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Article

The Association Between Caffeine Intake and Depression Among Healthcare Workers in a Large Tertiary Hospital in Jeddah, Saudi Arabia

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Abstract

Caffeine is widely consumed among health care workers (HCWs) as a coping mechanism for occupational demands and may influence depressive symptoms. This study investigated this relationship after adjustment for perceived stress and sleep quality. In this cross-sectional study on licensed HCWs at a tertiary hospital in Jeddah, Saudi Arabia, habitual caffeine intake was assessed using a validated caffeine food frequency questionnaire. Depressive symptoms were assessed using Patient Health Questionnaire (PHQ-9), with clinically relevant symptoms defined as PHQ-9 ≥ 10 . Perceived stress and sleep quality were measured. Logistic and linear regression models evaluated the associations with PHQ-9 ≥ 10 and PHQ-9 score respectively. Among 298 HCWs (mean age 37.5 years; 66.1% women), 18.5% had PHQ-9 ≥ 10 . Mean caffeine intake was 216 mg/day (median 125 mg/day). HCWs with PHQ-9 ≥ 10 reported a higher caffeine intake than those without (Mean 282 vs. 201 mg/day and median 169 vs. 114 mg/day; $p = 0.038$). Caffeine intake was significantly associated with PHQ-9 score but not with PHQ-9 ≥ 10 after full adjustment ($\beta = 0.331$; $p = 0.014$ per twofold increase). Perceived stress and sleep quality were independently associated with PHQ-9 ≥ 10 . Higher caffeine intake may reflect response to occupational strains rather than a primary depression risk driver.

Keywords: caffeine; depressive symptoms; healthcare workers; perceived stress; sleep quality

1. Introduction

Depression is a major contributor to the global burden of disease, affecting more than 300 million individuals worldwide, ranking as the single largest contributor to non-fatal health loss, and is among the top causes of disability-adjusted life years (DALYs) [1]. Healthcare workers (HCWs) are among the most vulnerable occupational groups for mental health challenges due to the unique nature and demands of their work [2,3]. Challenging work conditions, continuous attending to high patient needs, emotional strain, rotating shifts and disturbed sleep patterns increase their susceptibility to depression, anxiety and burnout. Reviews on depression among HCWs in Saudi Arabia reported high prevalence reaching around 75% in some professional categories [4]. These mental health challenges impose concerns given the implication on health care delivery, patient care quality and healthcare system sustainability.

Caffeine is the most widely consumed psychoactive substance [5], and therefore, its consumption is one of the behavioral factors that is of a growing interest in the context of mental health. HCWs turn to caffeine, most commonly through coffee, tea and energy drinks, as a coping

mechanism for occupational fatigue, to enhance short term alertness especially during long or irregular shifts and extended duty hours. A descriptive study of 600 healthcare providers in Saudi Arabia revealed that caffeine use was extremely common (94.3%) among them and that the average caffeine intake was 370 mg/day which is higher than adult average [6]. The primary neuropharmacological mechanism of caffeine is through antagonism of adenosine receptors in the nervous system which cause an increase in dopamine and noradrenaline activity, and in turn, increase arousal and wakefulness [7]. However, caffeine also might be harmful in the long term, contributing to disturbed sleep and increased stress levels, which are both contributors to depression, especially when consumed in high-doses [8].

Habitual moderate caffeine intake has been linked to decreased risk of depression in meta-analyses [9]. However, studies included in this meta-analysis were mostly done on general Western population, limiting its generalizability to HCWs in non-Western populations or high-burden settings. Evidence from high-stress populations is limited and often lack detailed adjustment for psychological and lifestyle related factors. For example, the Nurses' Health Study, a large cohort study, found that moderate caffeine intake, particularly from coffee, was associated with lower depression risk [10]. This previous study and other studies [11,12] mostly adjusted for lifestyle and medical conditions, but not always adjusted for stress physiology and sleep hygiene, which are well-established risk factors for depressive symptoms. While caffeine is widely used in HCWs, its relationship with depression remains unclear and might be confounded by chronic stress and poor sleep.

To our knowledge, no prior studies in Saudi Arabia have explored the independent association between caffeine consumption and depressive symptoms in HCWs while accounting for psychological distress and poor sleep. Accordingly, this study seeks to investigate the cross-sectional association between habitual caffeine intake and depression in HCWs in one of the largest affiliated hospitals in the region, and to explore the confounding roles of various demographic, psychological and lifestyle factors including stress and sleep quality. The findings may help clarifying whether the relationship between caffeine intake and depression is independent or reflects broader behavioral and psychological adaptation to work environment, which will be helpful for designing healthcare staff wellness interventions.

2. Materials and Methods

2.1. Study Design and Setting

A cross-sectional, questionnaire-based study was conducted among HCWs at King Abdulaziz University Hospital (KAUH), Jeddah, Saudi Arabia, between January and July 2025, to investigate the association between habitual caffeine consumption and depression status, and to explore whether this relationship is independent or confounded by stress, sleep quality and lifestyle factors.

2.2. Study Population and Sampling

Following approval from KAUH administration and institutional ethics committee, participants were recruited using convenience sampling. Eligible participants were licensed HCWs, including physicians, nurses, allied health professionals and support staff. Inclusion criteria were: age ≥ 22 years and current employment in KAUH for at least 6 months. Exclusion criteria included self-reported history of diagnosed psychiatric illness or chronic medical conditions requiring long-term medication use and pregnancy or recent childbirth (within the past 12 months) to reduce potential confounding by effects on mood, sleep or caffeine consumption.

An invitation containing the study information, consent form and study link was distributed via institutional email via Human Resources Unit. Participation was voluntary, and informed consents was obtained prior to enrollment.

2.3. Sample Size Estimation

Sample size was estimated using OpenEpi version 3.01 for cross-sectional studies with the assumptions two-sided 95% confidence level, 80% power, 1:1 ratio of unexposed to exposed. Based on an expected approximately 30% prevalence of moderate to severe depressive symptoms (PHQ-9 > 10) among HCWs in Saudi Arabia and an odds ratio of 2.0, the minimum required sample size was around 295 participants [13–15].

2.4. Data Collection

Data were collected using a structured, self-administered online questionnaire developed for this study and administered through the hospital's secure platform. It consisted of six sections including eligibility screening and medical history; demographic, anthropometric, lifestyle and occupational characteristics; caffeine intake assessment; depression assessment using the Patient Health Questionnaire (PHQ-9); sleep quality assessment using the Sleep Quality Questionnaire (SQQ); and perceived stress assessment using the Perceived Stress Scale (PSS-10).

The questionnaire was available in English and Arabic versions. Arabic versions of standardized instruments were obtained from validated versions [16–18]. Prior to distribution, the questionnaire was reviewed by two experts to ensure clarity and validity.

2.4.1. Screening and Medical History

To confirm inclusion and exclusion criteria, participants were asked whether they have any chronic diseases such as diabetes, blood pressure, or asthma, or were previously diagnosed with depression or using any psychiatric medications. Female participants were asked whether about pregnancy and recent childbirth. Ineligible responders were automatically excluded by the online system.

2.4.2. Demographics, Anthropometric, Lifestyle and Occupational Profile

This section collected self-reported information on participants' demographic, anthropometric, lifestyle and occupational characteristics. Participants reported their demographic data included age, sex, nationality, educational status, marital status, number of family members and income status. Self-reported anthropometric data included body weight (kg) and height (cm), which were used to calculate the body mass index (BMI). Occupational data included professional category (physician, nurse, allied health professionals and administrative/support staff) and continuous working hours. Working hours were then categorized to ≤ 40 and > 40 hours per week.

Lifestyle data included:

Smoking status: current smoker or non-smoker (never smoked or quit > 1 year)

Physical activity: engaging in more than 30 min of moderate or vigorous-intensity exercise at least twice a week during work or leisure times

Sleep duration: Continuous sleep duration (hours) per day. Sleep duration was then categorized to <6, 6–8 and >8 hours per day.

2.4.3. Caffeine Intake Assessment

Habitual caffeine intake was measured using a validated semi-quantitative caffeine food-frequency questionnaire (C-FFQ) adopted for local dietary patterns and available in English and Arabic [16]. Items included in the C-FFQ were coffee, tea, chocolate, and energy and soft drinks with standard frequency options and serving sizes. Reported intake was converted into average daily consumption. Total caffeine intake was calculated as a sum of multiplied intake frequency and portion size by caffeine content (mg/serving) for each item. Caffeine content was obtained from the U.S. Department of Agriculture database [19] and local information [20,21]. Matcha tea was added to the questionnaire and its caffeine content was based on published estimates [22]. The Arabic version of the FFQ underwent forward-backward translation and pilot validation on 20 participants.

Implausibly high intake (>800 mg/day) was verified through recontacting participants for re-confirmation. Participants who did not respond (n = 2) were excluded from the analysis.

2.4.4. Depression Assessment

Depression symptoms were assessed using PHQ-9 validated in English [23] and Arabic among Saudi populations [17]. Each of its 9 items is scored from 0 ("not at all") to 3 ("nearly every say"), yielding a total score of 0–27. A cutoff point of ≥ 10 was used to determine clinically relevant depression.

2.4.5. Sleep Quality Assessment

Sleep quality was assessed using the SQQ a self-reported validated tool was used to estimate participant's quality of sleep [24]. The questionnaire was translated to Arabic and its validity was tested. Participants rated their sleep quality over the past month using a 5-point Likert scale from 0 to 4 corresponding to strongly disagree, disagree, not sure, agree, or strongly agree. The questionnaire consists of ten items: six of them (3, 5, 6, 7, 8, 10) assess daytime sleepiness and four items (1, 2, 4, 9) evaluate sleep difficulty. Scores range from 0 to 40, with higher scores indicating poorer sleep quality. In the absence of a cut-off point for this scale, scores were analyzed continuously; for descriptive purposes, SQQ > 20 was used as an operational cutoff to additionally define poorer sleep quality, corresponding to an average item score of >2 (above midpoint).

2.4.6. Perceived Stress Assessment

Perceived stress was assessed using the PSS-10 [25,26]. Responses for 10 items are recorded on a 5-point Likert scale from 0 ("never") to 4 ("very often") or its reverse score yielding a score that ranges from 0 to 40 with higher scores indicating greater stress. Six are negative (1, 2, 3, 6, 9, 10) assessing perceived helplessness and four are positive (4, 5, 7, 8) evaluating perceived self-efficacy. Both English [25,26] and previously validated Arabic [18] versions were used. For descriptive analysis, PSS-10 > 20 was used to additionally define having higher perceived stress.

2.5. Ethical Considerations

Ethical approval was obtained from the Research Ethics Committee at King Abdulaziz University (KAU), reference No (HA-02-J-008). Informed consent was obtained from all participants, and their confidentiality and privacy was strictly maintained.

2.6. Statistical Analysis

Statistical Package for Social Sciences (SPSS) version 28 was used to analyze the data. Distributional assumptions for continuous variables were assessed by the Shapiro-Wilk test and by using visual inspection of histograms and Q-Q plots. Continuous variables are presented as mean \pm standard deviation SD and as median and interquartile range (IQR). Categorical variables are presented as frequency and percentages. Caffeine intake (mg/day) was examined both as a continuous intake and as intake categories (low (<200 mg/day), moderate (200–400 mg/day) and high (>400 mg/day)). Bivariate comparisons between participant with and without depressive symptoms were performed using independent-sample t-test for normally distributed variables and Mann-Whitney U test for non-normally distributed variables. One way ANOVA with Bonferroni post-hoc test was used to examine the differences in continuous psychological and sleep measures between coffee consumption categories. The chi-square test was used to examine association between categorical variables.

The association between categorical caffeine intake and depressive symptoms was assessed using binary logistic regression. Odds ratios (OR) and 95% confidence intervals (CI) were estimated for moderate and high intake, with low intake being the reference category. Three models were fitted. Model 1 (crude); Model 2 adjusted for age (per year), sex, BMI (per 1 kg/m²), smoking status, marital

status, living status, nationality, and physical activity; and Model 3 was additionally adjusted for stress and sleep quality scales (PSS-10 and SQQ scores).

The association between continuous caffeine intake and depressive symptoms was assessed linear models (general linear model/ANCOVA) with PHQ-9 score as the outcome and log2-transformed caffeine daily intake as the independent variable. Three models were fitted. Model 1 (crude); Model 2 adjusted for age (per year), sex, BMI (per 1 kg/m²), smoking status, marital status, living status, nationality, and physical activity; and Model 3 was additionally adjusted for stress and sleep quality scales (PSS-10 and SQQ scores). Model fit evaluation was conducted using the Hosmer-Lemeshow goodness-of-fit.

All tests were two-sided, and a *p* value <0.05 was considered statistically significant.

3. Results

A total of 298 HCWs responded to the survey and participated in the study. The mean age of participants was 37.5 ± 7.8 years and 197 (66.1%) of them were women (Table 1). Most of the participants were Saudi (71.5%) and married (64.4%). The mean BMI based on self-reported height and weight was 26.1 ± 5.09, with 42.6% having normal weight, 37.1% overweight and 17.6% obese.

Among participating HCWs, 55 (18.5%) met the criteria for having depressive symptoms (PHQ-9 ≥ 10) (Table 1). HCWs with depressive symptoms were significantly younger than those without (35.1 ± 6.9 vs 38.1 ± 7.9 years; *p* = 0.012). Sex, nationality, marital status, educational level, living status, household income, professional category, weekly work hours, sleep duration, smoking status and BMI did not differ significantly between those with and without depressive symptoms (all *p* > 0.05). Physical inactivity tended to be associated with having depressive symptoms, with higher proportion of inactivity among participants with depressive symptoms compared with those without (69.1% vs 53.1%; *p* = 0.066).

Table 1. Descriptive characteristics of the study participants (N = 298 HCWs).

Variable	Total (N = 298)	Without depressive symptoms		P-value
		(n = 243)	(n = 55)	
Age (years) mean ± SD	37.5 ± 7.8	38.1 ± 7.9	35.1 ± 6.9*	0.012
Sex n (n%)				
Men	101 (33.9%)	87 (35.8%)	14 (25.5%)	0.143
Women	197 (66.1%)	156 (64.2%)	41 (74.5%)	
Nationality n (n%)				
Saudi	213 (71.5%)	175 (72%)	38 (69.1%)	0.664
Non-Saudi	85 (28.5%)	68 (28%)	17 (30.9%)	
Marital status n (n%)				
Single	88 (29.5%)	67 (27.6%)	21 (38.2%)	0.124
Married	192 (64.4%)	163 (67.1%)	29 (52.7%)	
Divorced or widowed	18 (6%)	13 (5.30%)	5 (9.10%)	
Educational level n (n%)				
Diploma or less	44 (14.8%)	37 (15.2%)	7 (12.7%)	0.883
Bachelor	156 (52.3%)	127 (52.3%)	29 (52.7%)	
Postgraduate studies (Master or PhD)	98 (32.9%)	79 (32.5%)	19 (34.5%)	
Living status n (n%)				
Alone	45 (15.1%)	32 (13.2%)	13 (23.6%)	0.160
With parents and/or sibling	105 (35.2%)	88 (36.2%)	17 (30.9%)	
Married couple with children	106 (35.6%)	90 (37%)	16 (29.1%)	
Married couple without children	30 (10.1%)	22 (9.10%)	8 (14.5%)	
Living alone with children	12 (4%)	11 (4.50%)	1 (1.80%)	
Household income (SAR) n (n%)				

<8000	67 (22.5%)	55 (22.6%)	12 (21.8%)	0.835
8000–14.999	77 (25.8%)	63 (25.9%)	14 (25.5%)	
15.000–29.999	84 (28.2%)	66 (27.2%)	18 (32.7%)	
>30.000	70 (23.5%)	59 (24.3%)	11 (20%)	
Professional category n (n%)				
Physician	48 (16.1%)	37 (15.2%)	11 (20%)	0.746
Nurse	111 (37.2%)	90 (37%)	21 (38.2%)	
Specialist/Allied health	114 (38.3%)	96 (39.5%)	18 (32.7%)	
Technical support	25 (8.4%)	20 (8.20%)	5 (9.10%)	
Work hours/week mean ± SD	43.7 ± 8.7	43.5 ± 8.9	44.3 ± 8	0.587
Work hours category n (n%)				
≤40	155 (52%)	131 (53.9%)	24 (43.6%)	0.168
> 40	143 (48%)	112 (46.1%)	31 (56.4%)	
Sleep duration (hours/day) mean ± SD	6.3 ± 1.18	6.4 ± 1.2	6.2 ± 1.2	0.484
Sleep duration category (hours/day) n (n%)				
< 6	73 (24.6%)	57 (23.6%)	16 (29.1%)	0.584
6–7.5	180 (60.6%)	150 (62%)	30 (54.5%)	
≥ 8	44 (14.8%)	35 (14.5%)	9 (16.4%)	
Physical activity n (n%)				
Inactive	167 (56%)	129 (53.1%)	38 (69.1%)	0.066
Insufficiently active	86 (28.9%)	73 (30%)	13 (23.6%)	
Meets physical activity guidelines	45 (15.1%)	41 (16.9%)	4 (7.30%)	
Smoking status n (n%)				
Non-smoker	220 (73.8%)	183 (75.3%)	37 (67.3%)	0.530
Cigarette smoker	29 (9.7%)	21 (8.60%)	8 (14.5%)	
Shisha smoker	26 (8.7%)	20 (8.20%)	6 (10.9%)	
Electronic cigarette smoker	23 (7.7%)	19 (7.80%)	4 (7.30%)	
BMI (kg/m²) mean ± SD	26.1 ± 5.1	26 ± 5.2	26.7 ± 4.7	0.374
BMI category n (n%)				
Underweight	8 (2.7%)	7 (2.90%)	1 (1.80%)	0.117
Normal	126 (42.6%)	110 (45.6%)	16 (29.1%)	
Overweight	110 (37.2%)	83 (34.4%)	27 (49.1%)	
Obese	52 (17.6%)	41 (17%)	11 (20%)	

Data are mean ± SD for continuous and n (n%) for categorical variables. N = 298 HCWs. BMI was available for 296/298 participants as 2 did not report their height and weight. Percentages may not sum nu to 100% due to rounding. Insufficiently active: < 150 min/week (mod. activity) or < 75 min/week (vigorous), Meets physical activity guidelines: ≥ 150 min/week (mod. activity) or ≥ 75 min/week (vigorous). P-values from t-test for continuous variables and χ^2 for categorical variables. * p < 0.05.

Caffeine Intake by Depressive Symptom Status in HCWs

Caffeine intake among HCWs is summarized in Table 2. Among all participants, the mean caffeine intake was 216 ± 298 mg/day and the median was 125 mg/day (IQR 49–250). The majority of HCWs included had low caffeine intake (<200 mg/day) accounting for 67.4%. The mean caffeine intake in this group was 82 ± 58 mg/day and the median was 78 mg/day (IQR 31–128). Moderate intake was reported by 50 (16.8%) HCWs. The mean caffeine intake in this group was 274 ± 56 mg/day and the median was 259 mg/day (IQR 229–322). High caffeine intake (>400 mg/day) was reported by 47 HCWs (15.8%) with a mean of 722 ± 432 mg/day and a median of 561 mg/day (IQR 440–801).

Caffeine intake differed by depressive symptoms status (Table 2). HCWs with depressive symptoms had a significantly higher total caffeine intake compared with those without depressive symptoms (Mean ± SD: 282 ± 378 vs 201 ± 266; median (IQR): 169 (72–305) vs 114 (47–231); p = 0.038). Higher coffee intake was the main contributor to this difference in caffeine intake (Mean ± SD: 188 ±

259 vs 123 ± 200; median (IQR): 104 (21–239) vs 61 (12.5–146); $p = 0.037$). Tea intake did not differ significantly with depressive symptom status. The distribution of caffeine intake categories did not differ significantly with depressive symptom status.

Table 2. Caffeine intake (total and by source) by depressive symptoms status (N=298).

Variable	Total N = 298	Without depressive symptoms n = 243	With depressive symptoms n = 55	P-value
Total caffeine intake, mg/day				
Mean ± SD	216 ± 291	201 ± 266	282 ± 378	
Median (IQR)	125 (49–250)	114 (47–231)	169 (72–305)	0.038
Caffeine intake by source, mg/day				
Coffee, mean ± SD	135 ± 213	123 ± 200	188 ± 259	
Coffee, median (IQR)	67 (14–155)	61 (12.5–146)	104 (21–239)	0.037
Tea, mean ± SD	57 ± 106	58 ± 108	53 ± 98	
Tea, median (IQR)	18 (5–60)	18 (4–57)	23 (7–64)	0.423
Chocolate, mean ± SD	7 ± 25	5 ± 14	18 ± 49	
Chocolate, median (IQR)	1 (0–5)	0 (0–4)	3 (0–6)	<0.001
Energy drinks, mean ± SD	3 ± 10	3 ± 11	3 ± 7	
Energy drinks, median (IQR)	0 (0–0)	0 (0–0)	0 (0–5)	0.016
Soft drinks, mean ± SD	14 ± 30	12 ± 28	20 ± 40	
Soft drinks, median (IQR)	3 (0–15)	3 (0–11)	6 (1–19)	0.032
Caffeine intake category, n (n%)				
Low (<200 mg/day)	201 (67.4%)	169 (69.5%)	32 (58.2%)	
Moderate (200–400 mg/day)	50 (16.8%)	39 (16%)	11 (20%)	
High (>400 mg/day)	47 (15.8%)	35 (14.4%)	12 (21.8%)	0.242

Data are presented as mean ± SD and median (IQR) for continuous variables, and as frequency (%) for categorical variables. Depressive symptoms were defined as PHQ-9 ≥ 10. Continuous caffeine intake by depressive symptom status was analyzed using Mann-Whitney U test. Categorical caffeine intake category association was analyzed using χ^2 test. Percentages may not sum to 100% due to rounding. Significant p-values are shown in bold.

Psychological and Sleep Measures Among HCWs

Psychological and sleep measures among HCWs are summarized in Table 3. The mean PHQ-9 score was 5.93 ± 5.31 and the median was 5 (IQR 2–9). The mean PSS-10 score was 16.9 ± 5.78 and the median was 17 (IQR 14–20) with 63 (21.1%) classified as having high perceived stress (PSS-10 > 20). The mean SQQ score was 16.1 ± 9.32 and the median was 17 (IQR 9–23) with 108 (36.6%) classified as having poor sleep quality (SQQ > 20). Higher caffeine intake was associated with higher PHQ-9 scores ($p = 0.011$), higher perceived stress PSS-10 means ($p = 0.049$) and poorer sleep quality SQQ scores ($p = 0.013$). The prevalence of high perceived stress and poor sleep quality were also associated with higher caffeine intake ($p = 0.012$ and $p = 0.017$ respectively).

Table 3. Psychological and sleep measures among HCWs.

Measure	Mean (SD)	Median (IQR)	Range	n (%) above clinical cutoff
PHQ-9 (Depression)	5.93 ± 5.31	5 (2–9)	0–24	55 (18.5%)*
PSS-10 (Perceived stress)	16.9 ± 5.78	17 (14–20)	1–37	63 (21.1%)†
SQQ (Sleep Quality Score)	16.1 ± 9.32	17 (9–23)	0–40	108 (36.6%)‡

Data are presented as mean ± SD and median (IQR) for continuous data, and as frequency (%) for categorical data. *High depression defined as PHQ-9 ≥ 10. †High stress defined as PSS-10 > 20. ‡Poor sleep defined as SQQ > 20. PHQ-9, Patient Health Questionnaire-9; PSS-10, Perceived Stress Scale-10; SQQ, Sleep Quality Questionnaire.

Table 4. Psychological and sleep measures by caffeine groups among HCWs (N = 298).

Measure	Caffeine intake			P-value
	Low (<200 mg/day) n = 201	Moderate (200–400 mg/day) n = 50	High (>400 mg/day) n = 47	
PHQ-9, mean ± SD	5.29 ± 4.88	7.22 ± 4.95	7.28 ± 6.81	0.011
PSS-10, mean ± SD	16.3 ± 5.72	18.4 ± 5.18	17.5 ± 6.34	0.049
SQQ score, mean ± SD	15 ± 9.19 ^a	18 ± 8.67 ^{a,b}	18.7 ± 9.9 ^b	0.013
High stress, n (n%)	34 (16.9%)	12 (24%)	17 (36.2%)	0.012
Poor sleep, n (n%)	64 (32%)	19 (38.8%)	25 (54.3%)	0.017

Data are presented as mean ± SD continuous data, and as frequency (%) for categorical data. High stress defined as PSS-10 > 20. Poor sleep defined as SQQ > 20. Continuous outcomes were analyzed using one-way ANOVA and post-hoc pairwise comparisons were performed using the Bonferroni method; categorical outcomes were analyzed using χ^2 test. ^a and ^b are statistically significantly different ($p < 0.05$). PHQ-9, Patient Health Questionnaire-9; PSS-10, Perceived Stress Scale-10; SQQ, Sleep Quality Questionnaire.

Regression Models for the Association Between Caffeine Intake and Depressive Symptoms in HCWs

In crude logistic regression models, increased caffeine intake was associated with higher odds for having depressive symptoms as those who are consuming 200–400 mg/day of caffeine had OR of 1.481 (95% CI 0.687–3.193) and those consumed >400 mg/day had OR of 1.853 (95% CI 0.867–3.958) compared with those who consumed <200 mg/day (Table 5); however, these associations were not statistically significant. After adjustment for potential demographic, sociodemographic, lifestyle, stress and sleep cofounders, association between caffeine intake and depressive symptoms remained insignificant (200–400 mg/day: OR 1.083, 95% CI (0.396, 2.961); >400 mg/day: OR 0.975, 95% CI (0.338, 2.81) Table 5), whereas stress and sleep quality scores were independently associated with higher odds of depression ($p < 0.001$ for both).

In crude linear regression model, each 2-fold increase in caffeine daily intake was associated with 0.69 (CI 0.376, 0.998) point higher PHQ-9 score ($p < 0.001$) (Table 6). After adjustment for demographic and lifestyle variables, the effect remained approximately similar (Model 2: β 0.622 (CI 0.297, 0.947); $p < 0.001$). After additional adjustment for perceived stress (PSS-10) and sleep quality (SQQ), the association of caffeine intake and PHQ-9 was weakened but remained significant (Model 3: β 0.331 (CI 0.067, 0.595); $p = 0.014$). Higher stress and sleep quality scores were independently associated with higher odds of depression ($p < 0.001$ for both).

Table 5. OR of having depressive symptoms according to caffeine intake groups .

Caffeine intake	Model 1 (Crude)		Model 2 (Adjusted) [†]		Model 3 (Fully adjusted) [§]	
	OR (95% CI)	p-value	OR (95% CI)	p-value	OR (95% CI)	p-value
<200 mg/day	Ref.		Ref.		Ref.	
200–400 mg/day	1.481 (0.687, 3.193)	0.317	1.718 (0.724, 4.076)	0.22	1.083 (0.396, 2.961)	0.877
>400 mg/day	1.853 (0.867, 3.958)	0.111	1.561 (0.646, 3.775)	0.323	0.975 (0.338, 2.81)	0.962

Odds ratios (OR) from binary logistic regression. N=298. [†]Adjusted for age (per year), sex, BMI (per 1 kg/m²), smoking status, marital status, living status, nationality, and physical activity. [§]Additionally adjusted for stress and sleep quality scales.

Table 6. Association between continuous caffeine intake and PHQ-9 score.

Caffeine intake	β (95% CI)	p-value
Model 1 (Crude)	0.687 (0.376, 0.998)	<0.001
Model 2 (Adjusted) [†]	0.622 (0.297, 0.947)	<0.001
Model 3 (Fully adjusted) [§]	0.331 (0.067, 0.595)	0.014

β represents the difference in PHQ-9 per 1-unit increase in log₂-transformed caffeine intake (2 fold increase) (N = 298 HCWs). [†]Adjusted for age (per year), sex, BMI (per 1 kg/m²), smoking status, marital status, living status, nationality, and physical activity. [§]Additionally adjusted for stress and sleep quality scales.

4. Discussion

In this cross-sectional study of HCWs in a large tertiary hospital (KAUH) in Jeddah, 18.5% had depressive symptoms (PHQ-9 \geq 10). Average caffeine intake was 216 mg/day (median 125 mg/day) primarily driven by coffee intake, with 15.8% reporting high intake (>400 mg/day). Total caffeine intake was significantly higher among HCWs with depressive symptoms. Higher total caffeine intake was also associated with higher depressive symptoms (PHQ-9 scores), higher perceived stress (PSS-10) and poorer sleep quality (SQQ). Moderate (200-400mg/day) and high (>400mg/day) did not increase to odds of depressive symptoms after adjustment in logistic regression models, however, stress and sleep remained independently associated with depression. Together, this suggests that the association between caffeine intake and depression in this high-demand occupational group may largely be driven by stress burden and poor sleep hygiene rather than an independent caffeine-depression relationship.

The observed prevalence of having depressive symptoms (18.5%) in HCWs is generally lower than other Saudi reports [4,13,14] but broadly consistent with studies that used the same depressive symptoms diagnostic tool (PHQ-9 \geq 10) [15,27,28]. For example, in a multi-region cross-sectional study in the early COVID-19 outbreak that included > 15 hospitals in Saudi Arabia, significant depressive symptoms (PHQ-9 \geq 10) was prevalent in 18.2% among HCWs with diverse professions [27]. Another multi-center cross-sectional study in Jeddah, Saudi Arabia that involved care- and non-care-related professions from 10 primary healthcare centers reported a substantially higher PHQ-9 \geq 10 prevalence (36.3%) [14]. Differences in reported prevalence of depressive symptoms among HCWs in Saudi Arabia are attributable to variations in screening tools, pandemic phase, workload, role mix, and sampling strategies.

Average daily intake of caffeine in the present KAUH sample was moderate (216 mg/day) but highly right-skewed (median 125 mg/day), with nearly sixth (15.8%) of participants reported high intake (>400 mg/day). This distribution suggests that caffeine exposure in the majority of HCWs falls within the recommended safe caffeine limits for healthy adults [29,30]. However, a meaningful subset may have consumption levels that disrupt sleep and stress physiology. It is of a high importance that studies assess prevalence of higher than caffeine safe limits intake rather than just reporting mean mg/day.

When compared with Saudi general-population data, the observed intake in this study is comparable with a previously reported estimate from a large survey with an average of 218 mg/day caffeine intake in adults [31]. However, it is considerably lower than a previously reported average of 446 mg/day among Saudi governmental healthcare providers [32]. The lower average intake in this study might be due to differences in sampling frame and participant mix as we sampled healthcare worker including care- and non-care providers from a single large academic university, whereas the previous study included healthcare providers in governmental hospitals.

A key pattern in the finding of this study is that the daily caffeine exposure's continuous association between with PHQ-9 score remained significant after full adjustment while the categorical association did not. This could be explained by the possibility of information loss when dichotomizing depression, especially when the number of cases is relatively low that could limit precision of adjusted logistic models. Another explanation could be the J-shaped coffee/caffeine relationship with depression reported in meta-analysis of observational studies with >300,000 participant data [33]. In addition, stress and sleep attenuated the caffeine-depression relationship indicating that this relationship is partially explained by them. This is plausible as stress and sleep can be both confounders and mediators, as caffeine can induce arousal and worsen sleep which increases depressive symptoms. It would be more informative if prospective studies test mediation rather than treating stress and sleep purely as confounders. These studies also needed to establish

directionality in caffeine-depression relationship, as depressive symptoms are often accompanied by fatigue and impaired concentration; HCWs may increase caffeine consumption as adaptive measures to meet work demands suggesting reverse causation.

In contrast with our findings, systematic reviews and meta-analysis in general populations have consistently reported an inverse association between caffeine intake and depression, suggesting a protective effect [9,33,34]. This inconsistency could be due to differences in the context of the studies, as HCWs in tertiary hospitals may use caffeine to combat fatigue, which increases the likelihood that caffeine could be a marker of chronic under sleep rather than a luxury exposure. Another explanation is that many studies define the outcome as clinically diagnosed depression, but our study's outcome is depressive symptoms that are not clinically assessed, which are more sensitive to current stressors. Unmeasured factors can also explain this consistency, as factors such as night shifts, workload intensity and trauma exposure were not measured in the current study but were corrected for in some studies that were included in meta-analysis studies [34]. Our findings were also in contrast with other large cohort studies [10]. The protective associations in cohort studies may reflect correlated healthy behaviors including coffee bioactive polyphenols rather than the possible reverse causation in cross-sectional designs.

There are several strengths of this study. To the best of our knowledge, this was the first study to investigate the association among the HCWs population group in Saudi Arabia. In addition, validated questionnaires were used to detect the main association between caffeine consumption and depression, along with stress and sleep quality scales to control for confounders during analysis. Caffeine intake was assessed using a questionnaire that included most caffeinated items, covering both traditional beverages and trending drinks, including various types of coffee and tea. Participants were also asked about drink size to accurately estimate total daily caffeine intake. Moreover, sociodemographic and lifestyle characteristics, as well as stress levels, were adjusted for during analysis.

This study has some limitations. The cross-sectional study design captures participant conditions at a single point in time, and therefore reflects only one-time snapshot, while both caffeine consumption and depression may vary from time to time and across different periods. Therefore, the study cannot determine direction specifically, whether participants consume more caffeine due to depression-related feelings, or whether high caffeine consumption contributes to the development of depression or alternatively protects against it. Furthermore, the findings cannot be generalized to the wider population in Saudi Arabia because the study was conducted in a single center. Although the sample size was sufficient based on calculated sample size requirements, it remains relatively small for exploring associations using a cross-sectional design. Convenience sampling also may promote potential selection bias. In addition, self-reported questionnaires may be subject to recall bias, increasing the likelihood of measurement inaccuracy due to participant recall bias. Moreover, supplements containing caffeine and sleeping pills were not assessed for confounding control.

Future research using well-designed longitudinal and interventional designs with large sample size is needed to explore the causal relationship between caffeine consumption and depression among HCWs. Potential confounders such as sleep, anxiety and stress needs to be investigated carefully with exploring their mediation effects. Controlling for sociodemographic characteristics and work burden factors is required to better understand the association between caffeine consumption and depression in HCWs.

5. Conclusions

This cross-sectional study among HCWs in a large tertiary hospital in Saudi Arabia found the higher total caffeine intake was significantly associated with depressive symptom severity after adjustment for demographic and lifestyle factors, with attenuation by perceived stress and sleep quality. Categorical caffeine intake was not associated with clinically relevant depressive symptoms (PHQ ≥ 10) and perceived stress and sleep quality were independently associated with the presence of depressive symptoms (PHQ ≥ 10).

These findings suggest that caffeine may function as a behavioral broader response to occupational stress and sleep disruption in HCWs, and not a primary determinant of depression risk. Larger longitudinal studies that explore the mediator effect of stress and sleep and that consider timing and caffeine consumption patterns are required to examine the real effect of caffeine on depression. Interventions aimed at improving HCWs mental health needs to prioritize stress reduction and sleep hygiene.

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Abbreviations

The following abbreviations are used in this manuscript:

BMI	Body mass index
C-FFQ	Caffeine food-frequency questionnaire
DALYs	Disability-adjusted life years
HCWs	Healthcare workers
IQR	Interquartile range
KAUH	King Abdulaziz University Hospital
OR	Odds ration
PHQ-9	Patient Health Questionnaire-9
PSS-10	Perceived Stress Scale-10
SD	Standard deviation
SQQ	Sleep Quality Questionnaire

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