

Review

Relationship Between Salivary Cortisol and Psychological Scales in the Stress Assessment of Shift Workers: A Narrative Review

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Abstract

Background/Objectives: Cortisol, a stress-related protein found in saliva, is occupying an increasingly crucial role in stress research. While stress was previously assessed solely using psychological scales, the addition of cortisol as a biomarker has enabled more accurate stress assessment. Previously, stress among shift workers was evaluated both subjectively and objectively using psychological scales and cortisol levels. However, the variety of available psychological scales led to a lack of consensus on which ones should be used. This study reviewed papers investigating the relationship between cortisol and psychological scales to determine which ones should be used together. **Methods:** We searched for original research papers examining the relationship between psychological scales and cortisol levels among shift workers during a 20-year period from 1 January 2006 to 31 December 2025. The data were organized using psychological scales. **Results:** In total, 308 papers were selected, and after excluding those that met the exclusion criteria, 19 were chosen. Across the 19 studies, 10 different psychological scales were associated with cortisol. The most frequently associated psychological scales with cortisol were the Maslach Burnout Inventory (MBI), which appeared in four out of seven studies, followed by the Visual Analog Scale and Zung Self-Rating Depression Scale, which appeared in one out of two studies. **Conclusions:** We believe that the MBI is the most appropriate stress scale to evaluate in conjunction with cortisol; however, further evaluation is needed, particularly research that measures salivary cortisol and stress-related psychological scales using appropriate sampling methods.

Keywords: shift worker; mental health; stress; cortisol; psychological scale; saliva



Academic Editor: Firas Kobeissy

Received: 15 May 2026

Revised: 1 July 2026

Accepted: 2 July 2026

Published: 7 July 2026

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1. Introduction

Shift work can disrupt circadian rhythms, which regulate the sleep–wake cycle and physiological functions, and place significant physical and mental strain on workers, leading to increased stress [1]. Furthermore, long-term shift work has been shown to increase autonomic sympathetic nervous activity [2], which can affect hormone secretion and cause metabolic disorders, thereby increasing the risk of depression, cardiovascular disorders, and metabolic disorders in the future [3]. Therefore, assessing and managing stress in shift workers is considered useful for improving wellness and preventing medical risks.

Previous stress research has relied mainly on subjective stress measurement using psychological scales. However, psychological scales, being based on subjective self-perception, have inherent limitations and may lack objectivity [4]. Recently, objective assessments,

such as measuring stress-related proteins in saliva, have become available, making it possible to assess stress in the body easily and noninvasively. Therefore, using noninvasive biomarkers in addition to psychological measures to assess stress states is expected to be increasingly useful.

Saliva-based stress studies have used cortisol, α -amylase, secretory immunoglobulin A, and dehydroepiandrosterone, among others, but cortisol is considered the most useful [5–11]. Cortisol, the most widely used hormone in stress research, is a type of adrenal cortical hormone that is an essential hormone for the body and deeply involved in various physiological functions [12]. Salivary cortisol has been shown to correlate highly with serum cortisol and to reflect cortisol secretion accurately [13,14]. Saliva is considered the best specimen for stress research because it can be collected noninvasively, thereby reducing the stress and burden on subjects during sample collection. Recently, an increasing number of papers have reported the usefulness of salivary cortisol [15].

Shift work-induced circadian rhythm disruption impairs the function of the hypothalamic–pituitary–adrenal gland (HPA) axis, which regulates biological responses to stressful stimuli [16]. Abnormal HPA activity increases the risk of future cardiovascular and metabolic disease [17]. Cortisol, secreted by the adrenal cortex, is an indicator of the HPA axis and has been shown to be associated with job stress [18], chronic fatigue, and burnout [19,20]. Cortisol exhibits a diurnal rhythm, peaking upon awakening in the morning and gradually decreasing throughout the day until bedtime. Shift workers experiencing chronic stress exhibit lower cortisol levels upon awakening and a reduced slope by bedtime, indicating abnormalities in the HPA axis [21]. Cortisol also responds to acute stress, with cortisol levels rising during times of stress [22,23]. Therefore, in addition to irregular lifestyles due to shift work, long-term exposure to high stress can wear down both the body and mind and increase the risk of future health problems, highlighting the need for support for stress management. When considering stress support, stress must be measured and evaluated accurately.

Subjective and objective assessment of stress using cortisol and psychological scales is important for gaining a better understanding of the characteristics of shift workers and considering early support for stress. However, a variety of psychological scales are currently in use, and no consensus has been reached regarding the optimal one. Cortisol levels are characterized by diurnal variation, but it is unknown how accurately these diurnal variations are measured, and to what extent the relationship between cortisol and psychological scales has been reported in academic articles. Therefore, in the present study, we reviewed articles investigating the relationship between cortisol and psychological scales to determine which scales should be used in conjunction with cortisol. This study reviewed papers investigating the relationship between cortisol and psychological scales to clarify which ones should be used together.

2. Materials and Methods

2.1. Search Strategy and Selection Criteria

We searched SCOPUS, PubMed, and Google Scholar for relevant articles published over the 20-year period from 1 January 2006 to 31 December 2025. The search was conducted between January and March 2026. The search terms used were a combination of (“shift worker” OR “shift work”), (“saliva” OR “salivary”), (“psychological scale”), (“cortisol”), and (“stress”). Original articles written in English were eligible for review. The exclusion criteria included articles that used samples other than saliva or subjects other than shift workers, as well as those that did not examine the relationship between cortisol and psychological scales.

2.2. Data Extraction

The authors extracted data on publication year, paper title, abstract, study design, participant information, measured salivary stress-related proteins, psychological measures, and correlations with cortisol. The data were summarized for each psychological measure, and a narrative review was conducted according to the SANRA assessment criteria [24].

3. Results

3.1. Study Search and Inclusion

A total of 308 articles were identified from three different databases. After excluding duplicate articles, 157 were selected. Following further screening and eligibility assessment, 151 articles were selected. After reviewing the titles or abstracts and excluding 75 that met the exclusion criteria, 76 were selected. From these 76, 57 that met the exclusion criteria were removed, resulting in 19 articles included in the review. The reasons for the excluded studies are documented in the PRISMA flow chart (Figure 1) at each step [25].

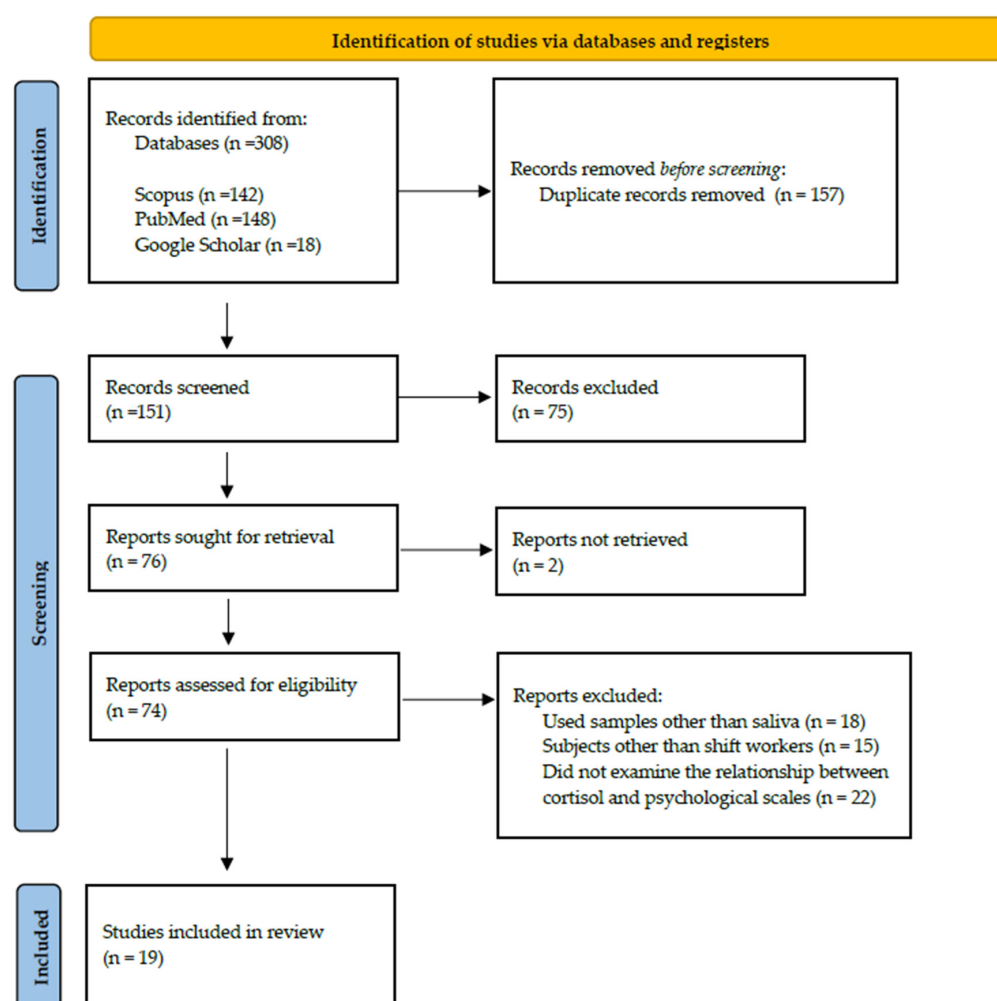


Figure 1. Review flow diagram of study identification, screening, eligibility, and inclusion.

3.2. Attributes of the Subjects in the Articles

In terms of the shift work patterns of the subjects in the included articles, four articles reported a three-shift system, five a two-shift system, and 10 an unknown system. The most common occupation in the included articles was nurse in seven and nurse and doctor in two. Regarding the gender of the subjects in the included articles, 14 articles reported both males and females, four reported only females, and one did not report gender (Table 1).

Table 1. Summary of 19 articles analyzing the relationship between various psychological scales and cortisol.

Author and Year of Publication	Study Design	Shift Pattern	Occupation	Gender	Sample Size	Psychological Scale	Relationship Between the Psychological Scale and Cortisol	Time of Saliva Collection	No. of Saliva Samples Collected	Main Limitation
Yamaguchi et al., (2024) [26]	Longitudinal study	Two-shift system	Nurse	Female	40	Maslach Burnout Inventory (MBI) The 15-item Occupational Fatigue/Exhaustion Recovery Scale	+ +	Upon awakening	Before three different day shifts within one month (3 times total)	Single facility, pandemic impact, uncontrolled physiological/work factors
Miyoshi et al. (2022) [27]	Intervention research	Unknown	Health-care worker	Male Female	18	MBI Sense of Coherence Connor-Davidson Resilience Scale Patient Health Questionnaire	— — — —	Before the yoga/mindfulness session (7:00 or 8:00 p.m.) and 1 h after	4 times (pre/post first and last program sessions)	small sample, lack of sub-analysis, uncontrolled confounders
Kuzmin et al. (2021) [28]	Cross-sectional study	Unknown	Nurse Doctor	Male Female	96	MBI Beck Depression Inventory Ways of Coping Checklist	— + —	8:00 a.m. to 9:00 a.m. (fasting)	1 time during the procedure	Specialized occupation only, cross-sectional
Deneva and Ianakiev (2021) [29]	Cross-sectional study	Unknown	Doctor Biologist Chemist Laboratory technician	Male Female	95	MBI State-Trait Anxiety Inventory Zung Self-Rating Depression Scale (SDS)	— — —	6:00 a.m. to 8:00 a.m.	1 time in the morning.	Small sample
Colonnello et al. (2021) [30]	Cross-sectional study	Unknown	Health-care worker	Male Female	90	MBI	+	End of shift (2:00 p.m. or 8:00 p.m.)	2 times at 7-min intervals	Lack of causality, female-dominated sample
Deneva (2019) [31]	Cross-sectional study	Unknown	Doctor	Male Female	308	MBI	+	6:00 a.m. to 8:00 a.m.	1 time in the morning	Descriptive cross-sectional design
Wingenfeld et al. (2009) [32]	Cross-sectional study	Unknown	Nurse	Male Female	279	MBI Maastricht Vital Exhaustion Questionnaire	+ —	7:00 a.m., 11:30 a.m., 5:30 p.m., and 8:00 p.m.	4 times during a day shift workday	Limited time points (4)
Bringel et al. (2023) [33]	Cross-sectional study	Two-shift system	Nurse Doctor Physiotherapist Speech therapist	Male Female	256	Burnout Characterization Scale	—	Around 4:30 p.m.	6 times total (pre/post intervention & sessions)	Small pilot study, female bias

Table 1. Cont.

Author and Year of Publication	Study Design	Shift Pattern	Occupation	Gender	Sample Size	Psychological Scale	Relationship Between the Psychological Scale and Cortisol	Time of Saliva Collection	No. of Saliva Samples Collected	Main Limitation
Cockerham et al. (2023) [34]	Prospective study	Two-shift system	Nurse	Male Female	81	The 14-item Perceived Stress Scale (PSS-14) Visual Analog Scale (VAS) Nurse Stress Scale (NSS) Multidimensional Fatigue Inventory (MFI-20)	— — — —	Pre-shift (6:00–7:00 a.m.) and post-shift (6:00–7:00 p.m.)	5 times (Baseline, Day 1 and 3 pre/post)	Limited to specific units, selection bias
Bani-Issa et al. (2020) [35]	Cross-sectional study	Unknown	Nurse Doctor Dentist (Others)	Female	335	PSS-14 Stress Symptoms Scale Brief Coping Scale	— — —	Upon awakening (7:00–8:00 a.m.) and at bedtime (7:00–8:00 p.m.)	2 times per participant	Insufficient duration/frequency
Cockerham et al. (2017) [36]	Cross-sectional study	Three-shift system	Nurse	Male Female	59	PSS-14 VAS NSS MFI-20	— + — —	Pre-shift (6:30–7:15 a.m.) and post-shift (6:45–7:15 p.m.)	4 times (pre/post for 2 consecutive 12 h shifts)	Limited facility type, sample loss (overtime)
Bergomi et al. (2017) [37]	Cross-sectional study	Unknown	Bus driver	Male Female	42	The 10-item Perceived Stress Scale Driver Stress Inventory	+ +	Shift start, middle, and end (Working hours unknown)	6 times (3 times on workdays and 3 on days off)	self-report bias, high biomarker variability
Zefferino et al. (2022) [38]	Randomized controlled trial	Three-shift system	Fisherman	Unknown	30	The Professional Stress Scale	+	8:00 a.m. and 2:00 p.m.	2 times per participant	Small sample of specific occupation, lack of control group
Lin et al. (2022) [39]	Cross-sectional study	Three-shift system	Nurse	Female	41	Nurse Stress Checklist	—	Upon waking and 30 min after waking	18 times (3 days/month for 3 months)	insufficient CAR points (2)
Pérez-Valdecantos et al. (2021) [40]	Cross-sectional study	Unknown	Nurse Doctor	Male Female	97	The revised version of the Medical Personnel Stress Survey	—	8:00 a.m., 12:00 p.m., 3:00 p.m., and 12:00 a.m.	4 times during a regular workday	Single-day follow-up, interference from diet/psychological perception
Briguglio et al. (2021) [41]	Cross-sectional study	Unknown	Nurse	Male Female	106	The Effort/Reward Imbalance Questionnaire	—	2 h after awakening and 10:00 p.m.	2 times total	Lack of causality, timing/circadian overlap

Table 1. Cont.

Author and Year of Publication	Study Design	Shift Pattern	Occupation	Gender	Sample Size	Psychological Scale	Relationship Between the Psychological Scale and Cortisol	Time of Saliva Collection	No. of Saliva Samples Collected	Main Limitation
Baba et al. (2015) [42]	Cross-sectional study	Two-shift system	Nurse	Female	36	SDS	+	10 specific times over 3 days (e.g., 8:00 a.m., 12:00 p.m., 5:00 p.m.)	10 times total covering day and night shifts	Difficulty in time management, sampling bias
Wirth et al. (2011) [43]	Cross-sectional study	Three-shift system	Police officer	Male Female	68	The Center for Epidemiologic Studies Depression Scale	—	Upon awakening, and 15, 30, and 45 min after	4 consecutive points (Cortisol Awakening Response: CAR)	Effect attenuation due to off-day sampling
Yamaguchi et al. (2022) [44]	Pilot study	Two-shift system	Nurse	Female	45	The Cumulative Fatigue Symptom Index	+	Before each shift (Day: 8:30 a.m.~, Night: 4:30 p.m.~)	4 times (before 2 day and 2 night shifts)	Single facility, small sample, sample loss

3.3. Psychological Measures Reflecting Cortisol Levels

A total of 19 articles examining 26 psychological measures were reviewed, 12 of which correlated cortisol levels with psychological measures. Additionally, 10 psychological measures correlated with cortisol in four of seven Maslach Burnout Inventory (MBI) articles [26,30–32], one of two Visual Analogue Scale (VAS) articles [34,36], and Zung Self-Rating Depression Scale (SDS) articles [29,42]. One article each involving the 10-item Perceived Stress Scale (PSS-10) [37], the Professional Stress Scale (PSS) [38], the Driver Stress Inventory (DSI) [37], the Beck Depression Inventory (BDI) [38], the 15-item Occupational Fatigue/Exhaustion Recovery Scale (OFER) [36], and the Cumulative Fatigue Symptom Index (CFSI) [44] was correlated with cortisol (Table 2).

Table 2. Summary of the relationships between cortisol and various psychological scales.

Psychological Scale Category	Name of Psychological Scale	No. of Articles	Positive Relation with Cortisol
Burnout	Maslach Burnout Inventory	7	4
	Burnout Characterization Scale	1	0
Stress	The 14-item Perceived Stress Scale	3	0
	Visual Analog Scale	2	1
	Nursing Stress Scale	2	0
	The 10-item Perceived Stress Scale	1	1
	Professional Stress Scale	1	1
	Driver Stress Inventory	1	1
	Nurse Stress Checklist	1	0
	Sense of Coherence	1	0
	Connor–Davidson Resilience Scale	1	0
	Revised version of the Medical Personnel Stress Survey	1	0
	Effort/Reward Imbalance Questionnaire	1	0
	Stress Symptoms Scale	1	0
Depression	Zung Self-Rating Depression Scale	2	1
	Beck Depression Inventory	1	1
	Patient Health Questionnaire	1	0
	The Center for Epidemiologic Studies Depression Scale	1	0
Fatigue	Multidimensional Fatigue Inventory	2	0
	The 15-item Occupational Fatigue/Exhaustion Recovery Scale	1	1
	The Cumulative Fatigue Symptom Index	1	1
	Maastricht Vital Exhaustion Questionnaire	1	0
Coping	Ways of Coping Checklist	1	0
	Brief Coping Scale	1	0

3.4. Summary of the Relationship Between Various Psychological Scales Related to Cortisol and Other Biomedical Measurements in Each Article

Stress-related psychological scales were extracted, and their relationships with cortisol are summarized in Table 2. The most common category of psychological scales used was “Stress” (11 articles), followed by “Depression” (4 articles), “Fatigue” (3 articles), and “Burnout” and “Coping” (2 articles each). The psychological scales used in each category were the MBI [26–32] and the Burnout Characterization Scale [33] for the “Burnout” category. In the “Stress” category, the following instruments were used: the 14-item Perceived Stress Scale (PSS-14) [34–36], VAS [34,36], Nursing Stress Scale (NSS) [34,36], PSS-10 [37], PSS [38], DSI [37], Nurse Stress Checklist [39], Sense of Coherence scale [27], Connor–Davidson Resilience Scale [27], revised version of the Medical Personnel Stress Survey [40], Effort/Reward Imbalance questionnaire [41], and Stress Symptoms Scale [41]. In the “Depression” category, the SDS [29,42], BDI [28], Patient Health Questionnaire [27], and Center for Epidemiologic Studies Depression Scale [43] were used. In the “Fatigue”

category, the Multidimensional Fatigue Inventory (MFI-20) [34,36], OFER [26], CFSI [34], and Maastricht Vital Exhaustion Questionnaire [31] were used. In the “Coping” category, the Ways of Coping Checklist [28] and Brief Coping Scale [35] were used. The most commonly used psychological scale across all categories was the seven-item version of the MBI, followed by three PSS-14s and two each of the VAS, NSS, SDS, and MFI-20.

3.5. Relationship Between Saliva Collection Time, Number of Collections, and Psychological Scales

Table 1 shows the saliva collection time and number of collections. Saliva collection times included single measurements at specific times such as upon waking, in the morning, and in the evening; two measurements before and after work shifts; and multiple fixed-point measurements for diurnal variation assessment. The most common saliva collection time was two measurements before and after work, followed by single measurements at predetermined times.

This study organizes the MBI, VAS, SDS, PSS-10, DSI, and BDI, which have shown the relationship between cortisol levels and psychological scales, based on saliva collection time. For the MBI, the four studies that showed a significant relationship between MBI and cortisol collected saliva at four time points: upon waking, between 6:00 a.m. and 8:00 a.m., after work (2:00 p.m. or 8:00 p.m.), and at 7:00 a.m., 11:30 a.m., 5:30 p.m., and 8:00 p.m. VAS samples were collected before and after work, from 6:30 a.m. to 7:15 a.m. and from 6:45 p.m. to 7:15 p.m. SDS samples were collected at three points: 8 a.m., 12 p.m., and 5 p.m. PSS-10 and DSI samples were collected at three points, but the times are unknown, at the start, during, and end of work. PSS samples were collected at 8 a.m. and 2 p.m. BDI samples were collected on an empty stomach between 8 a.m. and 9 a.m. OFER samples were collected upon waking. CFSI samples were collected at 8:30 a.m. on day shifts and at 4:30 p.m. on night shifts.

For major psychological scales used in multiple studies, although no association was found between cortisol and these scales, we organized them by saliva collection time. For the MBI, in the three studies that did not show a significant association with cortisol, samples were collected before and after the intervention (7 or 8 p.m. and one hour later), between 6 a.m. and 8 a.m., and between 8 a.m. and 9 a.m. Next to the MBI, the PSS-14 was used in all three studies, with samples collected before and after work, at 6 a.m. to 7 a.m. and 6 p.m. to 7 p.m., 7 a.m. to 8 a.m. and 7 p.m. to 8 p.m., and between 6:30 a.m. to 7:15 a.m. and between 6:45 p.m. to 7:15 p.m. For the VAS, in the one study that did not show a significant association, samples were collected before and after work, between 6 a.m. and 7 a.m. and between 6 p.m. and 7 p.m. For the SDS, in the one study that did not show a significant association, samples were collected between 6 a.m. and 8 a.m.

4. Discussions

Cortisol is the most commonly measured stress-related protein in stress research. A correlation between plasma and salivary cortisol has been reported, and saliva is less invasive and easier to measure than blood. Therefore, salivary cortisol has been used in many stress studies [12–15,30,45,46]. Given this background, the present study aimed to examine the relationship between salivary cortisol, a biological marker reflecting stress, and psychological measures to determine which psychological measures reflect cortisol most accurately.

In the reviewed literature, burnout-related scales were most commonly used to assess stress, and four of seven studies using the MBI examined cortisol levels. Burnout is a persistent, negative psychological response that typically occurs in workers as a result of long-term exposure to work-related stress [47]. Burnout consists of three sub-concepts: exhaustion, cynicism, and decreased job efficacy [48]. These sub-concepts are all work-

related psychological reactions, with various work-related stressors leading to exhaustion, followed by cynicism and decreased job efficacy, and ultimately burnout [49]. Therefore, it is likely that many studies consider burnout to be the result of stress [50]. Maslach and Jackson [51] developed the MBI as a psychological scale for evaluating burnout. The MBI is highly reliable and valid, and a large amount of stress research has been accumulated, making it a suitable scale for evaluating burnout. They defined burnout as a multifaceted phenomenon characterized by emotional exhaustion, depersonalization, and a decrease in personal accomplishment. Emotional exhaustion is a state of increased mental fatigue involving feelings and moods of being physically and mentally exhausted and not wanting to do anything. Depersonalization is a state of losing consideration and empathy for clients and colleagues and is manifested by a cold attitude toward clients and avoidance of contact. A decrease in personal accomplishment is a state in which one is unable to find joy in one's work and underestimates the importance of one's job.

Kristensen et al. [22] stated that depersonalization and a decrease in a sense of personal accomplishment indicate individual coping behaviors against stress, even in the context of burnout [52]. Regarding a paper examining the relationship between MBI and cortisol, Yamaguchi et al. [26] stated that burnout is the result of long-term work stress, which can induce negative feelings toward work and potentially lead to nurses being reluctant to retain their jobs. Because subjective indicators (i.e., psychological scales) are subject to bias and have limited accuracy, they used cortisol to assess burnout in nurses. The results showed a significant correlation between chronic fatigue and cortisol, suggesting that the cortisol profile of shift workers can be applied not only to fatigue assessment, but also to the detection of turnover risk. They also stated that the combination of cortisol and psychological scales could be used to predict turnover risk. Colonnello et al. [30] reported that individuals with high scores on the depersonalization subscale of the MBI had higher cortisol levels and tended to misclassify negative emotions as positive. However, they were unable to clarify the relationship between cortisol and depersonalization, and stated that further research focusing on threat signal processing and the reward system in healthcare workers who are prone to burnout is needed. Deneva and Ianakiev [31] hypothesized that chronic stress in the workplace is related to cortisol secretion, as cortisol plays a key role in the HPA axis, and examined the relationship between burnout and cortisol. They divided participants into burnout and control groups based on MBI scores and found that the burnout group had higher salivary cortisol levels than the control group. This finding clarified the relationship between cortisol and burnout and suggested the need for the development of burnout prevention programs. Furthermore, salivary cortisol and serum cortisol were correlated, demonstrating the usefulness of salivary cortisol [30]. Wingenfeld et al. [32] noted that burnout is significantly related to chronic stress and aimed to examine the relationship between burnout and cortisol in more detail by dividing participants into two groups based on MBI scores and comparing their daily cortisol levels. The results indicated that the burnout group had higher cortisol levels throughout the day [31], suggesting that burnout may be related to HPA dysregulation. Based on these findings, the MBI can be considered a psychological measure that reflects stress.

The VAS is a psychological scale used to measure perceived stress and quantify the magnitude of a person's feelings. The VAS has long been used in psychophysics, and its predecessor, the Graphic Rating Method, was published in 1921 [53]. Since 1969, many researchers have used the VAS to assess mood and sensations quantitatively. Currently, the VAS is used to measure a wide range of symptoms, including pain and stress. The VAS assesses stress intensity by measuring the marking length, with 0 mm representing no stress and 100 mm representing the most severe stress associated with intolerable feelings. In 2017, Cockerham et al. [36] reported a relationship between VAS and cortisol. The simplicity

and flexibility of the VAS make it an easy-to-use psychological scale. However, because it is ultimately a subject's own subjective evaluation, there is a large degree of individual variation, and it has been pointed out that quantitative analysis is difficult [54].

The validity of a psychological scale depends on how well it truly measures the construct. However, because there is no objective "gold standard" for the subjective experiences assessed by the VAS, it has been pointed out that its validity cannot be evaluated solely by criterion validity and must rely on construct validity. Furthermore, the VAS has a strong psychological component and may incorporate the subject's psychological state or dissatisfaction at the time, which raises the issue that it may not accurately reflect stress depending on the subject's situation [55]. Furthermore, previous studies examining the VAS and cortisol have provided little discussion regarding the findings, suggesting that further research is needed. Based on the above, when assessing stress using the VAS, it is important to confirm whether it accurately reflects stress and measures the construct.

The SDS is a psychological scale used for assessing depression. It assesses stress-induced depression and is widely applicable to both healthy individuals and patients [56]. Baba et al. [42] divided shift nurses into three groups based on SDS scores. The severe group, with the highest SDS scores, showed a rise in cortisol levels at 05:00 during the night shift, an earlier rise than the other two groups, suggesting a phase shift in their circadian rhythm. High SDS scores are thought to be related to circadian rhythm disorders as a result of increased mental tension and stress. A relationship between depression and circadian rhythm disorders has been reported [57], and individuals with high SDS scores and abnormal cortisol circadian rhythms are thought to be at higher risk for future depression. The BDI, a psychological scale for assessing depression, consists of questions about the subject's recent mood [58]. The BDI is suitable for screening workers for stress-induced depression and has been used in numerous studies [59,60]. The BDI reflects cortisol [28], and depression and stress are thought to be closely related. Therefore, the SDS and BDI are psychological scales that are widely considered to reflect stress-induced depression and cortisol.

Regarding the PSS, one of the PSS-10 questionnaires reflected cortisol levels, whereas all three PSS-14 questionnaires did not. The PSS-14 measures perceived or appraised stress, or the degree to which an individual assesses a situation as stressful [61–63]. Bergomi et al. [37] stated that the PSS-10, a shortened version of the PSS-14, was associated with cortisol levels because it is a psychological scale with fewer questions that is useful for detecting stress quickly in subjects. In the process of creating the PSS-10 from the PSS-14, the following four items were removed: "4. In the last month, how often have you dealt successfully with day-to-day problems and annoyances?", "5. In the last month, how often have you felt that you were effectively coping with important changes that were occurring in your life?", "12. In the last month, how often have you found yourself thinking about things that you have to accomplish?", and "13. In the last month, how often have you been able to control the way you spend your time?" As a result, the PSS-10 began to reflect cortisol. Therefore, although the PSS-10 is considered to be a psychological scale for assessing stress, further research is needed, as only one study has reported a relationship between the PSS-10 and cortisol [37]. On the other hand, papers using the PSS-14 did not explain why there was no correlation between the PSS-14 and cortisol, and Cockerhan et al. [34] stated that further research is needed.

A correlation between the PSS, a psychological scale for assessing occupational stress, and the DSI, which assesses driver stress, and cortisol has been reported [37,38]. Therefore, it seems advisable to assess stress using a psychological scale appropriate for the subject's occupation.

The CFSI and OFER, psychological scales used to assess chronic fatigue, also reflected cortisol levels. Yamaguchi et al. [44] investigated the relationship between chronic fatigue and cortisol in 2022 and 2024. In the 2022 study, early morning cortisol levels were significantly higher in nurses in the low-cortisol group, suggesting that cortisol regulation may not be functioning properly. Cortisol is characterized by diurnal variation, peaking upon awakening and then rapidly decreasing [20]. Furthermore, it is believed that individuals with high stress levels secrete less cortisol upon awakening, resulting in a more gradual increase in cortisol levels [40,64–66]. Therefore, it was suggested that chronic fatigue in nurses in the low-cortisol group may be affecting cortisol secretion. The 2024 study by Yamaguchi et al. [26] reported a relationship between OFER and cortisol and revealed that cortisol affects stress caused by chronic fatigue in nurses working shifts. Therefore, when analyzing the relationship between cortisol and psychological scales, it is important to set the time of saliva collection and interpret the results while considering diurnal fluctuations in cortisol.

The cortisol awakening response (CAR) is a reaction in which cortisol levels rise significantly during the first 30 to 45 min after waking in the morning. Because it combines aspects related to the reactivity index and circadian rhythm regulation, significant bias can occur in CAR estimates when the timing of sampling is uncertain [67]. Therefore, it is essential to strictly adhere to the specified saliva collection times when measuring salivary cortisol. Many of the studies reviewed collected saliva before or after work or at predetermined times, and few properly assessed the CAR; consequently, the association between salivary cortisol and psychological scales may not have been adequately evaluated. The lack of a consistent association between cortisol and the psychological scales commonly used to measure stress suggests that sampling may not have been consistent with CAR. Therefore, it is believed that appropriate saliva sampling procedures should have been followed. Since stress assessment using salivary cortisol is both simple and accurate, this is a field with great potential for future development. In future research, it will be necessary to clarify the timing of sampling to accurately evaluate CAR estimates.

Limitations

Although the objectives of this narrative review were met, this study has several limitations. There were variations in saliva measurement time in the 19 reviewed papers. Saliva measurements were mainly taken at or near the time of waking up, before and after shifts, several hours after waking up, and in the evening/night. In addition, the number of measurements varied in the literature. The time of saliva collection is important because cortisol is highest upon awakening after 30–45 min and has diurnal fluctuations, dropping rapidly thereafter. We conducted a 20-year literature review examining the relationship between salivary cortisol and psychological measures, but the number of articles covered was small, making it difficult to consider at what point saliva should be collected and the results should be compared. In addition, some of the literature had small sample sizes and gender bias, which could affect the validity of the results. As this study is a narrative review and involved only 19 publications, no definitive conclusions can be drawn; therefore, further research is required. Stress research using salivary cortisol is a field that will continue to develop. In the future, new systematic reviews and meta-analyses regarding salivary cortisol and psychological and occupational stress due to shift work are needed.

5. Conclusions

In the present study, we reviewed the relationship between cortisol and psychological scales among shift workers and considered which was optimal. Although a wide variety of

psychological scales have been used, it has become clear that few studies have appropriately applied the CAR assessment. At this point, we consider the MBI to be a suitable stress scale for use in conjunction with cortisol assessment; however, due to the limited number of studies reviewed and the inability to draw definitive conclusions, further evaluation is needed, and we must accumulate a body of research that measures salivary cortisol and stress-related psychological scales using appropriate sampling methods. We believe that if we can clarify the relationship between salivary cortisol and stress-related psychological measures, we will be able to gain a more detailed understanding of the stress levels experienced by shift workers.

Author Contributions: Conceptualization, Y.K. and M.Y.; Methodology, Y.K., N.K. and M.Y.; Investigation, T.S. and Y.N.; Data curation, N.K. and T.S.; Writing—original draft preparation, Y.K., N.K. and M.Y.; Writing—review and editing, Y.K., N.K. and M.Y.; Supervision, Y.N. and M.Y.; Project administration, N.K. and M.Y. All authors have read and agreed to the published version of the manuscript.

Funding: This research was supported by a Grant-in-Aid for Scientific Research from the Japan Society for the Promotion of Science [grant number JP24K13576] in FY2024.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: No new data were created.

Conflicts of Interest: The authors declare no conflicts of interest.

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