Perceived stress and burnout in nurses – the moderating role of age and network analysis perspective

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∎ Abstract

Introduction and Objective. The primary focus of the study was to examine the relationship between stress and burnout among nurses during the COVID-19 pandemic, with a special emphasis on exploring the moderating impact of age. Building upon Cohen, Camarck and Mermelstein's notion of perceived stress and Maslach's comprehensive understanding of burnout, the research aimed to shed light on how these factors interact within the nursing profession.
Materials and Method. The research employed a cross-sectional approach, conducting an extensive analysis through online surveys with a substantial cohort of 463 nurses. Two measures were used: the Perceived Stress Scale (PSS-10) and Maslach Burnout Inventory (MBI).
Results. The results of the study confirmed a positive and notable link between stress and burnout across all identified dimensions. Notably, age emerged as a crucial moderator, demonstrating statistical significance, particularly in the area of reduced personal accomplishment. The moderating effect of age was most pronounced within the oldest age group, highlighting the nuanced role of age in influencing the stress-burnout dynamic among nurses. Additionally, network analysis revealed consistent connectivity between stress and burnout nodes across age cohorts, underscoring the robustness of these associations within the nursing population.
Conclusions. The study confirmed the relationship between stress and burnout among nurses and highlights the moderating role of age, especially concerning reduced personal accomplishment. Urgent interventions are needed to equip nurses of all ages with coping strategies, particularly during challenging times like the COVID-19 pandemic.

∎ Key words

Maslach Burnout Inventory, network analysis, COVID-19, Stress, Nurses, Burnout, Perceived Stress, Coping Strategies, Age Moderation

INTRODUCTION

Stress constitutes a complex physiological and psychological reaction to perceived external threats or challenges, capable of disrupting physical, mental, and emotional balance [1]. This response initiates a sequence of physiological adjustments [2]. Stress can be analyzed from two aspects: distress – which is adverse and harmful, and as eustress – positive and motivating [3]. Alternatively, stress can be viewed as a process or transaction. The widely accepted theoretical model of stress by Lazarus and Folkman asserts that individuals play a crucial role in determining whether an event is 'taxing or exceeding his or her resources and endangering his or her well-being' [4, 5]. Cognitive processes of appraisal become pivotal in assessing whether a particular situation is potentially threatening, subsequently activating coping mechanisms to address the stressor and one's reactions to it [6]. While most individuals can manage stress experienced over short periods of time, persistent stress induces physiological changes.

Compared to physicians and pharmacists, nurses contend with the highest levels of stress [7]. A significant proportion, ranging from 42% – 92%, experiences moderate to high levels of stress [8]. The primary stressors include excessive workload, inadequate preparation, and dealing with patient deaths [9]. The nature of medical care giving demands that nurses exhibit empathy, proficiency and effective communication, particularly within stressful environments. However, workplace trauma, challenging interactions with patients, insufficient support, exhaustion, and exposure to workplace violence and bullying, are among their daily experiences [10]. The continual pressure and stress they face can lead to various adverse psychological outcomes, including burnout, absenteeism, and turnover. Existing literature on the subject confirms that prolonged stress contributes to diminished job satisfaction, compromised nurse-to-physician communication, increased number of medical errors, and mental health issues [11, 12].

Throughout the COVID-19 pandemic, stress levels surged globally, driven by concerns about infection, economic uncertainties, social isolation, and disruptions in daily routines [13, 14]. Healthcare professionals, including nurses, encountered additional stressors due to their frontline exposure to the virus, heightened workload, and moral dilemmas [15]. The pandemic revealed the critical need to address stress among healthcare workers to safeguard the well-being of the work force and ensure optimal patient care.

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Specifically in nurses, stress levels during the COVID-19 pandemic were further intensified by the challenges they confronted on the frontline [15]. A study investigating stress levels among nurses in Wuhan, China, during the COVID-19 pandemic revealed that 92% of nurses experienced moderate to high stress levels [16–18]. Similarly, in Spain, another study found that 54.9% of nurses reported high levels of stress during that time [19–22]. The multifaceted nature of stress experienced by nurses during the pandemic is influenced by factors such as workload, fear of infection, inadequate preparation, and insufficient staff support [23]. These findings emphasize the pressing need to address stress, particularly among nurses, amid the challenges posed by the COVID-19 pandemic. A study conducted by Hendy et al. during the COVID-19 pandemic further pinpointed inadequate preparation, workload, and lack of staff support as the most prevalent stressors among nurses [23]. Additionally, being a parent, fear of transmission to family members, and a low nurse-to-patient ratio were identified as positive predictors of stress in nurses. Conversely, the availability of protective equipment, level of education, and attention from hospital administration, were listed among the negative predictors for stress in nurses.

The ultimate outcome of prolonged psychological and emotional stress experienced at work is burnout, as postulated by Christina Maslach [24–26], who identified three dimensions of burnout: emotional exhaustion, depersonalization, and reduced sense of personal accomplishment [27]. Emotional exhaustion manifests as fatigue, diminished enthusiasm, and a decreased willingness to work, leading individuals to invest more and more energy into completing their tasks [28]. Depersonalization involves distancing from others, disregarding their humanity, and displaying lowered empathy and compassion. Reduced personal accomplishment is associated with perceiving one's competencies as inadequate, which is linked to a sense of insufficient success [29].

Burnout is a prevalent issue, especially among healthcare professionals, including nurses, which had a significant surge during the COVID-19 pandemic [30]. Among healthcare professionals, nurses experience higher burnout rates compared to others [30]. In addition, the pandemic exacerbated burnout among healthcare workers, particularly nurses, due to the unprecedented challenges they had to face on the front lines [31, 32]. Nursing is acknowledged as a high-risk profession for burnout [33–35]. A systematic review and meta-analysis examining burnout prevalence among nurses during the pandemic revealed a pooled prevalence of 52.7% [36, 37]. Nurses, at the forefront of the pandemic response, worked tirelessly to provide essential care, often at the expense of their own well-being. Maslach identified occupations prone to burnout due to high workplace stress, including teachers, lawyers, nurses, firefighters, military personnel, and other human service professionals [26]. Jobs demanding high empathy, professional commitment, communication, and negotiation skills, coupled with high expectations, make employees vulnerable to burnout. A study in early 2020 on frontline nurses in Wuhan, China, found that approximately half of the participants reported moderate to high levels of burnout [38]. The demand to meet expectations is a significant factor contributing to emotional strain, a crucial component of burnout [26]. Furthermore, burnout can be triggered by work-related factors, such as lack of control over organization in the workplace, nonsensical procedures, excessive bureaucracy, and inadequate compensation for efforts [39–43]. Weilenmann et al. who also studied nursing staff during the COVID-19 pandemic, linked burnout to professional experience, working hours, exposure to COVID-19 patients, and perceived employer support [44]. Recent studies on healthcare workers indicated that female nurses and frontline staff in particular, reported higher levels of anxiety, depression, and burnout during the COVID-19 pandemic [44].

The persistent global challenge of nursing shortage and high turnover rates have prompted researchers to examine the connection between stress and burnout within the profession. One significant factor influencing the strength of this relationship is age. As noted by Cai et al. [45], nursing staff aged 50 and above reported the highest levels of stress, particularly when confronted with the death of their patients. In addition, exhaustion stemming from heavy workloads was notably elevated in this age group. Interestingly, stress exhibited by colleagues had a more pronounced impact on older staff compared to other age groups. A question arises here: what could be the reason for this age-related differentiation in stress levels or burnout among nursing professionals?

A crucial factor contributing to the observed age-related differentiation in stress levels or burnout among nursing professionals, may be associated with the roles inherent in the successive stages of adulthood [46]. The early adulthood phase is marked by high energy, dynamism, and exceptional performance, encompassing the economic utilization and regeneration of one's resources [47]. Individuals in this stage possess a clear sense of their competences and limits, taking responsibility for decisions and their consequences [48]. The achievement of identity during this period facilitates the establishment of deeper interpersonal relationships, and enables individuals to adopt the perspectives of others [49]. Furthermore, early adulthood is a time for identity exploration and consolidation, allowing individuals to develop a clearer sense of self and values, enhancing their ability to form meaningful connections with others. The process of identity achievement not only enriches interpersonal relationships but also equips individuals with the ability to empathize and understand different perspectives. These interpersonal skills are particularly crucial for nurses who frequently work in teams, and interact with diverse patients and colleagues. Additionally, early adulthood is characterized by a heightened sense of responsibility and accountability, making individuals more likely to take charge of their decisions and their outcomes. In the nursing profession, where patient well-being is paramount, assuming responsibility for one's actions is of utmost importance. Nurses must make critical decisions ensuring alignment with professional standards and ethical principles. It is essential to recognize that the characteristics and experiences of early adulthood are not isolated; they are interconnected with later developmental stages. As individuals transition through middle and late adulthood, their perspectives, priorities, and coping mechanisms may evolve. Therefore, addressing the challenges faced by nurses in different stages of adulthood requires a nuanced understanding of their unique needs and stressors. In conclusion, early adulthood emerges as a significant period characterized by high energy, self-discovery, and interpersonal growth.

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In the subsequent developmental phase of middle adulthood, individuals often experience their peak performance. This stage is described as both the happiest and most fulfilling period of life, but it also brings the highest intensity of stressful situations, overload, aging-related challenges, and midlife crises [46]. During middle adulthood, individuals tend to reach a high level of realism and often step into the role of experts, leveraging their years of experience to assist others in problem-solving. While middle adulthood is characterized as a generally happy and fulfilling period, it also presents unique challenges. With increased responsibilities in both work and personal life, individuals may encounter high-intensity stressful situations, including managing complex patient cases, handling administrative duties, and balancing family commitments. The combination of workload and personal responsibilities can lead to feelings of overload and burnout, particularly in the demanding nursing profession. In addition to work-related stressors, middle adulthood is marked by aging-related concerns and midlife crises. As individuals age, they may confront physical and mental changes that impact overall well-being and coping abilities. The pressure to achieve personal and professional milestones before reaching later stages of life can contribute to a midlife crisis, prompting individuals to reassess their goals and achievements.

However, middle adulthood is also a time of increased realism and wisdom. With years of experience, individuals gain a better understanding of their strengths and limitations. This self-awareness enables them to approach challenges with a more pragmatic and composed mindset, making informed decisions and handling stressful events with resilience. Middle-aged individuals often play a crucial role in mentoring and supporting their colleagues, including younger nurses and healthcare professionals. Moreover, middle adulthood is characterized by a focus on the essential aspects of life. Individuals prioritize core values, relationships, and long-term goals, directing energy towards what truly matters to them. This ability to prioritize and maintain perspective helps individuals keep their distance from less critical events or distractions, enabling them to channel efforts into the most important issues at hand. In recognizing the unique challenges and strengths of middle adulthood, healthcare organizations must acknowledge the specific needs of nurses in this age group. Providing tailored support, stress management programmes, and opportunities for professional growth, can help mitigate stress and burnout during this crucial phase of nurses' lives and careers. Nurturing the well-being of middle-aged nurses ensures a more sustainable and fulfilling nursing workforce, benefitting both professionals and the patients they serve [50].

In the phase of late adulthood, individuals become increasingly aware of the passing years and must face the physiological and psychological consequences of aging [51]. This period may pose challenges in reconciling one's life outcomes, and the realization that aspirations from previous developmental stages have not been fulfilled and goals remain unattained. Such factors, among others, may contribute to a crisis [52]. Late adulthood is also marked by the potential attainment of equilibrium in the processes of involvement and control. When engagement strategies surpass control, actions may lack direction and purpose, causing feelings of frustration and stress. Conversely, an emphasis on control may stifle creativity, contributing to a chronic state of stress and ultimately leading to burnout [29]. Navigating through late adulthood can be particularly demanding as individuals seek a balance between their engagement in life's activities and the extent of control they maintain. The interplay of engagement and control becomes crucial, impacting both well-being and potential burnout risks [53]. During this phase, individuals may reflect on the profound impact of life choices made in earlier stages, prompting contemplation on life's meaning and purpose. The potential for regret or unmet expectations may contribute to distress and increase the risk of burnout. However, late adulthood also offers opportunities for growth and enrichment. Many individuals find solace in establishing a deeper sense of meaning and contentment by prioritizing relationships, engaging in meaningful activities, and contributing to their communities or passing on wisdom to younger generations [54].

For nurses in late adulthood, this life phase may coincide with a professional transition towards retirement or a reduced workload. The shift from a demanding nursing career to a more leisurely pace can present both challenges and opportunities. While retirement may offer relaxation and personal pursuits, it can also lead to a loss of identity and purpose, potentially impacting emotional well-being. To support nurses during this significant life transition and mitigate the risk of burnout, healthcare organizations can offer retirement planning programmes, provide opportunities for continued engagement in meaningful activities, and foster a supportive work environment that recognizes the value of experienced nurses' contributions.

The global nursing shortage and high turnover rate have prompted researchers to analyze the relationship between stress and burnout within the nursing profession. A key factor influencing this relationship is the age of nurses. As revealed in a study by Cai et al. [45], nurses aged 50 and above experienced the highest stress levels when faced with patient deaths; they also reported heightened exhaustion due to heavy workloads. Notably, stress from colleagues impacted older staff more significantly than their younger counterparts. The age-related disparities in stress and burnout may be influenced by the roles inherent in successive stages of adulthood, encompassing high energy and dynamism in early adulthood, peak performance and heightened stress intensity in middle adulthood, and an increased awareness of passing years and life consequences in late adulthood [48]. The unique challenges and coping mechanisms associated with different life stages contribute to these age-related variations in stress levels and burnout experiences among nurses.

Research has explored the moderating role of age in the stress-burnout relationship among nurses, generating varied findings. While some studies have suggested that age may not significantly moderate the stress-burnout relationship [55], others, such as those by Chen and Silverstein [56, 57] conducted in 2020, have reported potential age-related differences. Conversely, Akman et al. [58] found that working experience did not impact burnout in paediatric nurses in Turkey. Schooley et al. [59], however, identified a significant effect of age on emotional exhaustion and depersonalization. Additionally, Zheng et al. [60] reported that younger age and less working experience were associated with lower personal achievement. Examining the moderating role of age across various dimensions of burnout offers valuable insights for tailoring interventions to support nurses' mental health and well-being, especially during the challenges posed by the pandemic. Each dimension of burnout—

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emotional exhaustion, depersonalization, and reduced personal accomplishment—may be influenced differently by age-related factors. This investigation has the potential to advance our understanding of the complex interplay between stress and burnout in nursing. By identifying age-related differences and understanding their implications on different dimensions of burnout, healthcare institutions can implement customized approaches to enhance nurses' mental health, resilience, and job satisfaction. This tailored support ultimately contributes to the overall quality of patient care, particularly during the demanding times of a pandemic and beyond.

The primary objective of this study was to examine the moderating role of age in the relationship between experienced stress and burnout (H1). This investigation holds the potential to advance our comprehension of the intricate dynamics between stress and burnout in nursing. This study focused on three distinct dimensions of burnout, each explored through the following sub-hypotheses:

H1.1 – Age acts as a moderator in the relationship between perceived stress and emotional exhaustion among nurses.

H1.2 – Age acts as a moderator in the relationship between perceived stress and depersonalization among nurses.

H1.3 – Age acts as a moderator in the relationship between perceived stress and reduced sense of personal accomplishment among nurses.

An additional perspective, which will be investigated further, involves employing analysis of the network to delve into the intricate structure of relationships between burnout dimensions. This analytical approach could unveil the nuanced dynamics wherein interactions between stress and various dimensions of burnout persist. By scrutinizing the interconnectedness of these dimensions through a network lens, the aim is to gain deeper insights into how stress impacts emotional exhaustion, depersonalization, and reduced personal accomplishment uniquely across different age groups. This methodological extension has the potential to enrich our understanding of the multifaceted interplay between stress and burnout among nurses. Furthermore, it offers a novel perspective on how age-related factors may shape the manifestation of burnout dimensions, thereby informing tailored interventions to support the mental well-being and job satisfaction of nurses amid the challenges posed by the COVID-19 pandemic and beyond. The second objective was to explore psychological networks [61, 62] between stress and burnout (items-level) at different levels of stress abstraction: 1) single stress dimension level, and 2) stress items level. It was expected that the networks should provide insight into which level of abstraction is best for predicting burnout based on stress. Additionally, the obtained networks were compared between two age groups: younger (aged 23–45) and older nurses (aged 46–67).

MATERIALS AND METHOD

Participants. The participants of the study were 463 women ($M_{age} = 44$; $SD_{age} = 10.31$) who lived in the places of residence in Poland: village (5%), town with up to 50,000 inhabitants (29%), town with up to 100,000 inhabitants (25%), and a town with more than 100,000 inhabitants (41%). Nurses reported working in the following workplaces: public hospital (65%), private hospital (4%), private clinic (8%), public clinic (9%), nursing home (1%), other (13%). The sample size was determined using power estimation (RStudio [63]; data simulation: simglm package [64]; power estimation: simr package [65]) assuming small effect sizes of predictors in the traditional regression model (total $R^2 = 4\%$). Ethical approval for conducting the research was obtained from the Scientific Research Ethics Committee of University of Economics and Human Sciences in Warsaw (decision no. 2/10/2023), and all procedures were conducted in accordance with the highest ethical standards, including adherence to the principles outlined in the Helsinki Declaration.

Measures. The study was conducted through an online survey using Google Sheets at the beginning of the COVID-19 pandemic in April 2020 in Poland. This period marked a critical juncture in the trajectory of the pandemic, characterized by heightened uncertainty and rapidly evolving circumstances within the healthcare system. Conducting the survey online allowed for efficient data collection while adhering to social distancing measures, and minimizing potential risks to participants' health. Moreover, leveraging digital platforms facilitated broad accessibility, enabling participation from nurses across diverse geographical regions and healthcare settings. By gathering data during this pivotal period, the study aimed to provide timely insights into the experiences of nurses amidst the unprecedented challenges posed by the pandemic, shedding light on the dynamics of stress and burnout within this crucial frontline workforce.

Two questionnaires were used to measure stress: Perceived Stress Scale (PSS-10) and Maslach's Burnout Inventory (MBI). The PSS-10 by Cohen, Kamarck and Mermelstein [66], adapted by Ogińska-Bulik and Juczyński [67], is a widely utilized tool designed to evaluate the intensity of stress experienced in various life situations during the previous month. Comprising 10 items, the scale prompts participants to reflect on subjective feelings and experiences related to personal problems, events, behaviours, and coping strategies. Each item is rated on a 5-point Likert scale, ranging from 0 (never) to 4 (very often), allowing respondents to indicate the frequency of their experiences. The PSS-10 assesses both situational and dispositional aspects of stress, capturing individuals' perceptions of stressors and their perceived ability to cope with them effectively. Through its comprehensive approach, the scale provides valuable insights into respondents' stress experiences, shedding light on the prevalence and impact of stress across different domains of life. Previous research has demonstrated the validity and reliability of the PSS-10 in various contexts, with correlations observed between perceived stress levels and indicators, such as work-related stress intensity as assessed by such measures as the Subjective Work Evaluation Questionnaire. Additionally, the scale has been associated with ability of individuals to manage and overcome stress-related difficulties, highlighting its utility in predicting physical health outcomes and healthcare utilization. Moreover, studies have suggested that perceived stress is negatively associated with task-oriented coping strategies, indicating that individuals may adopt different approaches to coping based on their perceived stress levels. Furthermore, it is theorized that action-oriented coping strategies may serve as moderators or buffers against the effects of stress, highlighting the complex interplay between stress perception, coping mechanisms, and psychological well-being.

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The Polish adaptation of the MBI scale by Pasikowski [68] comprises 22 test items, each allocated to one of the three dimensions of burnout: emotional exhaustion, depersonalization, and reduced personal accomplishment. Respondents rate their frequency of experiencing each item on a 7-point Likert-type scale, ranging from 0 (never) to 6 (every day). This comprehensive tool allows for a nuanced assessment of burnout across its various dimensions, capturing the frequency and intensity of burnout experiences among individuals working in diverse professional settings. The MBI scale demonstrates robust psychometric properties, ensuring its reliability and validity in effectively measuring the burnout phenomenon. Its Polish adaptation by Pasikowski [68] has further enhanced its utility in collecting the nuanced experiences of burnout within the Polish context, facilitating comprehensive research and intervention efforts aimed at addressing burnout among professionals.

RESULTS

Moderation analysis. Hayes Macro (PROCESS v3.5, number of samples: 5,000, model #1) was used to verify the moderation model. Before carrying out the analysis, all variables were standardized ($M=0$; $SD=1$). In the first step, significance of the whole model was verified (Tab. 1).

Table 1. Moderation models

Model	Dependent variable	R^2	F	df1	df2	p
1	Exhaustion	.39	97.51	3	459	<.001
2	Depersonalization	.23	45.09	3	459	<.001
3	Reduced sense of personal accomplishment	.16	28.26	3	459	<.001

Moderation analysis for each dependent variable included in the concept of burnout indicated that predictors explain the dependent variable significantly ($p <.001$). In the next step, it was verified whether the independent variable (stress), moderator (age), as well as their interaction significantly explain the dependent variable (Tab. 2).

Table 2. Moderation analyses for emotional exhaustion, depersonalization and reduced sense of personal accomplishment

Model	Independent variable	Coefficients	t	p
	Model 1 – Emotional exhaustion			
	Constant	.001	.02	.983
	Stress	.633	17.09	<.001
	Age	.108	2.91	<.01
	Interaction	.005	.04	.898
	Model 2 – Depersonalization			
	Constant	.003	.08	.94
	Stress	.481	11.54	<.001
	Age	.021	.52	.607
	Interaction	.019	.46	.644
	Model 3: Reduced sense of personal accomplishment			
	Constant	.015	.34	.738
	Stress	.364	8.36	<.001
	Age	-.086	-1.98	<.05
	Interaction	.086	2.05	<.05

Experienced stress was found to be a significant predictor ($p <.001$) for every model of burnout. The nature of the relationship was positive, meaning that the higher the experience of stress, the higher the level of burnout. In the case of age, it was found to be a significant predictor ($p <.05$) of emotional exhaustion (positive relationship) and reduced sense of accomplishment (negative relationship). Interaction analysis (moderation) showed that the relationship was not significant for emotional exhaustion (Fig. 1) and depersonalization (Fig. 2); however, it was found for reduced sense of personal accomplishment (Fig. 3).
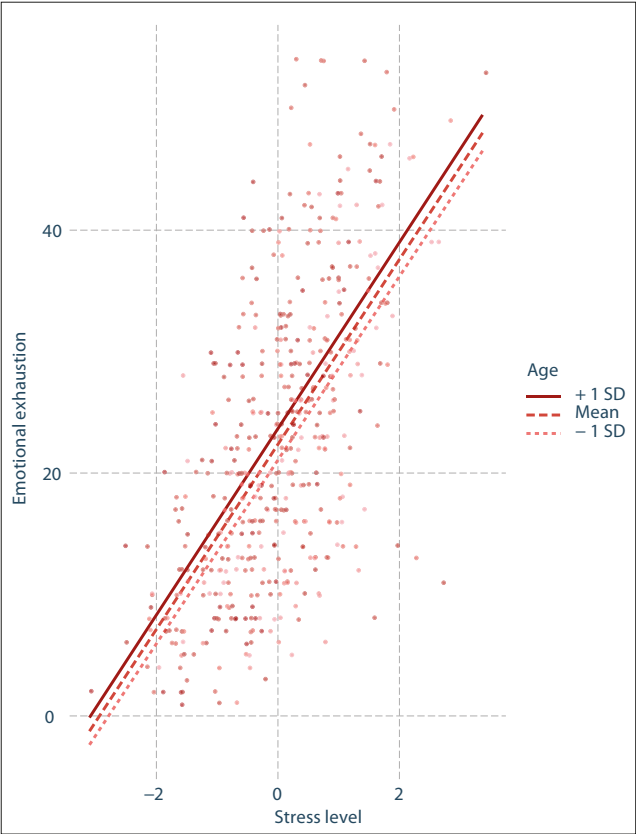

Figure 1. Interaction of stress* age and emotional exhaustion

Moderation analysis (Tab. 3) showed that the relationship between stress and reduced sense of personal accomplishment, although significant, was low for the youngest participants ($\beta =.28$), and moderate (towards high) for the oldest participants ($\beta =.45$). In other words, the older the person, the stronger the relationship between stress and reduced sense of personal accomplishment.

Table 3. Relationship between stress and reduced sense of personal accomplishment at different ages (moderator levels)

Age	β	t	p
– 1SD	.28	4.7	<.001
0 SD	.36	8.36	<.001
1SD	.45	7.3	<.001

In order to verify whether the observed interactions can be described as full moderation, Johnson-Neyman analysis was conducted [69]. The results of the analysis showed that
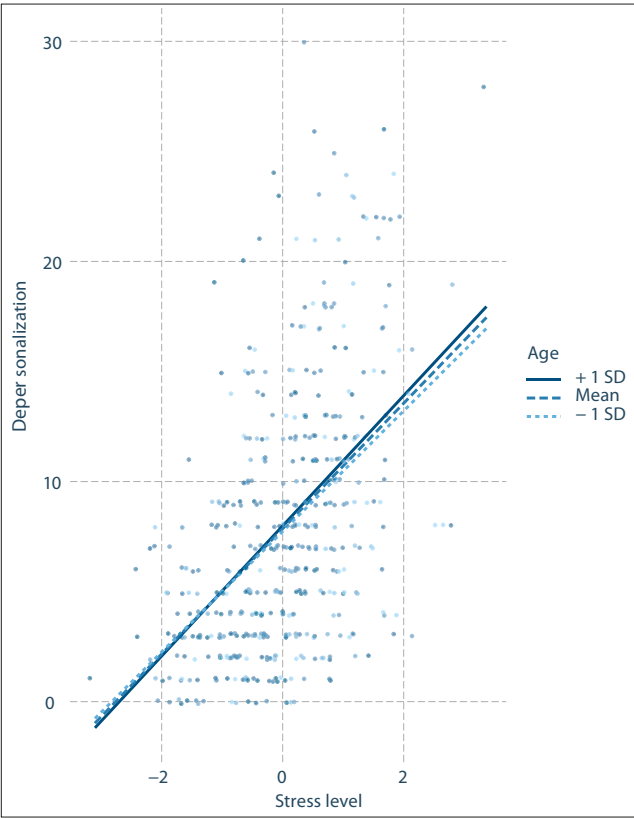
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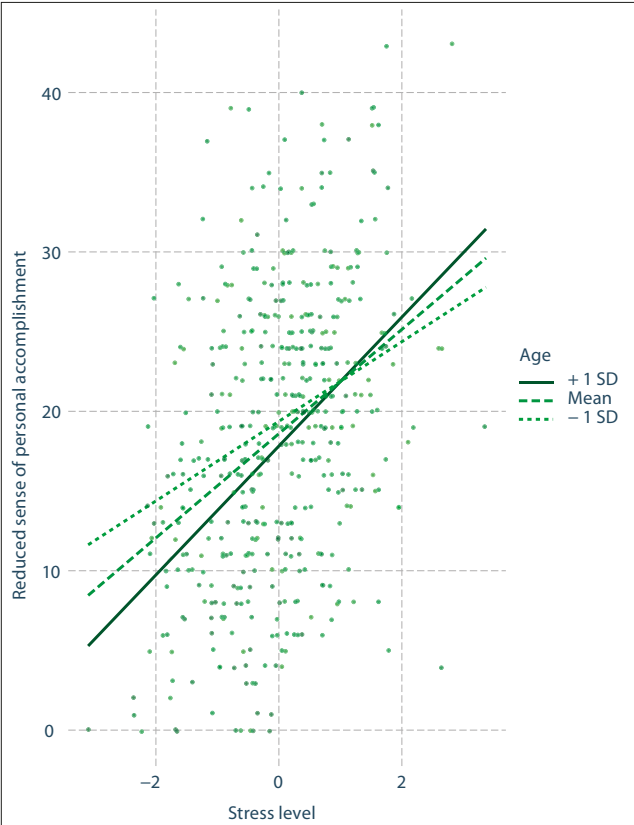**Figure 2.** Interaction of stress* age and depersonalization

Figure 3. Interaction of stress* age and reduced sense of personal accomplishment

the relationship between perceived stress and reduced sense of personal accomplishment was present at all levels of the moderator (lowest predictive value β =.19) was obtained

for approximately -2 *SD*). This means that although there is a trend showing that as age increases, the strength of the relationship between stress and diminished sense of personal accomplishment increases; for individuals at any age group there is always a significant relationship between the predictor and the dependent variable.

Network analysis. Results of network analyses are presented in accordance with the standards outlined by Burger et al. [70], and were conducted using R-version 4.2.2 on May 8, 2024. For network estimation, the estimateNetwork function from the bootnet package was used [62]. Visualization of the networks was performed using the qgraph package [71].

The initial sample of 463 nurses (with complete data) was divided into two subsamples based on the nurses' age: younger nurses (aged 23–45 years, N = 220) and older nurses (aged 46–67 years, N = 243). A Gaussian graphical model implemented in the qgraph R package was utilized, incorporating graphical lasso regularization and EBIC model selection (EBICglasso, [72]). The lambda parameter for the graphical lasso was determined using the extended Bayesian information criterion; a tuning parameter gamma was set to 0.5. Two levels of representation for stress dimensions were explored, ranging from broad (single dimension) to detailed (10 items), and their correlations with 22 burnout items investigated. The accuracy of the networks was assessed using a bootstrap method implemented in the R-package bootnet [62], employing non-parametric bootstrapping for edges stability (nBoots = 1000) and replication simulator analysis.

Generally, the outcomes of the non-parametric bootstrap analysis revealed wide and considerably overlapped confidence intervals of edges weights for both younger and older nurses networks, regardless of the level of representation of stress dimension. Thus, caution is advised in interpreting the sequence of edge estimates.

The findings from the replication simulator analysis, conducted with the ReplicationSimulator function in the bootnet R package, showed the expected replicability of both stress-burnout networks in both group of nurses that should be expected, if the estimated networks were the true networks, using different sample sizes (Fig. 4). The analysis showed that the stress items-level network and the stress dimension-level network should be expected to be replicated with a similar strength.

Figure 5 illustrates the networks of younger and older nurses for two levels of stress abstraction. In this representation, edges denote regularized partial correlations between stress (single dimension vs. items level) and burnout (items level). To enhance interpretability, the *classic* theme in qgraph was employed [71], with fading colors within constructs edges, *colorblind* theme for edges between stress and burnout, and standardized the average layout across the four network plots using the convenient circular layout. No specific minimum/maximum/cut values were applied for network visualization.

Nodes strength, betweenness and closeness centrality measures for both networks in both groups of nurses are presented in figure 6.

In the network of younger nurses, twelve burnout items were positively connected with the single stress dimension, while ten lack such a connection. This pattern is similarly observed in the network of older nurses, where thirteen
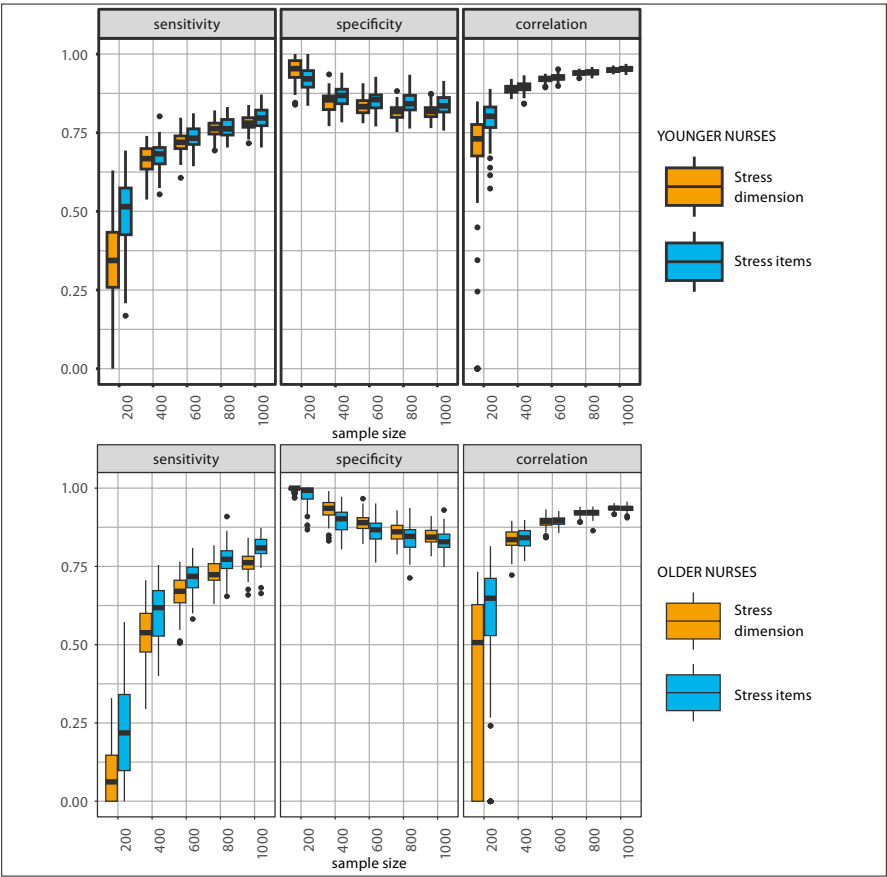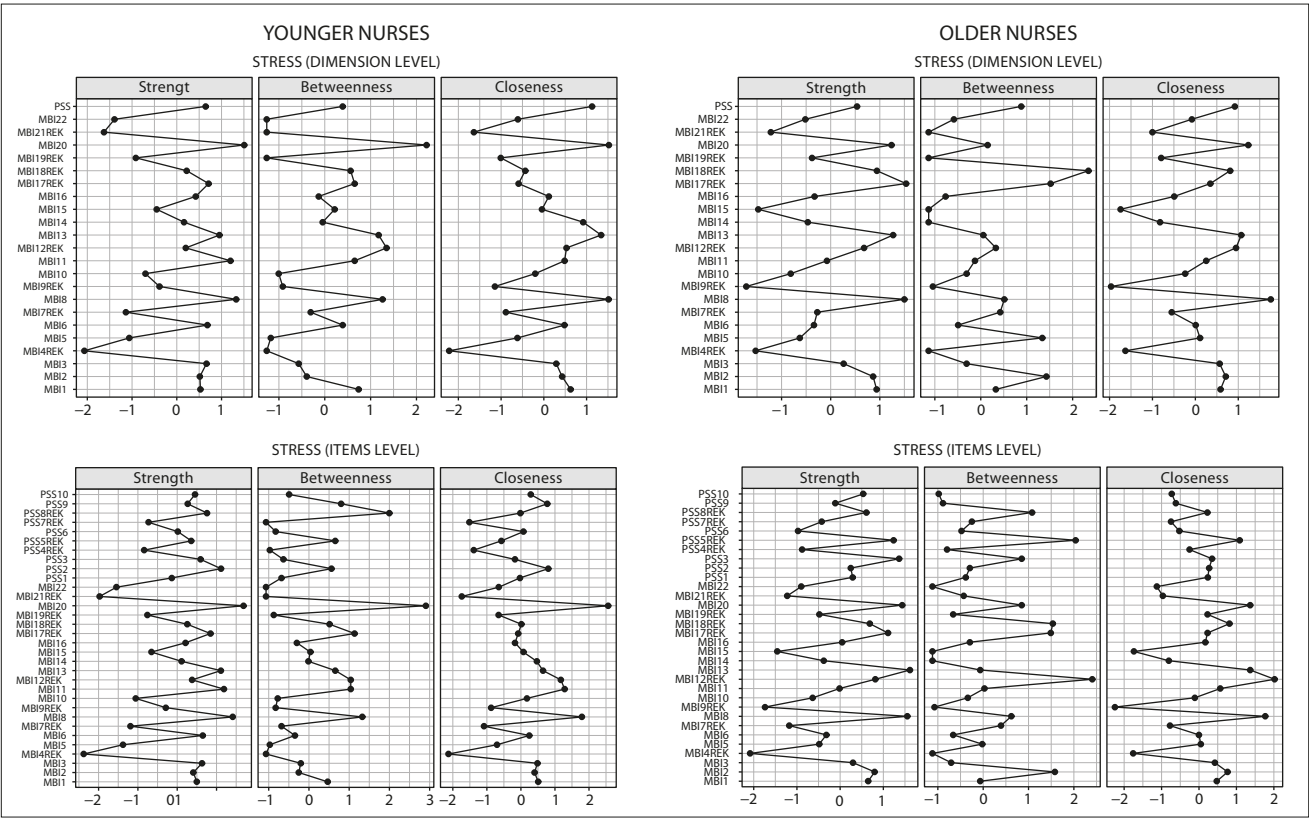
Figure 4. Expected replicability of both stress-burnout networks in both group of nurses, using different sample sizes
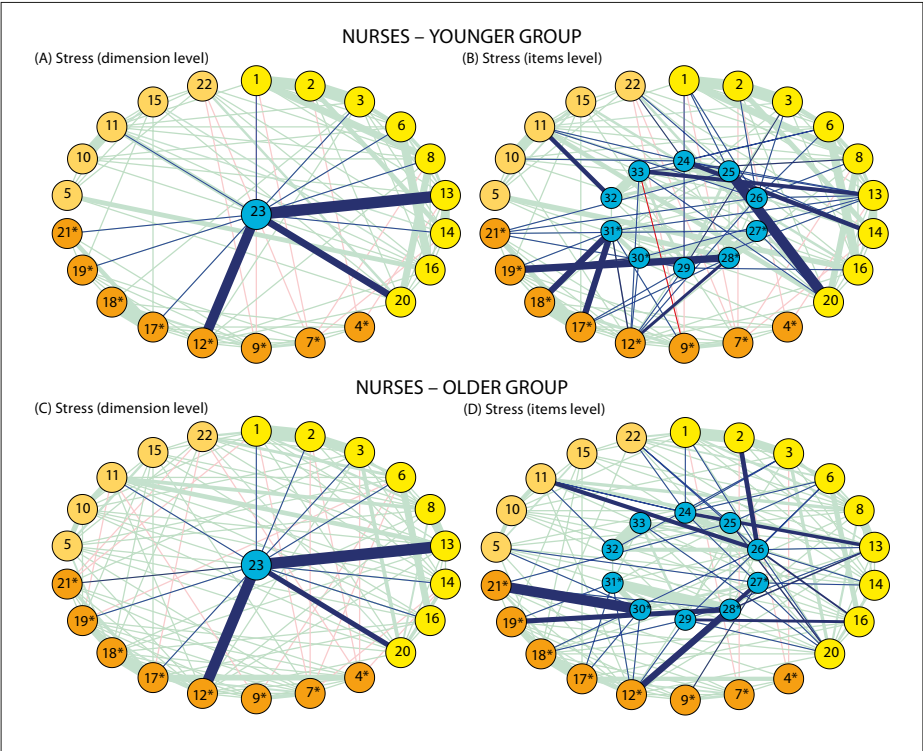
Figure 5. The networks display relationships between burnout (yellow/orange nodes) and stress (blue nodes) at two levels of abstraction: single dimension (panels A and C) and items (panels B and D). The top panel shows networks for younger nurses, while the bottom one depicts networks for older nurses. Nodes labeled 1, 2, 3, 6, 8, 13, 14, 16, and 20 represent MBI (emotional exhaustion) items; nodes 4, 7, 9, 12, 17, 18, 19, and 21 represent MBI (reduced sense of personal accomplishment) items; nodes 5, 10, 11, 15, and 22 represent MBI (depersonalization) items; node 23 represents the PSS-10 general score; nodes 24 through 33 represent PSS-10 items. Numbers with asterisks denote items reverse-scored before entering network estimation

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Figure 6. Nodes strength, betweenness and closeness centrality estimates for the younger and older nurses groups' networks between stress (single dimension vs. items level) and burnout

burnout items were positively connected with the single stress dimension, with the remaining nine lacking such a connection. Particularly regarding the depersonalization subdimension of burnout, four of the five items showed no connections with the single stress dimension in both the networks of younger and older nurses.

At the stress item level, in the network of younger nurses, eighteen burnout items predominantly exhibit positive connections with specific stress items, whereas only four burnout items lacked connections with any stress item. Conversely, in the network of older nurses, seventeen burnout items had positive connections with specific stress items, while five did not. The items comprising the depersonalization subdimension of burnout exhibited more connections with stress represented at the item level than as a single dimension.

In both groups of nurses, the predictive capability of stress (at both the single dimension and item-level) for burnout (item-level) was investigated using a 10-fold cross-validation approach [61]. Group comparisons were conducted by assessing the variance in edges and overall strength through the Network Comparison Test (NCT; [73]), employing 1,000 iterations and setting the seed to '1'. This evaluation determined whether the networks differed in edge characteristics and overall level of connectivity.

Given the primary interest of the current study in global distinctions in network connectivity, other tests offered by the NCT were not included in this analysis. To examine the performance of network models estimated at different levels of stress (single dimension vs. items) in predicting burnout items, the out-of-sample predictability of each burnout item was examined [74] using a 10-fold cross-validation method [75]. This assessment calculated out-of-sample R-squared estimates for each burnout item within each network model [61] (Tab. 4)

Bolded R-squared estimates highlight which level of stress served as a better predictor of burnout items separately for younger and older nurses. As observed, a slight majority of burnout items were better predicted by the single stress dimension: 13 out of 22 for older nurses and 14 out of 22 for younger nurses. The remaining burnout items are better predicted at the item level of stress.

The network invariance test conducted within the Network Comparison Test procedure revealed no significant differences between corresponding edges of the network with a single stress dimension across the younger and older nurses' networks ($M = 0.222$; $p = .535$). This indicated that the weights of corresponding edges in both networks were similar [73]. Furthermore, the global strength invariance test also demonstrated that there were no significant differences in the overall level of connectivity between nodes [73] across the younger and older nurses' networks, where stress was represented as a single dimension ($S = 0.392$; $p = .619$).

In the case of the stress represented at the items-level, the network invariance test also revealed no significant differences between corresponding edges across the younger and older nurses' networks ($M = 0.216$; $p = .683$). The global strength invariance test demonstrated that there were no significant differences in the overall level of connectivity between nodes across the younger and older nurses' networks ($S = 0.496$; $p = .509$).

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Table 4. Out of sample predictive accuracy (R^2) of burnout items in networks at different abstraction levels of stress

Stress level	M1	M10	M11	M12R	M13	M14	M15	M16	M17R	M18R	M19R	M2	M20	M21R	M22	M3	MI4R	M5	M6	M7R	M8	M9R
OLDER NURSES																						
Stress dimension	**0.559**	0.303	0.408	**0.420**	**0.615**	**0.314**	**0.130**	0.313	**0.421**	**0.436**	0.309	0.568	**0.537**	0.166	**0.241**	0.497	**0.103**	**0.251**	**0.347**	**0.173**	0.610	0.110
Stress items	0.553	**0.304**	**0.418**	0.419	0.605	0.308	0.127	**0.322**	0.416	0.434	**0.323**	**0.577**	0.533	**0.201**	0.233	**0.501**	0.101	0.247	0.340	0.160	**0.611**	**0.115**
YOUNGER NURSES																						
Stress dimension	**0.533**	0.279	0.510	**0.347**	**0.555**	0.468	**0.246**	**0.406**	**0.400**	0.373	0.171	**0.592**	0.585	**0.111**	0.140	**0.567**	**0.015**	0.165	**0.570**	**0.109**	**0.585**	**0.201**
Stress items	0.531	**0.281**	**0.526**	0.315	0.532	**0.472**	0.244	0.399	0.397	**0.385**	**0.187**	0.589	**0.596**	0.101	**0.145**	0.567	0.008	**0.169**	0.566	0.095	**0.585**	0.189

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DISCUSSION

Research on factors influencing nurses' intention to quit reveals that burnout is a direct contributing factor in approximately one-third of cases [76]. The demanding nature of the nurses' job, coupled with prolonged exposure to stressors, results in exhaustion over time, as the profession does not readily allow for quick resource regeneration. This chronic exhaustion can subsequently lead to burnout. In the current study, stress was found to have a significant and positive correlation with all dimensions of burnout, including emotional exhaustion, depersonalization, and reduced personal accomplishment. These findings align with the meta-analysis conducted by Galaniset al. [37], which reported that during the COVID-19 pandemic, 34.1% of nurses experienced emotional exhaustion, 12.6% experienced depersonalization, and 15.2% reported low personal achievement. Notably, these scores were considerably higher, even among nurses working in highly stressful environments [37].

In summary, the present study, in conjunction with prior research, emphasizes the substantial correlation between stress and burnout among nurses. Burnout, identified as a direct cause of the intention to quit in a significant number of cases, resulted from the prolonged exposure to stressors inherent in nursing work. The meta-analysis further emphasized the severity of the issue, revealing elevated levels of emotional exhaustion, depersonalization, and reduced personal accomplishment among nurses working in the challenging circumstances of the COVID-19 pandemic.

The current study identified a correlation between age and two out of three occupational burnout scales: emotional exhaustion and reduced sense of personal accomplishment. This observation appears to diverge from the results of the meta-analysis by Gómez-Urquiza et al. [77], which found a significant inverse relationship between age, emotional exhaustion, and depersonalization. It is crucial to note that the current study was cross-sectional, making it challenging to establish causation, particularly considering it was conduct during the COVID-19 pandemic. In another study conducted during the COVID-19 pandemic [38], emotional exhaustion was observed in twice as many nurses compared to the current study, depersonalization occurred more than three times as often, and low personal achievement was noted more than four times as often. These disparities in results may be attributed to cultural differences and the heightened severity of the pandemic in China, where the research was conducted. Therefore, while the findings of the present research indicate a correlation between age and emotional exhaustion, as well as reduced personal accomplishment, the context of the COVID-19 pandemic and potential cultural influences must be considered when interpreting these results, especially in the light of variations observed in studies conducted in different regions.

Furthermore, the current study found a relationship between age and stress concerning burnout, specifically for one of its three subscales: reduced sense of personal accomplishment. This implies that as individuals age, the relationship between stress and reduced personal accomplishment becomes stronger. This phenomenon may be attributed to younger individuals generally having a lower sense of personal accomplishment due to their relatively limited experience [78, 79]. On the contrary, for older adults, a decline in personal achievement may result in heightened stress, particularly for those at the pinnacle or end of their careers. Consequently, the perception of reduced personal accomplishment does not evoke the same stress response across different age groups. These age-related distinctions underscore the significance of considering age as a pivotal factor when addressing stress and burnout in nursing professions. Recognizing interplay between age and stress on specific burnout subscales, such as reduced sense of personal accomplishment, can contribute to more targeted and effective interventions tailored to the unique needs of individuals at different stages of their nursing careers.

The conclusion drawn from the network analysis suggests that both younger and older nurses' networks display similar connectivity between stress and burnout nodes, indicating comparable patterns of association between these variables across different age groups. Moreover, the strength of correlations between these nodes appears to be consistent across age cohorts. However, it is important to exercise caution in interpreting the results, as the stability of all estimated networks is questionable. The edge estimates should also be interpreted with caution due to the potential instability of the network structures. Additionally, it is worth noting that the sizes of the younger and older nurses' groups may be insufficient to achieve a high level of accuracy in the presented network analysis. Therefore, while the findings provide valuable insights, further research with larger sample sizes is warranted to validate and strengthen the observed network patterns.

The presented study comes with several limitations. Firstly, there appears to be a circular relationship between perceived stress and burnout. Factors such as the perception of achievement, decreased willingness to work, and lower empathy can generate stress, which, in turn, may lead to burnout. Although existing literature supports burnout as an outcome of stress [80], the present study does not delve into explaining their causal nature. Secondly, the data on stress levels were self-reported and pertained to events occurring in the previous month [81]. Utilizing a physiological, unbiased measure collected at different time intervals could provide more accurate insights. Additionally, lack of control over the specificity of duties performed by nurses and the type of healthcare facilities they worked in (teaching hospitals, provincial hospitals, private clinics, or hospices) introduced uncontrolled variance that could have influenced the observed relationships between the studied variables.

Finally, a noteworthy limitation is the cross-sectional nature of the study. While it sheds light on the intricate relationship between stress, burnout and age in nursing professions during the COVID-19 pandemic, this design limits the ability to establish causality and generalizability. To address these limitations, future research should consider conducting longitudinal studies to explore the dynamic interactions between stress, burnout, and age over time. This approach would offer a more comprehensive understanding of these phenomena and facilitate the development of targeted interventions to address the unique needs of nurses at different stages of their careers.

Moving forward, future research should delve deeper into the influence of professional experience on burnout and chronic stress among healthcare professionals. Longitudinal studies could provide valuable insights into how burnout evolves over the course of a nurse's career, shedding light on the cumulative effects of prolonged exposure to stressors in

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the workplace. By tracking nurses' experiences over time, researchers could better understand the trajectory of burnout and identify critical junctures where interventions may be most effective in preventing or mitigating its development. Moreover, qualitative studies exploring the subjective experiences of nurses at different career stages could offer rich contextual information about the factors contributing to burnout and chronic stress.

Understanding the unique challenges faced by novice nurses versus seasoned veterans may inform tailored strategies for support and intervention. Additionally, investigating the role of organizational factors, such as workload, staffing levels, and organizational culture, in shaping the experience of burnout among nurses with varying levels of experience could provide actionable insights for healthcare institutions seeking to foster a more supportive work environment. Furthermore, given the potential impact of burnout on patient care outcomes, future research should explore the ripple effects of burnout across the healthcare system. Examining the relationship between nurse burnout and patient satisfaction, quality of care and clinical outcomes, could highlight the broader implications of addressing burnout, not only for the well-being of nurses, but also for the overall effectiveness of healthcare delivery.

Examining stress and burnout in healthcare professionals is particularly crucial, given that burnout can potentially impact patient outcomes. Alleviating burnout among nurses holds the potential to enhance their quality of life, subsequently improving the overall quality of care in healthcare settings [82]. Given the evident correlation between stress and burnout symptoms, it becomes imperative to implement initiatives aimed at equipping nurses with effective coping strategies for stress. Recent research indicates that female nurses attending to COVID-19 patients experienced elevated levels of stress, depression [79] and burnout [83]. Providing emotional and social support has demonstrated positive outcomes, with empathy and social support emerging as mild but significant protective factors against burnout [84–87]. Emphasizing emotional support, the conveyance of positive emotions, such as concern and reassurance, has proven effective in facilitating the expression of pain, fear and hope, making it a valuable component in designing support programmes for vulnerable individuals during a pandemic crisis [51]. Considering the moderating role of age in the stress-burnout relationship, future interventions should tailor their programmes to account for age-related differences. This targeted approach aims to better support nurses at various stages of their careers, ultimately promoting their well-being in healthcare settings.

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