0.0001[c]**
Effort-reward balance								
Ratio > 1 (ERI), n (%)***	60 (14.9)	7 (8.6)	19 (16.8)	20 (19.0)	7 (14.0)	1 (3.2)	6 (27.3)	0.1002[a]
Overcommitment (score 6 to 24) Mean (SD)	15.9 (4.1)	16.7 (3.3)	17.3 (4.1)	14.6 (4.1)	14.1 (4.0)	14.1 (4.0)	16.9 (5.3)	**< 0.0001[c]**

Table 1. Analysis of Karasek and siegrist models. This table presents the distribution of Karasek and Siegrist scores and profiles according to job function. Results are expressed as means (SD) or n (%). Percentages are calculated based on all participants included in the analysis, excluding those with missing values. Statistical comparisons across the six occupational categories were performed using the Chi² test[a], Fisher's exact test[b], or Kruskal-Wallis test[c], as appropriate. **n* = 5 missing (2 technicians, 1 secretary, 1 midwife, 1 other) for professional profiles. ***n* = 76 missing (51 gynaecologists, 17 biologists, 1 technician, 4 secretaries, 3 others) for iso-strain profile. ****n* = 62 missing (48 gynaecologists, 11 biologists, 2 technicians, 1 secretary); SD: standard deviation.

	All participants (*n* = 464)*	Gynaecologist (*n* = 129)	Biologist (*n* = 124)	Technician (*n* = 107)	Secretary (*n* = 51)	Midwife (*n* = 31)	Other functions (*n* = 22)	*p*-value
Work stress*								
Mean (SD)	5.9 (2.0)	5.7 (2.0)	6.2 (2.0)	6.3 (1.9)	5.7 (2.0)	4.6 (2.1)	6.0 (2.3)	**0.0005[a]**
Score n, (%)								
Low (1 to 4)	102 (22.0)	37 (28.7)	18 (14.6)	13 (12.1)	12 (23.5)	16 (51.6)	6 (27.3)	**0.0001[b]**
Moderate (5 to 7)	270 (58.3)	76 (58.9)	74 (60.2)	66 (61.7)	31 (60.8)	12 (38.7)	11 (50.0)	
High (8 to 10)	91 (19.7)	16 (12.4)	31 (25.2)	28 (26.2)	8 (15.7)	3 (9.7)	5 (22.7)	
Job satisfaction**								
Mean (SD)	6.8 (1.9)	7.1 (1.7)	6.8 (1.8)	6.2 (2.1)	7.1 (2.0)	7.0 (1.6)	6.5 (2.2)	**0.0158[a]**
Score n, (%)								
Low (1 to 4)	55 (11.9)	8 (6.2)	14 (11.3)	19 (17.9)	6 (11.8)	4 (12.9)	4 (18.2)	0.0985[b]
Moderate (5 to 7)	230 (49.7)	73 (56.6)	63 (50.8)	54 (50.9)	20 (39.2)	11 (35.5)	9 (40.9)	
High (8 to 10)	178 (38.4)	48 (37.2)	47 (37.9)	33 (31.1)	25 (49.0)	16 (51.6)	9 (40.9)	

Table 2. Analysis of work stress and job satisfaction assessed using visual analog scales. This table presents work stress and job satisfaction among ART professionals (*n* = 464) based on their functions, as assessed using visual analog scales. Scores are expressed as means (SD) or n (%). Statistical comparisons across the six occupational categories were conducted using the Kruskal-Wallis test[a] or the Chi² test[b], as appropriate. **n* = 1 missing (1 biologist); ***n* = 1 missing (1 technician).

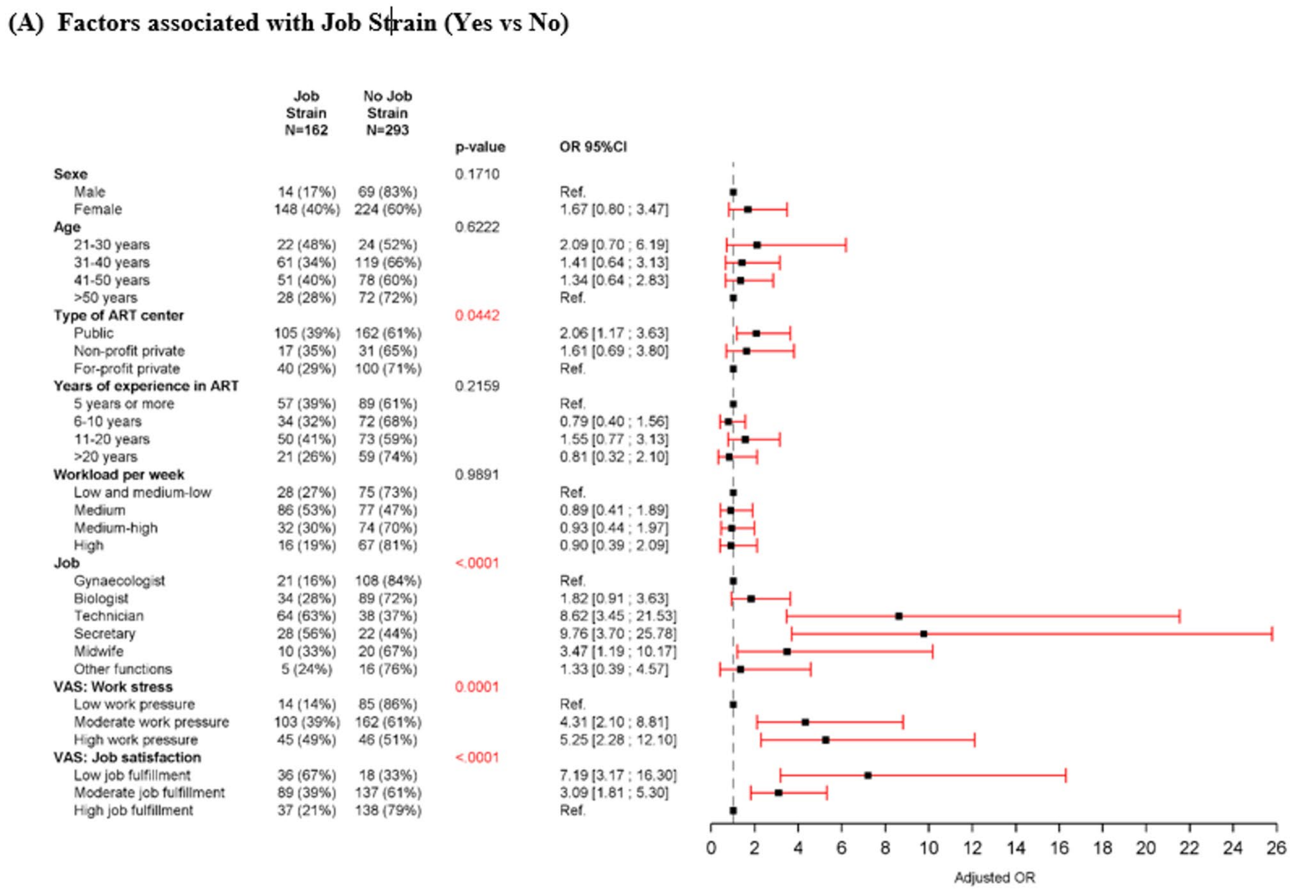

Fig. 2. Factors associated with job strain (**A**), iso strain (**B**) and effort-reward imbalance (**C**)—multivariable logistic regression.

work stress, and job satisfaction measured by VAS scores. Common exclusions across all analyses were non-binary participants ($n = 2$) and missing data for VAS job satisfaction and work stress ($n = 2$). Specific exclusions for each analysis were: job strain ($n = 5$), iso-strain ($n = 81$), and ERI ($n = 62$). Black points represent OR estimates, and red lines show 95% CI.

Comparison of work experiences and work-related stress across functions based on Karasek and siegrist models

All functions agreed that their work required them to work quickly and manage an excessive workload, with no significant differences between them. However, 91.6% of technicians reported that their work demanded long periods of intense concentration, a higher proportion compared to other functions ($p = 0.0496$). Despite this, technicians did not report frequent interruptions before completing their tasks. In contrast, the majority of secretaries stated that their tasks were often interrupted before completion (90.2%) and that their work was very hectic (76.5%) ($p < 0.0001$).

All professionals agreed that their work involved repetitive tasks, with no significant differences between them. Gynaecologists, along with biologists, reported having considerable latitude in their jobs, unlike technicians ($p < 0.0001$). Most biologists (97.6%) reported having varied activities ($p = 0.282$) and opportunities to develop their professional skills (95.2%), while only 23.4% of technicians felt their work required creativity.

Additionally, 82.0% of secretaries felt supported by their hierarchy, and 84.3% believed their supervisor paid attention to their concerns—significantly higher proportions than those of technicians, among whom only 49.5% felt their supervisor cared about their well-being. However, the majority of professionals reported receiving support from their colleagues.

Biologists were the professionals who reported putting in the most effort at work. One third of them stated they had significant responsibilities and had to work extra hours, significantly more than in other professions. Nearly half of the technicians felt their chances of promotion were slim. A minority of biologists (17.7%) expressed satisfaction with their salary and promotion prospects compared to other professionals ($p < 0.0001$), and only 12.1% felt they received the respect and recognition they deserved at work.

Finally, for the majority of biologists, work-related stress negatively impacted their personal lives. For example, 66.9% of biologists started thinking about work-related issues as soon as they woke up, 66.1% had difficulty relaxing after returning home, and 68.5% still had work on their minds at bedtime. These proportions were higher compared to those reported by other functions (Table 3).

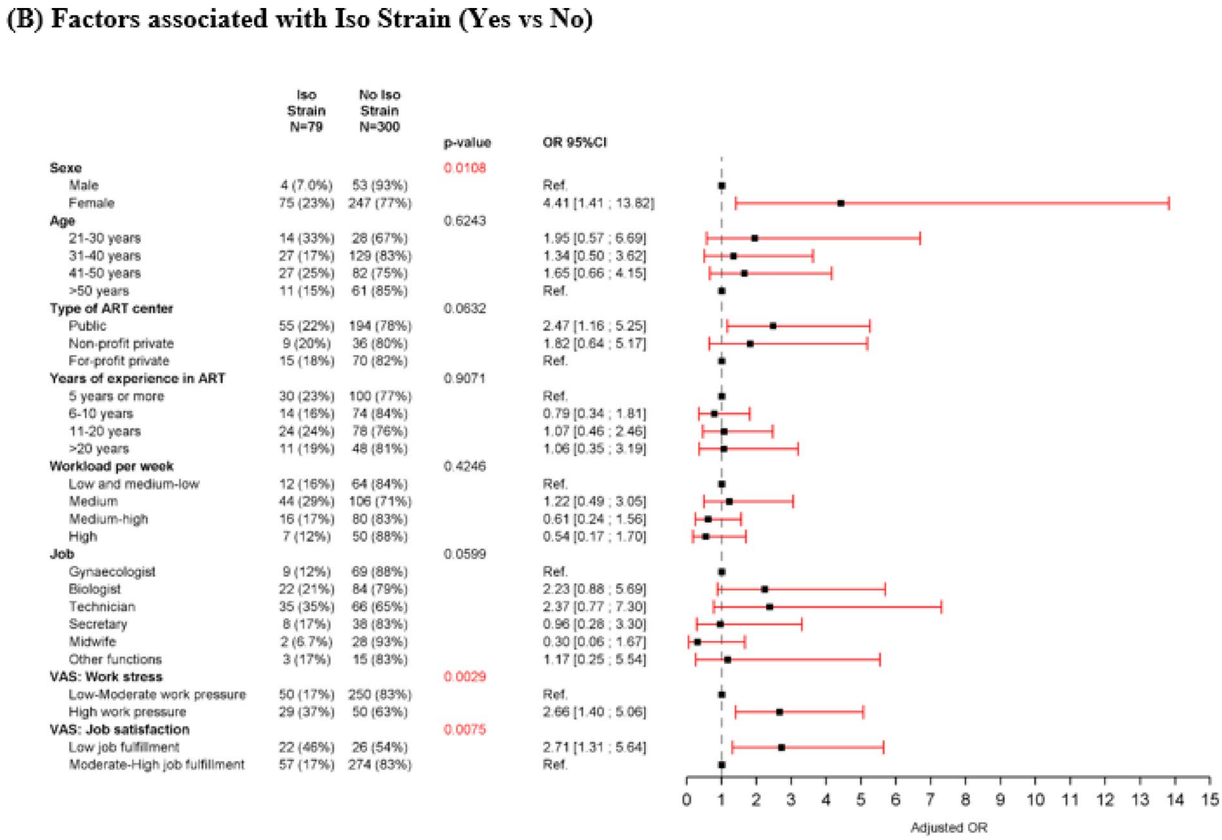

Fig. 2. (continued)

Discussion

This study found that 35.7% of professionals in French ART centres experienced job strain, with 20.9% in an iso-strain situation and 14.9% showing an imbalance between efforts and rewards, as measured by Karasek's and Siegrist's scales[11,15]. The prevalence of job strain observed in this study was significantly higher than the 23.2% reported in the general French population[24]. However, our findings align with previous research on healthcare professionals, where job strain prevalence ranged widely, such as 30.1–95.8% in emergency departments and 67.0% among intensive care nurses[25–27]. The decline in well-being among healthcare workers post-COVID-19 further contextualizes these results, with burnout affecting over one-third of public health workers globally[17,18,28].

Our study highlighted the significant impact of occupational roles on job strain, with secretaries facing a ninefold higher risk and technicians an eightfold increased risk compared to gynaecologists. This finding is particularly notable given the growing body of literature on health issues among IVF professionals, which predominantly focuses on embryologists[20–23,29,30]. Previous studies have shown that UK embryologists experience physical ailments, including musculoskeletal disorders, ocular and auditory issues, as well as injuries from needlesticks and liquid nitrogen[23]. Additionally, 27.8% of UK embryologists reported mental health problems[23]. In Spain, while embryologists reported better physical health than the general population, 36.3% were at high risk of burnout[20]. High levels of burnout have also been recently reported among UK (59%) and US (62%) embryologists[22]. Although our study did not specifically assess burnout, it found that 62.9% of technicians experienced job strain, with 34.6% in an iso-strain situation—conditions that often precede burnout.

Burnout is a specific and extreme form of chronic job stress, characterized by emotional exhaustion, depersonalization, and reduced accomplishment. In contrast, job strain is a broader condition characterized by high psychological demands at work combined with low control over how to meet those demands, which influences worker health and stress levels. It is often associated with feelings of stress, fatigue, and reduced well-being. Work pressure is the most frequently cited stress factor by ART professionals and the most significant predictor of the three dimensions of burnout[29]. Our findings demonstrated a strong correlation between work pressure and job strain. The higher the perceived work stress, as measured by the VAS, the greater the likelihood of experiencing job strain. A similar relationship was observed for iso-strain and ERI. Notably, work stress had a more significant impact on the risk of job strain than workload, as no significant link was found between weekly working hours and job strain. Additionally, low job fulfillment was significantly associated with an increased risk of job strain, iso-strain, and ERI.

Although the literature does not specifically address stress among IVF secretaries, studies on similar professional categories indicate that administrative employees are prone to job strain. In the 2003 SUMER survey, 31.3% of administrative employees were classified as strained, higher than the 23.2% average for all workers[24]. Our findings align with these results, showing that less qualified employees are more vulnerable to

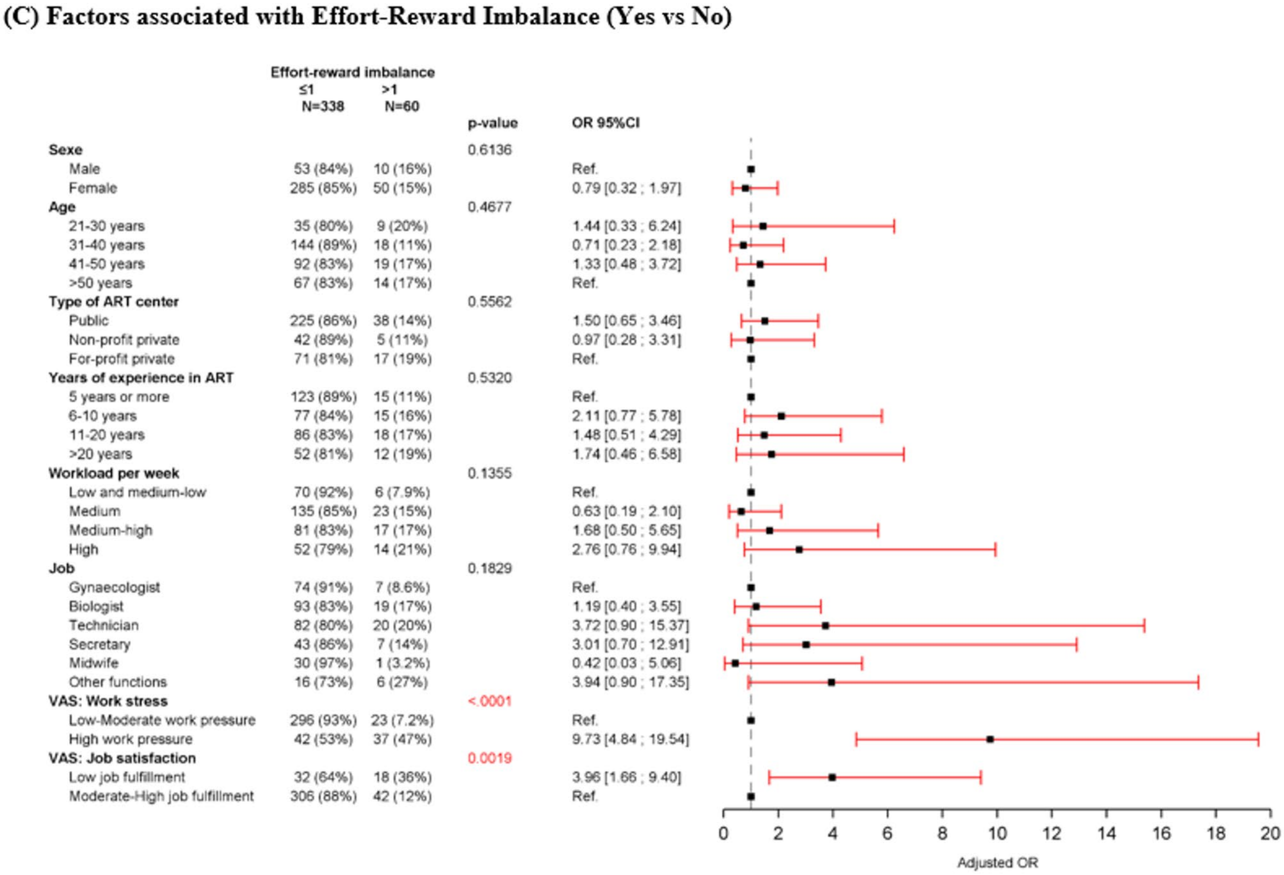

Fig. 2. (continued)

job strain than those in higher-skilled professions. Specifically, 55.8% of gynaecologists and 51.6% of biologists were classified as active profiles, while 62.9% of technicians and 56.0% of secretaries were classified as stressed profiles. Additionally, research by Larsman et al. on medical secretaries highlighted that adverse psychosocial work conditions, such as high work demands, could contribute to the development of neck and shoulder symptoms through the mechanism of stress-induced sustained muscle activation[31]. Additionally, working in a public centre was identified as a significant factor contributing to job strain. To our knowledge, however, no studies directly compare work stress or job strain between professionals in public and private IVF centres.

Gender was found to be associated with the risk of iso-strain in our study, with female professionals being four times more likely to experience iso-strain than their male counterparts. This finding is particularly important given the increasing number of women in the healthcare workforce, which now comprises 75% globally[32] and 90% in nursing and midwifery roles[33]. Our results align with López-Léria's et al. research, which highlighted that female embryologists tend to have poorer mental health and a greater risk of burnout compared to their male colleagues[20]. In contrast, Urteaga's study found no correlation between gender and burnout risk[29]suggesting that the relationship between gender and work-related stress may vary across different contexts and studies.

While gender played a significant role in our study, we did not find any correlation between age and the risks of job strain or iso-strain. This differs from López-Lería's findings, which showed that embryologists over the age of 45 had significantly higher mental health scores (MCS-12) compared to those under 35[20]. Higher mental health scores are generally associated with a lower risk of burnout, reinforcing the importance of mental health in the workplace.

Work stressors are typically associated with work design, management, and the social context. In IVF centres, a survey conducted by ESHRE identified three major sources of stress: time and workload (61.6%), organizational, team, and management issues (60.4%), and job content and work environment (50.3%), coming either from internal factors (e.g., work planning) or external ones (e.g., funding, legislation), as well as patient-related difficulties (e.g., poor response, depression, or unrealistic expectations)[30]. More recently, Urteaga et al. revisited these stressors in IVF centres and proposed a classification into six categories: working under pressure, overloaded schedules, lack of professional recognition, communication difficulties among team members, management of complex patients, and delivering bad news[29]. According to their study, working under pressure was the most frequently experienced stressor in ART work.

In our study, a detailed analysis of responses to the Karasek and Siegrist questionnaires shed light on similar work stressors. Professionals across all roles reported the need to work quickly and manage excessive workloads. In contrast to Lopez-Leria's findings, which reported an impact of a workload exceeding 45 h per week on

	Gynaecologist (n = 129)	Biologist (n = 124)	Technician (n = 107)	Secretary (n = 51)	Other functions (n = 53)	P-value
KARASEK						
Psychological demand						
Quantity and speed						
K10 - My work requires me to work very fast (agree)	100 (77.5)	92 (74.2)	76 (71.0)	38 (74.5)	42 (79.2)	0.7549[a]
K12 - I am asked to perform an excessive amount of work (agree)	74 (57.4)	66 (53.2)	61 (57.0)	37 (72.5)	28 (52.8)	0.1899[a]
K13 - I have enough time to do my work properly (disagree)	72 (55.8)	51 (41.1)	61 (57.0)	23 (45.1)	29 (54.7)	0.0726[a]
Complexity and intensity						
K14 - I receive conflicting orders from other people (agree)	108 (83.7)	99 (79.8)	62 (57.9)	32 (62.7)	39 (73.6)	**< 0.0001**[a]
K11 - My work requires me to work intensively (agree)	117 (90.7)	111 (89.5)	98 (91.6)	40 (78.4)	46 (86.8)	0.1311[a]
K15 - My work requires long periods of intense concentration (agree)	103 (79.8)	111 (89.5)	98 (91.6)	41 (80.4)	44 (83.0)	**0.0496**[a]
Fragmentation and predictability						
K16 - My tasks are often interrupted before completion, requiring me to restart them later (agree)	77 (59.7)	99 (79.8)	44 (41.1)	46 (90.2)	41 (77.4)	**< 0.0001**[a]
K17 - My work is very hectic (agree)	52 (40.3)	76 (61.3)	48 (44.9)	39 (76.5)	28 (52.8)	**< 0.0001**[a]
K18 - Waiting for work from colleagues or other departments often slows down my own work (agree)	44 (34.1)	50 (40.3)	39 (36.4)	21 (41.2)	20 (37.7)	0.8441[a]
Decision latitude						
Latitude or discretion						
K4 - My work allows me to make decisions on my own (agree)	127 (98.4)	120 (96.8)	57 (53.3)	33 (64.7)	36 (67.9)	**< 0.0001**[a]
K6 - In my job, I have very little freedom to decide how I do my work (disagree)	110 (85.3)	93 (75.0)	40 (37.4)	36 (70.6)	44 (83.0)	**< 0.0001**[a]
K8 - I have the opportunity to influence the course of my work (agree)	115 (89.1)	106 (85.5)	57 (54.3)	37 (74.0)	41 (80.4)	**< 0.0001**[a]
Skill utilization						
K2 - In my work, I perform repetitive tasks (disagree)	119 (92.2)	105 (84.7)	97 (90.7)	45 (88.2)	44 (83.0)	0.2353[a]
K5 - My work requires a high level of skill (agree)	1 (0.8)	1 (0.8)	11 (10.3)	12 (23.5)	4 (7.5)	**< 0.0001**[a]
K7 - In my work, I have varied activities (agree)	121 (93.8)	121 (97.6)	96 (89.7)	46 (90.2)	45 (84.9)	**0.0282**[a]
Skill development						
K1 - In my work, I have to learn new things (agree)	127 (98.4)	122 (98.4)	96 (89.7)	51 (100.0)	53 (100.0)	**0.0008**[b]
K3 - My work requires me to be creative (agree)	89 (69.0)	80 (64.5)	25 (23.4)	31 (60.8)	39 (73.6)	**< 0.0001**[a]
K9 - I have the opportunity to develop my professional skills (agree)	121 (93.8)	118 (95.2)	74 (69.2)	41 (80.4)	44 (83.0)	**< 0.0001**[a]
Social support from the hierarchy						
K22 - My supervisor is good at getting his/her subordinates to work together (agree)	62 (78.5)	68 (62.4)	65 (60.7)	41 (82.0)	37 (72.5)	**0.0104**[a]
K21 - My supervisor helps me to complete my tasks (agree)	64 (81.0)	72 (66.7)	68 (64.2)	34 (68.0)	34 (65.4)	0.1312[a]
K20 - My supervisor pays attention to what I say (agree)	66 (82.5)	80 (72.7)	68 (63.6)	43 (84.3)	43 (81.1)	**0.0090**[a]
K19 - My supervisor cares about the well-being of his/her subordinates (agree)	63 (78.8)	69 (63.9)	53 (49.5)	36 (75.0)	38 (73.1)	**0.0002**[a]
Social support from colleagues						
K23 - The colleagues I work with are professionally competent (agree)	127 (98.4)	121 (97.6)	105 (98.1)	51 (100.0)	51 (96.2)	0.7496[b]
K26 - The colleagues I work with help me to complete my tasks (agree)	120 (93.0)	115 (92.7)	100 (93.5)	49 (96.1)	50 (94.3)	0.9400[a]
K25 - The colleagues I work with are friendly (agree)	127 (98.4)	114 (91.9)	95 (88.8)	49 (96.1)	49 (92.5)	**0.0354**[a]
K24 - The colleagues I work with show interest in me (agree)	118 (91.5)	117 (94.4)	91 (85.0)	49 (96.1)	49 (92.5)	0.0796[a]
SIEGRIST						
Effort at work						
S1 – I'm always under pressure because of my heavy workload	36 (27.9)	49 (39.5)	29 (27.1)	18 (35.3)	14 (26.4)	0.1711[a]
S2 - I am frequently interrupted in my work	27 (20.9)	52 (41.9)	25 (23.4)	19 (37.3)	16 (30.2)	**0.0019**[a]
S3 - I have a lot of responsibilities at work	30 (23.3)	42 (33.9)	25 (23.4)	5 (9.8)	10 (18.9)	**0.0111**[a]
S4 - I often have to work extra hours	34 (26.4)	36 (29.0)	16 (15.0)	6 (11.8)	10 (18.9)	**0.0213**[a]
S5 - My job requires physical effort	10 (7.8)	10 (8.1)	10 (9.3)	3 (5.9)	3 (5.7)	0.9143[a]
S6 - My job has become increasingly demanding over the past few years	30 (23.3)	44 (35.5)	25 (23.4)	14 (27.5)	11 (20.8)	0.1234[a]
Rewards						
S7 - I receive the respect I deserve from my superiors	11 (13.6)	20 (17.7)	23 (21.9)	8 (16.0)	6 (11.3)	0.4394[a]
S8 - I receive the respect I deserve from my colleagues	2 (1.6)	10 (8.1)	7 (6.5)	2 (3.9)	1 (1.9)	0.1016[a]
S9 - I receive adequate support at work when facing difficult situations	6 (4.7)	16 (12.9)	16 (15.0)	4 (7.8)	5 (9.4)	0.0793[a]
S10 - I am treated unfairly at work	6 (4.7)	8 (6.5)	11 (10.3)	2 (3.9)	5 (9.4)	0.3804[a]
S11 - I am currently experiencing or anticipate an unwanted change in my job situation	9 (7.0)	23 (18.5)	25 (23.4)	6 (11.8)	10 (18.9)	**0.0076**[a]
S12 - My chances of promotion are slim	19 (14.7)	19 (15.3)	52 (48.6)	20 (39.2)	20 (37.7)	**< 0.0001**[a]
S13 - My job security is at risk	6 (4.7)	7 (5.6)	9 (8.4)	2 (3.9)	3 (5.7)	0.7399[a]
Continued						

	Gynaecologist (n = 129)	Biologist (n = 124)	Technician (n = 107)	Secretary (n = 51)	Other functions (n = 53)	P-value
S14 - My current position aligns well with my education and training	5 (3.9)	5 (4.0)	11 (10.3)	3 (5.9)	5 (9.4)	0.1863[a]
S15 - Given all my efforts, I receive the respect and recognition I deserve at work	7 (5.4)	15 (12.1)	32 (29.9)	5 (9.8)	9 (17.0)	**< 0.0001**[a]
S16 - Given all my efforts, I am satisfied with my promotion prospects	11 (8.5)	22 (17.7)	50 (46.7)	10 (19.6)	14 (26.4)	**< 0.0001**[a]
S17 - Given all my efforts, I am satisfied with my salary	36 (27.9)	22 (17.7)	54 (50.5)	25 (49.0)	22 (41.5)	**< 0.0001**[a]
Overcommitment						
S18 - I often feel rushed at work	113 (87.6)	114 (91.9)	77 (72.0)	43 (84.3)	46 (86.8)	**0.0006**[a]
S19 - I start thinking about work problems as soon as I wake up	73 (56.6)	83 (66.9)	49 (45.8)	17 (33.3)	22 (41.5)	**0.0001**[a]
S20 - I can easily relax and forget about work when I get home	82 (63.6)	82 (66.1)	45 (42.1)	18 (35.3)	23 (43.4)	**< 0.0001**[a]
S21 - My loved ones say that I sacrifice too much for my work	85 (65.9)	86 (69.4)	37 (34.6)	17 (33.3)	21 (39.6)	**< 0.0001**[a]
S22 - Work is still on my mind when I go to bed	86 (66.7)	85 (68.5)	46 (43.0)	15 (29.4)	27 (50.9)	**< 0.0001**[a]
S23 - I have trouble sleeping at night if I've put off something I should have done that day	73 (56.6)	81 (65.3)	44 (41.1)	21 (41.2)	27 (50.9)	**0.0017**[a]

Table 3. Distribution of responses to the Karasek and siegrist questionnaires categorized by occupational function. The table details the distribution of responses from the Karasek and Siegrist questionnaires, expressed as numbers and percentages, across occupational functions. Midwifes and other functions were grouped in one category. Statistical comparisons across the five occupational categories were performed using the Chi² test[a] or Fisher's exact test[b], as appropriate.

physical health and burnout, our study did not find a correlation between workload and the risk of job strain[20]. Technicians, in particular, reported long periods of intense concentration, with 91.6% citing this demand—a significantly higher proportion than in other roles. Their tasks require fine motor skills and sustained attention, often involving long hours of microscope or computer use. Additionally, the constant focus necessary to avoid errors in sample handling, as well as the extensive documentation for quality control and legal compliance, further increases their stress. This is exacerbated by the unpredictable work schedules found in many embryology laboratories[21].

Moreover, most secretaries reported that their tasks were often interrupted before completion (90.2%) and that their work was very hectic (76.5%). As the primary point of contact for patients, doctors, and biologists, secretaries manage both in-person and phone-based communication. Despite these challenges, most secretaries felt they had the opportunity to influence the course of their work, whereas technicians generally agreed that they had limited freedom in how they performed their tasks.

Our study found that most professionals felt supported by their hierarchy in completing their tasks. However, differences were observed between roles regarding the level of attention supervisors paid to employees' concerns. Nearly half of the technicians reported that their supervisors showed little concern for their well-being, while the majority of professionals in other roles indicated receiving support from their colleagues. Social support is widely recognized as a key factor in mitigating stress. Facchin et al. emphasized the dual role of teams, which can both contribute to stress and serve as a protective factors[34]. Working with colleagues of varying personalities can be particularly beneficial in managing daily stress, especially among embryologists. Working with individuals of varying personalities can be especially helpful in managing daily stress, particularly among embryologists. This suggests that support and mutual assistance among colleagues are crucial protective elements[35]. Improving collective moral resilience—defined as a shared capacity for mutual trust and connectivity—emphasizes the importance of strong colleague relationships in fostering a resilient work environment[28].

Occupational stress can lead to negative emotions (such as feeling tense), physical symptoms (like chest pain), behavioural issues, and a decline in job satisfaction or motivation, all of which contribute to lower staff well-being[6,36,37]. All of which can contribute to lower well-being in staff. Work-related stress, burnout and anxiety are known to decrease work performance[38]. Work-related stress affects not only the health of professionals but also the quality of care[39]. Poorer professional well-being has been linked to suboptimal care, including omissions in relevant diagnostic tests, medication errors, and a reduced likelihood of delivering the highest quality care. In contrast, better professional well-being is associated with improved patient satisfaction[40,41]higher patient compliance[42]and overall improvements in care quality[43]. As patient care increasingly involves multidisciplinary teamwork[44]future research could explore how team dynamics and the collective well-being of healthcare professionals influence patient outcomes[45].

Preventing occupational stress in healthcare professionals requires a multi-faceted approach that addresses both contextual and individual well-being strategies[38]. Contextual interventions could include increasing autonomy and reducing administrative burdens, while individual strategies might focus on promoting work-life balance, fostering personal interests, and strengthening social connections[29]. Carpenter et al. emphasized the critical role of interprofessional teamwork and collaboration in enhancing healthcare outcomes, including staff welfare[6]. Future research should explore how personal traits, work-related factors, and social dynamics contribute to burnout[20]. Effective stress management requires comprehensive risk assessments along with preventive and protective measures, such as workshops[30]. Specifically in the field of ART, Boivin's et al. study on ESHRE members found that the most frequently recommended workshops focused on patient communication and counselling, managing patient-related challenges, and clinical topis[30].

This study presents limitations. The email-based survey may have introduced selection bias, potentially underrepresenting certain groups and limiting generalizability. Individuals most affected by stress may have been more inclined to participate. Since the survey was primarily distributed through French scientific societies, which are mainly composed of biologists and gynaecologists, secretaries and nurses—who are less involved in these societies—may have been underrepresented. Due to the lack of precise demographic data on ART professionals in France, we could not determine if our sample fully represented all centres. However, our sample appears to reflect the professional distribution in French ART centres, where there are fewer nurses compared to foreign centres, as gynaecologists often take on some of their responsibilities. Compared to Urteaga's study among Spanish fertility association members, our sample included four times fewer nurses (6.7% vs. 32%) but twice as many biologists and embryologists (50.6 vs. 28%)[29]. Unlike Urteaga's study, we also included secretaries, providing a more comprehensive view of the workforce. While our sample was representative within the French context, the results may be influenced by country-specific occupational and employment characteristics. Furthermore, although we used the well-established JCQ model[11]a more holistic approach that combines both subjective and objective stress measures could provide a deeper understanding of occupational stress in ART centres and identify areas for preventive interventions[36]. The ERI model also requires cautious interpretation; while there is strong support for the link between high effort, low reward, and stress, findings related to overcommitment are less consistent[46].

In conclusion, our study highlighted the high prevalence of occupational strain (35.7%) among French ART professionals, with secretaries and technicians being particularly affected. This underscores the urgent need for targeted interventions that address more than just workload management. Future research should delve deeper into the specific stressors present in ART centre environments, such as role ambiguity, ethical challenges, or the emotional demands of patient care. Additionally, it would be valuable to investigate the potential protective effects of positive factors like job satisfaction, team cohesion, or professional autonomy. A deeper understanding of how these factors influence both staff well-being and patient outcomes could inform the creation of comprehensive, tailored support programs aimed at reducing stress and improving the overall work environment for ART professionals.

Data availability

Relevant data are available in the article and in its supplementary material. The complete database, including complementary data not presented in the article, is recorded on a secured server with limited access only to authorized users. If an access to these complementary data is needed, they can be shared on reasonable request to the corresponding author.

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Author contributions
LD designed the study and wrote the article. FB checked the database and did the statistical analysis. NS revised the article and approved the final draft. All the authors contributed to the scientific discussions and reviewed the article.

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Declarations

Competing interests
The authors declare no competing interests.

Additional information
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Correspondence and requests for materials should be addressed to L.D.

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