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Job Stress Among Saudi Nurses: A Meta-Analysis

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Abstract
Background: Occupational stress is a highly recorded problem in the nursing profession and is linked to negative effects on nurses, patients, and health care institutions. There is a shortage of workforce, high demand for services, and a rapid growth of the healthcare system, due to which there is more occupational stress among nurses in Saudi Arabia. Even though several primary research studies have investigated occupational stress among Saudi nursing populations, reported estimates vary widely, and no consensus has been reached about the magnitude of occupational stress as a whole.
Objective: This meta-analysis aimed to estimate the pooled prevalence of occupational stress among nurses in Saudi Arabia and to explore sources of between-study variability.
Methods: An observational-study meta-analysis was carried out in line with PRISMA 2020 guidelines. Systematic searches were conducted in PubMed/MEDLINE, Scopus, Web of Science, CINAHL, and Embase for peer-reviewed studies published from January 2016 to December 2025; the final search was completed on 31 December 2025. Eligible studies were quantitative observational studies conducted in Saudi Arabia that reported nurse-specific occupational-stress prevalence using a defined threshold or provided sufficient data to calculate prevalence. Burnout-only, fatigue-only, continuous-score-only, review, non-peer-reviewed, and mixed healthcare-provider studies without extractable nurse-only stress data were excluded.
Results: After re-screening and duplicate/overlap checking, the final quantitative synthesis comprised 13 eligible observational studies including 5,164 nurses. The pooled prevalence of moderate-to-high occupational stress among Saudi nurses was 43.8% (95% CI: 36.2-51.6). Heterogeneity was extremely high ($I^2 = 96.4\%$, $p < 0.001$; $\tau^2 = 0.085$), and the 95% prediction interval was wide (19%-71%); consequently, the pooled estimate should be interpreted as an average across markedly heterogeneous clinical, geographic, and methodological contexts rather than as a precise national prevalence figure. Subgroup, sensitivity, and meta-regression analyses indicated that region, measurement instrument, publication year, and sample size contributed to variability, but more than 80% of the heterogeneity remained unexplained. Funnel-plot inspection and Egger's test did not show statistically significant small-study effects, although interpretation was cautious because of high heterogeneity.
Conclusion: Occupational stress affects a substantial but heterogeneous proportion of nurses in Saudi Arabia, highlighting an important workforce and patient safety concern. Such results highlight the importance of further longitudinal and intervention-based research to identify modifiable organizational, leadership, and policy-level factors associated with elevated occupational stress; because all included studies were cross-sectional, recommendations are framed tentatively and should not be interpreted as causal evidence.
Keywords: Occupational stress; Nurses; Saudi Arabia; Meta Analysis; Healthcare System

1 Introduction

In occupational psychology, occupational stress is any condition that appears when job demands are too high to manage and thus leads to negative psychological, physiological, and behavioral reactions [1]. In the context of healthcare workers, occupational stress is an extended state of disproportion in terms of the workload, responsibility, and organizational resources, which frequently results in emotional fatigue and diminished work performance [2].

Occupational stress is widely recognized as a significant concern within the nursing profession because it is highly complex and emotionally charged. Workloads, time pressure, shift work, ethical issues, and frequent exposure to patient suffering and death are routine experiences of nurses [3]. Staffing shortages, rising patient acuity, and administrative burdens are added to these stressors and increase cognitive and emotional workloads imposed on nurses [4].

The impacts of sustained occupational stress in nurses are not limited to personal well-being. Observational studies have shown that elevated stress correlates with adverse patient safety outcomes, with a higher incidence of medication errors, adverse events, and compromised standards of care [5]. Occupational stress contributes to absenteeism, burnout, and turnover intention, which undermine workforce retention and increase healthcare expenditure at an organizational level [6]. Since nurses are central to healthcare provision, unmanaged occupational stress poses a systemic risk to service sustainability and care quality.

The Saudi healthcare system has experienced rapid growth over the last several decades due to population growth, changes in disease patterns, and large-scale health sector reforms under Vision 2030. Healthcare is delivered through both public and private sectors, with hospitals representing the predominant care setting [7]. Despite this expansion, workforce challenges remain, particularly within the nursing profession.

The composition of the nursing workforce in Saudi Arabia has historically been characterized by a bicultural mix of Saudi and expatriate nurses, with expatriate nurses comprising a substantial proportion of the workforce [8]. This workforce structure has introduced additional occupational stressors related to language barriers, cultural adaptation, workplace integration, and perceived inequities in workload distribution and career advancement [9].

Cultural and organizational factors also influence occupational stress among nurses in Saudi Arabia. Hierarchical management structures, limited professional autonomy, and high patient-to-nurse ratios contribute substantially to occupational strain [10]. Furthermore, shift work, extended working hours, and increasing workload intensify work-related stress, particularly in tertiary and emergency care settings. These contextual factors suggest that occupational stress among Saudi nurses may differ in both magnitude and determinants compared with other healthcare systems, highlighting the need for context-specific investigation.

Although several studies have examined occupational stress among nurses in Saudi Arabia, the available evidence is largely derived from single-center, cross-sectional studies with relatively small sample sizes. Consequently, reported prevalence estimates vary considerably, limiting the generalizability of individual findings [11]. Differences in measurement instruments, sampling strategies, and study settings further contribute to the observed heterogeneity.

Meta-analysis enables quantitative synthesis of available evidence by generating pooled prevalence estimates while accounting for between-study heterogeneity. Compared with narrative or traditional systematic reviews, meta-analysis provides statistically robust summary estimates, identifies potential sources of variability through subgroup analyses and meta-regression, and improves statistical precision [12].

Despite the increasing number of studies investigating occupational stress among nurses worldwide, evidence specific to Saudi Arabia remains limited and inconsistent. Existing reviews generally combine data from multiple countries or regions without considering the unique organizational, cultural, and healthcare characteristics of Saudi Arabia. This evidence gap limits the ability to develop evidence-based workforce policies and targeted stress-reduction interventions.

The primary aim of this meta-analysis was to estimate the pooled prevalence of occupational stress among nurses working in Saudi Arabia. In addition, the study sought to assess the extent of between-study heterogeneity, examine whether occupational stress prevalence differed according to geographic region, measurement instrument, and methodological quality through subgroup analyses, and investigate potential sources of heterogeneity using meta-regression, with publication year and sample characteristics evaluated as possible moderators.

2 Methods

2.1 Study Design

The research was conducted as a meta-analysis of observational studies on occupational stress in nurses in Saudi Arabia. It was designed using established quantitative synthesis principles for prevalence meta-analyses in health research (Borenstein et al., 2009). The document followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 statement to support transparency, reproducibility, and methodological rigor. Because study settings, study populations, and measurement tools were expected to differ, a random-effects approach was prespecified. For terminological consistency, the term occupational stress is used as the primary standardised label throughout this manuscript. The alternative expressions job stress and work-related stress appear only where they (i) form part of an instrument name (e.g., Job Stress Questionnaire), (ii) appear in original Boolean search syntax, or (iii) are reproduced from direct citations of primary studies, in line with the underlying ICD-11 / WHO occupational-health terminology in which these terms are treated as closely related synonyms of the same latent construct.

2.2 Search Strategy

Five electronic databases, PubMed/MEDLINE, Scopus, Web of Science, CINAHL, and Embase, were searched. These databases were selected to cover nursing, medical, public-health, and allied-health literature. The definitive search range was January 2016 to December 2025, and the final search was run on 31 December 2025. This date and range were used consistently in the Abstract, Methods, Results, and PRISMA flow diagram.

Each database search strategy used controlled vocabulary where available (for example, MeSH terms in PubMed) and free-text keywords. The core Boolean search combined terms for occupational stress, nursing, and Saudi Arabia: ("job stress" OR "occupational stress" OR "work-related stress" OR "workplace stress") AND (nurse OR nurses OR "nursing staff") AND ("Saudi Arabia" OR KSA). Truncation, synonyms, and database-specific syntax were applied as appropriate. Reference lists of eligible articles and relevant reviews were also checked manually to minimize retrieval bias. The complete database-specific search strategies, including the exact line-by-line syntax for PubMed/MEDLINE, Scopus, Web of Science, CINAHL, and Embase, together with the dates of execution and total records retrieved per database, are provided in Supplementary File S1 to support full reproducibility and methodological transparency.

2.3 Eligibility Criteria

Eligibility criteria were defined before study selection. Studies were included if they used a quantitative observational design, such as cross-sectional or cohort studies, were conducted exclusively in Saudi Arabia, and involved registered nurses or nursing staff working in hospital or clinical settings. Eligible studies also had to report the

prevalence of occupational stress using clearly defined thresholds or provide sufficient data to calculate prevalence and had to be published as full-text articles in peer-reviewed journals.

Studies were excluded if they used qualitative methods, were review articles, systematic reviews, or meta-analyses, or focused on mixed healthcare populations without extractable nurse-specific data. Conference abstracts, editorials, dissertations, and other non-peer-reviewed sources were also excluded. Studies reporting only burnout, fatigue, or continuous stress scores without defined cut-off thresholds, as well as studies lacking sufficient statistical data for meta-analysis, were not eligible.

2.4 Study Selection Process

All records identified through database searching and hand-searching were transferred to reference-management software, and duplicates were removed. Titles and abstracts were screened independently by two reviewers against the eligibility criteria, followed by independent full-text assessment of potentially eligible studies. Disagreements were resolved through discussion, and a third reviewer was consulted when consensus could not be reached. Potentially duplicate or overlapping datasets were checked by comparing author groups, setting, city/region, recruitment period, sample description, and outcome definition; when overlap was suspected, the most complete peer-reviewed report with extractable nurse-specific occupational-stress prevalence was retained.

2.5 Quality Assessment

Methodological quality and risk of bias were assessed using the modified Newcastle–Ottawa Scale (NOS) for cross-sectional studies. Studies were evaluated according to predefined criteria, with higher scores indicating a lower risk of bias (Table 1). Because the original Newcastle–Ottawa Scale was developed for cohort and case–control studies, it is not directly applicable to cross-sectional designs [13]. Therefore, the present meta-analysis adopted the cross-sectional adaptation proposed by Modesti et al. [14] (Supplementary Text S1), which evaluates studies across three domains: Selection (representativeness of the sample, sample size justification, non-respondents, and ascertainment of exposure), Comparability (control for potential confounding factors, such as age, sex, and clinical unit), and Outcome (outcome assessment and statistical reporting). The modified scale allocates a maximum of five stars for Selection, two for Comparability, and three for Outcome, yielding a total possible score of 10. Study quality was classified as high (8–10 stars; low risk of bias), moderate (5–7 stars; moderate risk of bias), or low (0–4 stars; high risk of bias), consistent with previous prevalence meta-analyses using the same instrument [14]. Quality assessment was performed independently by two reviewers, with disagreements resolved through discussion and, when necessary, adjudication by a third reviewer. Studies were subsequently categorized according to quality level, which was incorporated into subgroup and sensitivity analyses.

2.6 Statistical Analysis

Meta-analysis was performed using pooled prevalence estimates of occupational stress only. The primary analysis used the Freeman-Tukey double-arcsine transformation to stabilize variance and a random-effects model with restricted maximum likelihood (REML) estimation to account for between-study variability. This specification was used consistently for the primary pooled analysis. Cochran's Q test and the I^2 statistic were used to assess heterogeneity, with values of 25%, 50%, and 75% interpreted as low, moderate, and high heterogeneity, respectively. Between-study variance (τ^2) and a 95% prediction interval were also calculated to show the expected range of true prevalence across settings.

Pre-specified subgroup analyses were conducted by dominant geographic region, measurement instrument type, and study quality, using mutually exclusive categories where possible. Meta-regression analyses explored publication year, sample size, and mean age as potential moderators. Leave-one-out sensitivity analysis and influence diagnostics were used to assess whether the pooled estimate was driven by any single study. Publication bias or small-study effects were assessed using funnel-plot visualization and Egger's regression test, with $p < 0.05$ indicating possible asymmetry; findings were interpreted cautiously because heterogeneity was high.

3 Results

3.1 Study Selection

A total of 1,168 records were retrieved from PubMed/MEDLINE, Scopus, Web of Science, CINAHL, Embase, and manual reference screening. After 439 duplicate records were removed, 729 titles and abstracts were screened. Of these, 661 records were excluded because they were not conducted in Saudi Arabia, did not include nurses, used qualitative or review designs, or did not report occupational-stress outcomes.

Sixty-eight full-text articles were assessed for eligibility. Fifty-five were excluded after full-text review because they were review/scoping-review articles, non-peer-reviewed sources, burnout-only or fatigue-only reports, continuous-score-only studies without a defined prevalence threshold, mixed healthcare-provider studies without extractable nurse-specific data, duplicate or overlapping datasets, or reports with insufficient statistical information. In particular, ResearchGate-only records were excluded from the primary analysis, and the overlapping Arar primary-healthcare-center reports were checked so that only one dataset contributed to the pooled analysis. Ultimately, 13 observational studies met all eligibility criteria and were included in the quantitative synthesis. Figure 1 presents the corrected PRISMA 2020 flow diagram.

3.2 Characteristics of Included Studies

The final analysis included 13 studies reporting occupational-stress prevalence among nurses. Studies that reported burnout, fatigue, or continuous stress scores

Table 1. Methodological Quality Assessment of Included Studies Using the Modified Newcastle–Ottawa Scale (NOS)

Author (Year)	Selection (0–5)	Comparability (0–2)	Outcome (0–3)	Total Score (0–10)	Quality Level
Abdel-Azeem et al. (2024)	5	2	3	10	High
Abdoh et al. (2021)	5	2	3	10	High
Ageel & Shbeer (2022)	5	1	3	9	High
Alanazi et al. (2019)	4	1	2	7	Moderate
Almazan et al. (2019)	5	1	3	9	High
AlMuammar et al. (2022)	5	2	3	10	High
Al-Mutairi et al. (2022)	4	1	2	7	Moderate
Almutairi et al. (2024)	5	2	3	10	High
Bakhsh et al. (2023)	5	2	3	10	High
Hawsawi et al. (2024)	4	1	2	7	Moderate
Abumalik et al. (2024)	5	2	3	10	High
Rasheed et al. (2024)	5	2	3	10	High
Shdaifat et al. (2023)	5	2	3	10	High

without defined prevalence thresholds were excluded from the quantitative synthesis to maintain conceptual consistency of the primary outcome. For mixed healthcare-provider studies, only nurse-specific occupational-stress prevalence data were eligible. The 13 included studies were published between 2019 and 2024 and contributed a total sample of 5,164 nurses. Sample sizes ranged from 175 to 1,120 nurses. The studies covered major Saudi regions and care settings, including hospitals, primary healthcare centers, intensive care units, emergency/tertiary care settings, and multi-region samples. Validated or structured occupational-stress instruments included the Perceived Stress Scale (PSS), Nursing Stress Scale (NSS), HSE Management Standards Indicator Tool, job-stress questionnaires, and other occupational-stress measures. Table 2 summarizes study characteristics, instruments, and prevalence-based outcomes.

3.3 Pooled Prevalence of Occupational Stress

Using a random-effects model, the pooled prevalence of moderate-to-high occupational stress among nurses in Saudi Arabia was estimated at 43.8% (95% CI: 36.2-51.6), based only on studies reporting nurse-specific occupational-stress prevalence. In view of the extreme between-study heterogeneity ($I^2 = 96.4\%$) and the wide 95% prediction interval (19%–71%) reported in Section 3.4, this pooled value should be interpreted as a summary average across markedly heterogeneous settings, instruments, and time periods rather than as a precise national point estimate of occupational-stress prevalence among Saudi nurses. Individual study estimates ranged from lower prevalence in some primary-healthcare settings to higher prevalence in intensive-care, emergency, and pandemic-period settings.

The forest plot (Figure 2) shows substantial variability in study-level prevalence estimates. The pooled prevalence was 43.8% (95% CI: 36.2–51.6), while the wide prediction interval (19%–71%) indicates that true prevalence may differ substantially across comparable clinical settings. Larger studies contributed more precise estimates, but the random-effects model was retained because heterogeneity was very high. Pandemic-period studies and high-acuity clinical settings tended to report higher stress prevalence.

3.4 Heterogeneity Assessment

Statistical heterogeneity was high, with Cochran's Q test statistically significant ($Q = 333.3$, $df = 12$, $p < 0.0001$) and $I^2 = 96.4\%$, indicating substantial variability across studies. The between-study variance was considerable ($\tau^2 = 0.085$). The 95% prediction interval ranged from 0.19 to 0.71 (19% to 71%), indicating that true occupational-stress prevalence among nurses in Saudi Arabia is likely to vary markedly across clinical settings, regions, and study conditions. Leave-one-out sensitivity analysis did not identify a single study that fully explained the heterogeneity; the pooled estimate remained within the same broad range after sequential removal of individual studies.

This wide prediction interval is consistent with the variability observed in subgroup analyses and supports interpreting the pooled prevalence as an average across heterogeneous contexts rather than as a single common Saudi prevalence. The magnitude of heterogeneity justified the use of a random-effects model and the additional subgroup, sensitivity, and meta-regression analyses.

3.5 Subgroup Analyses

Subgroup analyses were conducted after restricting the dataset to eligible studies reporting nurse-specific occupational-stress prevalence only. Subgroup categories were recalculated to be internally consistent with the final total number of included studies (n = 13). Because some geographic and measurement-instrument categories contained only one or two studies, those subgroup estimates were interpreted descriptively or not pooled when pooling would be unstable. Measurement-instrument subgrouping excluded burnout-only and fatigue-only outcomes and retained only occupational-stress prevalence measures. Table 3 presents the corrected subgroup analysis structure and results. Following independent re-verification of the city/region of data collection for each included study, the geographic classification used in Table 3 was corrected: Almazan et al. (2019) and Rasheed et al. (2024), both conducted in Riyadh, were re-allocated from the "multi-region/multi-center" category to the Central region category. The Western (Jeddah; AlMuammar et al., 2022) and Southern (Jazan; Ageel & Shbeer, 2022) regions remained represented by a single study each, and no pooled estimate was computed for these single-study subgroups; they are retained in Table 3 for completeness,

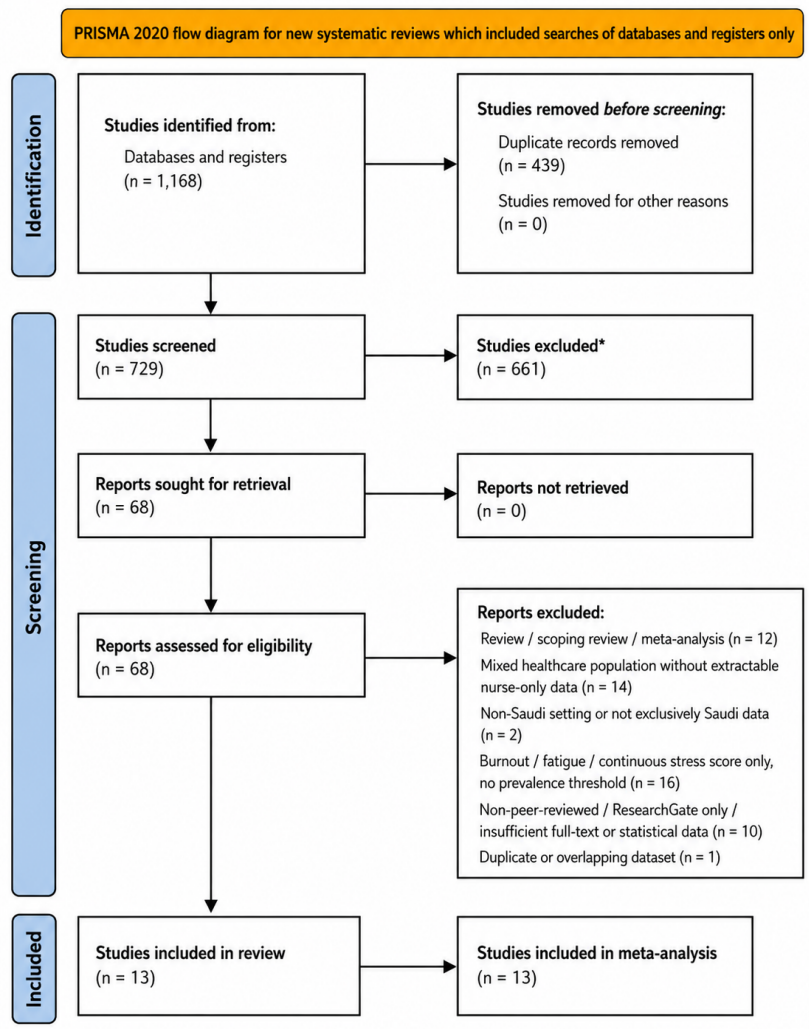

Figure 1. PRISMA 2020 flow diagram for the corrected study-selection process.

but are explicitly flagged as "not pooled" and should not be used for between-region comparison.

Note. CI = confidence interval; PSS = Perceived Stress Scale; NSS = Nursing Stress Scale; HSE = Health and Safety Executive; ProQOL = Professional Quality of Life Scale. Subgroups represented by a single study were not pooled and should be interpreted descriptively only.

Because several geographic and instrument categories contained one study, pooled estimates were not calculated for those categories. NSS, HSE, and ProQOL were retained as separate instrument categories rather than combined, because these tools differ in content, scoring, and stress thresholds. The Central and multi-region subgroup estimates were recalculated after reclassifying the Riyadh-based studies by Almazan et al. (2019) and Rasheed et al. (2024) into the Central region; therefore, subgroup comparisons should be interpreted cautiously.

3.6 Meta-Regression Findings

Meta-regression analysis demonstrated a negative association between publication year and occupational-stress prevalence (β = -0.009, 95% CI: -0.016 to -0.002, p = 0.013), indicating a modest but statistically significant decrease in reported prevalence over time. This finding is consistent with Figure 3, which shows a downward fitted slope.

Sample size was also negatively associated with prevalence estimates (β = -0.00021, 95% CI: -0.00038 to -0.00004, p = 0.018), suggesting that smaller studies tended to report higher occupational-stress prevalence, consistent with possible small-study effects or greater contextual instability in smaller samples.

Exploratory meta-regression also examined mean age and the proportion of expatriate nurses where these data were available. Although the observed associations were directionally suggestive, none reached statistical significance ($p > 0.05$), and they were therefore interpreted cautiously.

Overall, the meta-regression model explained approximately 18.7% of the between-study variance ($R^2 = 0.187$). Publication year and sample size contributed to heterogeneity; however, most of the variability remained unexplained, indicating that institutional, staffing, cultural, and measurement-related factors not captured in the included studies may have influenced the reported prevalence. The meta-regression results are presented in Figure 3.

These findings should be interpreted with caution for

Table 2. Characteristics of studies included in the meta-analysis (n = 13)

Author (Year)	Region / City	Study Setting	Study Design	Sample Size (n)	Stress Measurement Instrument	Reported Outcome	Study Quality*
Abdel-Azeem et al. (2024)	Multi-region (KSA)	Hospitals	Cross-sectional	1,120	Occupational stress scale; burnout scale not pooled	Nurse-specific occupational-stress prevalence extracted	High
Abdoh et al. (2021)	Multi-center	PHC centers	Cross-sectional	423	Perceived Stress Scale	Occupational-stress prevalence	High
Ageel & Shbeer (2022)	Jazan	ICUs	Cross-sectional	180	HSE Management Standards Tool	Occupational-stress prevalence	High
Alanazi et al. (2019)	Arar	PHC centers	Cross-sectional	175	Job Stress Questionnaire	Occupational-stress prevalence	Moderate
Almazan et al. (2019)	Riyadh	Acute care hospital	Cross-sectional	250	Nursing Stress Scale	Occupational-stress prevalence	High
AlMuammar et al. (2022)	Jeddah	University hospital	Cross-sectional	310	Occupational Stress Scale	Nurse-specific occupational-stress prevalence extracted	High
Al-Mutairi et al. (2022)	Hafr Al-Batin	Hospitals	Cross-sectional	289	Job Stress & Presenteeism Scale	Occupational-stress prevalence	Moderate
Almutairi et al. (2024)	Multi-region	Hospitals & PHC	Cross-sectional	640	Occupational Stress Questionnaire	Nurse-specific occupational-stress prevalence extracted	High
Bakhsh et al. (2023)	Multi-region	Hospitals	Cross-sectional	512	Perceived Stress & Coping Scale	Occupational-stress prevalence	High
Hawsawi et al. (2024)	Multi-region	Hospitals	Cross-sectional	280	Stress & Coping Questionnaire	Occupational-stress prevalence	Moderate
Abumalik et al. (2024)	Multi-region	Hospitals	Cross-sectional	370	Occupational Stress Scale	Occupational-stress prevalence	High
Rasheed et al. (2024)	Riyadh	Teaching hospital	Cross-sectional	205	Perceived Stress Scale	Occupational-stress prevalence	High
Shdaifat et al. (2023)	Multi-region	Hospitals	Cross-sectional	410	ProQOL/work-related stress instrument	Occupational-stress prevalence extracted; ProQOL burnout/fatigue domains not pooled	High

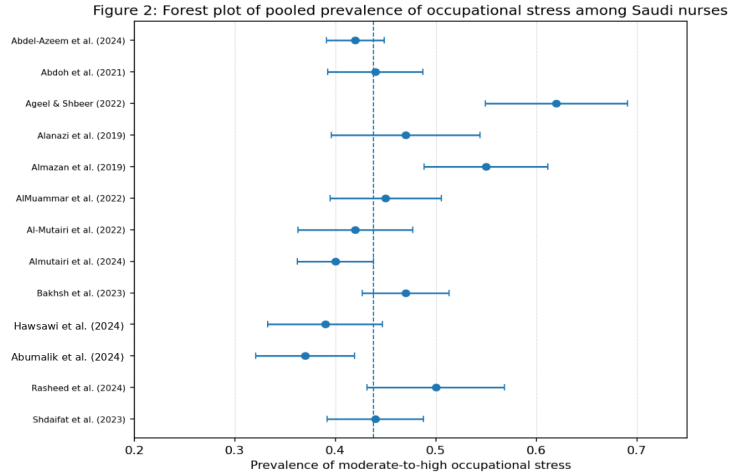

Figure 2. Forest plot of pooled prevalence of occupational stress among Saudi nurses in the final eligible dataset. Squares represent study-level prevalence estimates, horizontal lines show 95% confidence intervals, and the diamond represents the REML random-effects pooled estimate. The vertical dotted lines indicate the 95% prediction interval.

two reasons. First, the analysis included only 13 studies, which is below the commonly recommended minimum of approximately 10 studies per covariate for stable meta-regression models [12]. Consequently, the estimated coefficients for publication year and sample size may be subject to imprecision and overfitting. Second, the model explained less than one-fifth of the observed between-study variance ($R^2 = 18.7\%$), indicating that more than 80% of the heterogeneity remained attributable to unmeasured moderators. Potential contributors include nurse-to-patient ratios, hospital type (tertiary versus primary care), the proportion of expatriate nurses, shift-work intensity, and unit-specific acuity (e.g., intensive care units versus primary healthcare centers). Therefore, the observed associations for publication year and sample size should be regarded as hypothesis-generating rather than definitive evidence of effect modification. Future primary studies should systematically report these variables to facilitate more informative subgroup and meta-regression

3.7 Publication Bias

The funnel plot (Figure 4) showed some visual asymmetry, but Egger's regression test was not statistically significant (p = 0.18). Therefore, there was no strong statistical evidence of publication bias or small-study effects. However, because heterogeneity was very high, funnel-plot asymmetry and Egger's test should be interpreted cautiously rather than as definitive evidence for or against publication bias.

4 Discussion

4.1 Principal Findings

This Saudi-specific meta-analysis provides a quantitative synthesis of occupational-stress prevalence among nurses in Saudi Arabia. The pooled prevalence estimate of 43.8% indicates that a substantial proportion of nurses experience moderate-to-high occupational stress. However, given the very high heterogeneity ($I^2 = 96.4\%$) and the wide prediction interval, this pooled estimate should be interpreted cautiously as an average across highly variable study contexts rather than as a single definitive national prevalence.

The level of occupational stress identified in this synthesis is broadly consistent with previous studies conducted in Saudi primary healthcare centers, intensive care units, tertiary hospitals, and pandemic-related nursing settings [16–19]. Higher stress estimates reported in high-acuity

Table 3. Subgroup analysis of pooled prevalence of occupational stress among nurses in Saudi Arabia

Subgroup Variable	Number of Studies (n)	Pooled Prevalence (%)	95% Confidence Interval	I^2 (%)	p-value (Q-test)
Overall estimate	13	43.8	36.2-51.6	96.4	<0.001
Dominant geographic region					
Central region (Riyadh)	2	46.6†	35.9–57.4	91.5	0.001
Western region (Jeddah/Makkah/Madinah)	1	Not pooled (single study)	-	-	-
Southern region (Jazan/Asir)	1	Not pooled (single study)	-	-	-
Northern region (Arar/Hafr Al-Batin)	2	33.4	24.5-43.6	88.2	0.004
Multi-region/multi-center	7	43.2‡	36.5–50.1	96.1	<0.001
Measurement instrument / broad questionnaire category					
Perceived Stress Scale (PSS)	4	42.6	33.8-51.8	93.6	<0.001
Nursing Stress Scale (NSS)	1	Not pooled (single study)	-	-	-
HSE Management Standards Indicator Tool	1	Not pooled (single study)	-	-	-
Generic job/occupational-stress questionnaires (broad category)	6	41.1	32.0-50.8	94.5	<0.001
ProQOL/work-related stress instrument	1	Not pooled (single study)	-	-	-
Study quality					
High quality	10	44.0	35.4-52.9	96.1	<0.001
Moderate quality	3	38.0	28.9-48.1	92.7	0.002

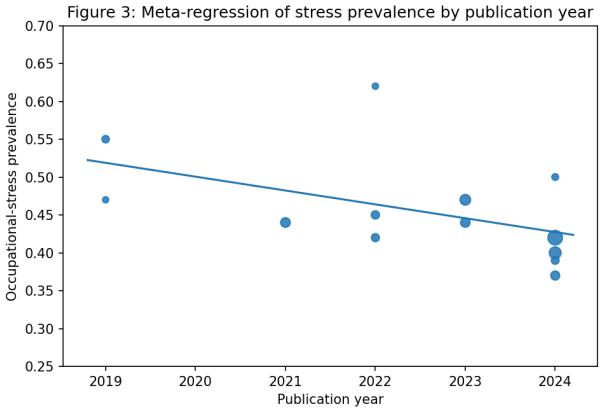

Figure 3. Meta-regression of occupational-stress prevalence by publication year. Circles represent individual studies, circle size reflects study weight, and the fitted line shows the association between publication year and occupational-stress prevalence.

and COVID-19-related settings likely reflect increased workload, infection risk, staffing shortages, and emotional demands placed on nurses.

Compared with regional and international evidence, occupational stress among Saudi nurses remains an important workforce concern. Nevertheless, direct comparisons should be interpreted cautiously because of differences in stress measurement instruments, cut-off thresholds, healthcare systems, staffing models, and organizational contexts across countries. These findings support the need for Saudi-specific workforce planning and targeted occupational stress reduction strategies rather than relying solely on pooled international estimates.

4.2 Explanation of Heterogeneity

One of the key findings of this meta-analysis was the very high heterogeneity ($I^2 > 95\%$) and the wide variation in prevalence estimates across studies. This heterogeneity represents a major limitation of the pooled estimate and most likely reflects genuine differences in clinical settings, staffing conditions, geographic regions, measurement instruments, and study designs rather than random statistical variation alone. For interpretive clarity, heterogeneity in the present meta-analysis can be understood as comprising two conceptually distinct components, consistent with the framework described in the Cochrane Handbook for Systematic Reviews of Interventions [12]. Clinical heterogeneity reflects true differences in study populations and healthcare contexts, including primary healthcare centers, acute-care wards, intensive care units, tertiary hospitals, regional healthcare infrastructure, the proportion of expatriate versus Saudi nurses, shift patterns, nurse-to-patient ratios, and pandemic versus non-pandemic data collection periods. Methodological heterogeneity arose because the included studies employed at least five different occupational stress instruments with varying item content, scoring systems, and cut-off thresholds for moderate-to-high stress. In addition, most studies used non-probability sampling methods and differed in their handling of response rates. The combined effect of these sources of heterogeneity reduced the precision and external generalizability of the pooled estimate. Accordingly, the prediction interval (approximately 19%–71%) suggests that the true prevalence of occupational stress among Saudi nurses may vary substantially across clinical and organizational settings and should not be interpreted as a single national prevalence. This perspective should guide the interpretation of the findings by

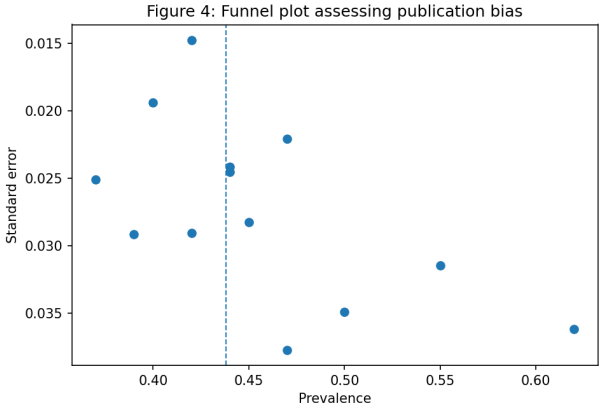

Figure 4. Funnel plot assessing publication bias/small-study effects. Each circle represents one included study plotted against its standard error, and dashed diagonal lines indicate the pseudo 95% confidence-interval boundaries around the pooled prevalence estimate.

clinicians, healthcare managers, and policymakers.

Variability in measurement instruments was an important contributor to heterogeneity. The included studies used different occupational stress measures, including the Perceived Stress Scale, Nursing Stress Scale, HSE Management Standards Indicator Tool, and other job-stress questionnaires [20–22]. Burnout-only and fatigue-only measures were excluded from the revised quantitative synthesis because burnout, fatigue, continuous stress scores, and occupational-stress prevalence represent related but distinct constructs.

Organizational and cultural characteristics unique to the Saudi healthcare system may also have contributed to the observed heterogeneity. Hierarchical management structures, limited professional autonomy, and unfavorable nurse-to-patient ratios have been identified as important occupational stressors among Saudi nurses [23]. These institutional differences across healthcare settings and regions likely influenced the variation in reported prevalence estimates.

Workforce composition constituted another potential source of heterogeneity. Because expatriate nurses comprise a substantial proportion of the Saudi nursing workforce, language barriers, cultural adaptation, job insecurity, and unequal opportunities for professional development may contribute to higher occupational stress [24]. Consequently, studies including a larger proportion of expatriate or younger nurses may have reported higher prevalence estimates, providing a plausible explanation for part of the observed between-study variability.

4.3 Implications for Nursing Leadership and Policy

The findings of the present meta-analysis have important implications for nursing leadership and healthcare policy in Saudi Arabia. Given the substantial heterogeneity observed across studies, interventions should be tailored to specific organizational and clinical contexts rather than adopting a uniform approach.

Workforce policies should prioritize improving nurse-to-patient ratios and ensuring equitable workload distribution. Several included studies identified excessive workload, shift intensity, and organizational pressure as major contributors to occupational stress [25,18]. Accordingly, workforce planning under Saudi Vision 2030 should emphasize sustainable staffing models, staff retention, and improvements in the work environment to mitigate chronic occupational stress.

The implementation of structured stress management programs is also warranted. Previous studies conducted in Saudi Arabia have recommended interventions such as resilience training, peer-support initiatives, and improved access to psychological and mental health services, particularly in response to challenges experienced during the COVID-19 pandemic [26,19]. Nevertheless, the effectiveness of these interventions is likely to vary according to organizational context and should therefore be evaluated before widespread implementation.

Leadership-focused interventions also represent a promising strategy for reducing occupational stress. Evidence suggests that transformational leadership, supportive supervision, and emotionally intelligent management are associated with improved staff well-being and reduced occupational stress [22]. Consequently, leadership development programs for nurse managers may represent a cost-effective approach to improving the work environment and promoting workforce well-being within Saudi healthcare organizations.

4.4 Strengths of the Meta-Analysis

This study has several notable strengths. First, it is a Saudi-specific meta-analysis that quantitatively synthesized prevalence data on occupational stress among nurses, addressing an important gap in the literature. Second, the revised analysis applied a clearer statistical framework, including a prespecified Freeman-Tukey transformation, REML random-effects modeling, τ^2, prediction interval, subgroup analysis, meta-regression, sensitivity analysis, and cautious publication-bias assessment. Third, the analysis drew on more than 5,000 nurses across different regions and care settings. These strengths should nevertheless be interpreted alongside substantial heterogeneity and methodological variability across studies.

4.5 Limitations

Despite these strengths, several limitations should be acknowledged. The dominance of cross-sectional designs limits causal inference and prevents firm conclusions about temporal relationships between stressors and outcomes. A major limitation is the very high heterogeneity ($I^2 = 96.4\%$), which reduces the precision and interpretability of a single pooled prevalence estimate. The pooled result should therefore be viewed as a summary average across diverse settings rather than a definitive national rate.

Measurement variability also remains a key limitation. Although the revised eligibility criteria restricted the primary analysis to prevalence-based occupational-stress outcomes, included studies still differed in instruments, cut-off thresholds, settings, and sampling methods. Some regions and rural/peripheral settings were underrepresented. Future research should use nationally representative, multicenter designs and standardized occupational-stress measures to improve comparability and strengthen evidence for Saudi nursing workforce policy. A specific methodological limitation that warrants explicit acknowledgement is the pooling of prevalence estimates obtained from non-equivalent psychometric instruments. There were at least five different tools used in the 13 studies included, such as the Perceived Stress Scale (PSS), the Nursing Stress Scale (NSS), the HSE Management Standards Indicator Tool and the Professional Quality of Life Scale (ProQOL), as well as several non-standardized job-stress questionnaires; they vary in item content, scoring algorithms, latent constructs (perceived psychological stress vs. nursing-specific occupational stressors vs. work-environment hazards), and the cut-off conventions used to define "moderate-to-high" stress. The methodological challenges of aggregating prevalence across conceptually different instruments and the impact of this on the between-study variance is likely to be great. Subgroup analysis was done on instruments, and if two or more studies used the same instrument, or a broad, clearly comparable questionnaire category, then that category was retained, but PSS was retained as a separate category, generic job/occupational-stress questionnaires were retained only as a broad descriptive category, and NSS, HSE and ProQOL were not pooled because there was only one study each. The pooled 43.8% should consequently not be understood as a construct-equivalent prevalence rate for the country as a whole. A second related limitation is that publication year and sample size were the only moderators identified in the meta-regression model that were statistically associated with the observed between-study variance, and accounted for <20% of between-study variance; thus, >80% of the variance was attributed to unknown moderators. Future primary studies should systematically report plausible but not well recorded moderators, such as the ratio of nurses to patients, hospital type, ratio of expatriate to Saudi nurses, shift schedules, and unit acuity, that could be used to determine the moderators in future syntheses to better identify and quantify the actual factors that moderate the prevalence of Saudi nurse occupational stress.

5 Conclusion

The present meta-analysis indicates that occupational stress is widespread among nurses in Saudi Arabia, with an estimated pooled prevalence of 43.8% for moderate-to-high occupational stress. By synthesizing 13 observational studies across different regions and clinical settings, the study shows that occupational stress among Saudi nurses is an important and continuing workforce issue. Nevertheless, the very high heterogeneity and wide prediction interval mean that the pooled estimate should be interpreted as an average across diverse contexts rather than as a precise national prevalence.

The implications for healthcare leadership and policy are descriptive rather than causal. Occupational stress among nurses has been associated, in cross-sectional Saudi and international evidence, with workforce sustainability, patient safety, and care-quality concerns, although causal direction cannot be established from the present cross-sectional synthesis. Tentative, evidence-informed strategies that warrant further evaluation include adequate staffing, manageable workloads, supportive supervision, and leadership practices that promote psychological safety. Structured stress-management, wellbeing, and leadership-development programs aligned with national healthcare transformation goals should be tested in prospective and interventional studies before being recommended as causal solutions to improve nurse retention and system performance.

Future studies should prioritise longitudinal and interventional designs, standardised occupational-stress instruments, and nationally representative multicentre sampling that includes underrepresented regions, in order to establish causal relationships and inform evidence-based workforce policy for Saudi nurses.

Declarations

Ethics Approval and Consent to Participate

Not applicable. This study is a systematic review and meta-analysis based on previously published data and did not involve direct contact with human participants or animals.

Consent for Publication

Not applicable.

Availability of Data and Materials

All data generated or analyzed during this study are included in this article and its supplementary materials.

Competing Interests

The authors declare that they have no competing interests.

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Authors' Contributions

Mohammed Abdullah Alrasheedi contributed to conceptualization, literature searching, data extraction, analysis, interpretation, and manuscript drafting. Dhakir Abbas Ali contributed to methodology, supervision, interpretation, and critical revision. Hafizah Che Hassan contributed to supervision, interpretation, critical revision, and final approval of the manuscript. All authors read and approved the final manuscript.

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Declaration of Generative AI Use

During the preparation of this manuscript, the authors used generative artificial intelligence (AI) tools to assist with language editing, improving readability, formatting, and refining the presentation of the manuscript. AI-generated content was carefully reviewed, verified, and edited by the authors. No AI tool was used to generate, analyze, or interpret the study data, nor to make scientific decisions or conclusions. The authors assume full responsibility for the content of this publication.

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