Research article

The effect of COVID-19 anxiety on nurses' productivity determinants through perceived workload and individual job performance: A Bayesian mediation analysis

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A R T I C L E   I N F O

A B S T R A C T

This study aims to predict how COVID-19 anxiety affects productivity determinants by examining the role of perceived workload and individual job performance as mediators using Bayesian mediation analysis. To achieve the study's objectives, all nurses working at Imam Reza Hospital were recruited to participate. To gather data, all eligible and voluntary nurses were asked to complete questionnaires that included the Corona Disease Anxiety Scale (CDAS), Individual Job Performance Questionnaire (IJPQ), NASA Task Load Index (NASA-TLX), and Workforce Productivity Questionnaire. Of the total number of nurses employed, 222 (126 women and 96 men) nurses fully completed the questionnaires. Out of these, 140 individuals were married and 82 were single. The mean ± standard deviation (SD) of the age and experience were 28.56 ± 5.78 and 8.49 ± 6.50, respectively. GeNIe software version 2.0 utilized to analyze the Bayesian network. The results showed that for the high COVID-19 anxiety and high workload states, with a probability of 100 %, the probability of high evaluation and high environment increased by 16.6 % and 16.3 %, respectively, but low evaluation and low environment decreased by 22.4 % and 22 %, respectively. In the high COVID-19 anxiety and low IJP states with a probability of 100 %, most change was related to the high ability (6 % increase), low evaluation (3.9 % increase), high incentive (3.8 % increase), low ability (4.6 % decrease) and low support (2 % decrease). Regarding COVID-19 anxiety (high 100 %), workload (high 100 %) and IJP (low 100 %), most of the increase was related to high environment and high evaluation by an increase of 17.3 and 17.2 %, respectively. Also, the value of low evaluation and low environment was reduced by 24 and 23.4 %, respectively. The study's findings confirm that nurses have been more productive during the COVID-19 pandemic, despite facing high workloads and the COVID-19 anxiety.

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1. Introduction

Nurses, who are the central core of the healthcare system, often face numerous challenges [1–4]. However, the corona pandemic has disproportionately influenced nurses compared to other professions [5]. The anxiety of contracting COVID-19 among nurses has significantly increased due to the adverse effects of the disease on individuals, the high mortality rate associated with it, and the direct exposure of nurses to infected patients [6–8]. On the other hand, nurses have been required to take measures to prevent the spread of COVID-19 and manage their anxiety of contracting the disease, such as using personal protective equipment and making behavioral changes. However, these measures have negatively impacted the individual job performance of nurses [9,10]. The declined job performance among nurses can be attributed to the fact that their work often involves a considerable amount of teamwork and interpersonal interaction, both with colleagues and with patients and their families [11,12]. Furthermore, due to concerns about the risk of contracting and spreading COVID-19 to colleagues and family members, nurses have reduced their contact with patients infected with the virus, obligatorily. This reduced contact has been shown to have a negative impact on the job performance of nurses, as their work often requires extensive interaction with patients and their families [13,14]. As a consequence of the dearth of nursing personnel in Iran and the concomitant outbreak of the corona pandemic, the nursing staff has experienced a marked upswing in their workload [15]. This upswing is attributable to the substantial influx of patients seeking medical attention at the hospital, as well as the substantial number of patients admitted to other departments. In response, the nursing staff has extended their shifts and redoubled their efforts to provide optimal patient care, which has contributed to a notable increase in their workload [15].

The escalation of workload and the concomitant decline in individual nurse performance may precipitate a reduction in organizational productivity [16,17]. This decrement in productivity can occur as a result of the deterioration of key components of productivity such as ability, motivation, and compatibility [18]. According to the study conducted by Babamohammadi and colleagues, the COVID-19 outbreak has resulted in an increased workload for nurses, leading to heightened levels of stress and reduced productivity [19]. As per the findings of Abbasi et al. a surfeit of workload can have deleterious effects on the work ability, performance, and quality of life of nurses. This can manifest as cognitive failures, ultimately culminating in compromised performance [20,21]. Apart from the workload, performance, and other psychosocial factors, such as job satisfaction and job stress, which can influence the productivity of nurses, the apprehension of contracting COVID-19 also exerts a noteworthy impact on their work productivity [22–27].

Although several studies have explored the nursing profession during the COVID-19 pandemic, there has been limited attention given to the profound influence of the behavioral dimensions of job performance on overall productivity. Furthermore, previous investigations into the relationship between workload, job performance, and productivity have often relied on common statistical methods. Additionally, existing studies have predominantly focused solely on the ultimate impact on productivity, neglecting to identify the specific parameters that are most susceptible to the aforementioned factors.

The present study aims to predict the effect of COVID-19 anxiety on the determinants of productivity by assessing the mediating role of perceived workload and individual job performance. To achieve this objective, a Bayesian mediation analysis will be employed to determine the respective contributions of each variable in modulating the parameters that determine productivity.

2. Material and methods

This study is a cross-sectional and descriptive-analytical investigation that was conducted among nurses who are affiliated with Aja University of Medical Sciences in Tehran, Iran. The approval for conducting interviews and surveys with participants was granted by the ethics committee of Aja University of Medical Sciences, with the reference number IR.AJAUMS.REC1400.060. The data was collected during the sixth peak of the COVID-19 pandemic in February 2022 The COVID-19 pandemic in Iran until February 2022 resulted to in 69452942 confirmed cases of COVID-19 and 135,276 deaths. Also, the vaccination rate was 164.39 doses per 100 people. To achieve the study's objectives, all nurses who were working in the Imam Reza hospital were recruited to participate. They were requested to provide their consent for participating in the study, and those who declined to complete the questionnaire were excluded (… people). Additionally, nurses who had a secondary job and began working after the outbreak of COVID-19 were not included in the study. To gather data, all eligible and voluntary nurses were asked to complete questionnaires that included the Corona Disease Anxiety Scale (CDAS), Individual Job Performance Questionnaire (IJPQ), NASA Task Load Index (NASA-TLX), and Workforce Productivity Questionnaire (WPQ). The value of Cronbach's alpha for CADS, IJPQ, NASA-TLX and WPQ is 0.879, 0.9, 0.897 and 0.861, respectively.

2.1. Corona disease anxiety scale (CDAS)

This questionnaire comprises 18 items that measure the level of anxiety induced by the risk of contracting COVID-19. The items are scored on a 4-point Likert scale, ranging from zero (never) to three (always). The overall anxiety score is calculated by summing the scores of all items. A higher score indicates a higher level of perceived anxiety. The validity and reliability of this scale have been confirmed in the study conducted by Ailipour et al. [28].

2.2. Individual job performance questionnaire (IJPQ)

Abbasi et al. developed a questionnaire to evaluate behavioral aspects of job performance. This questionnaire assesses individual job performance based on behavior, rather than results. The IJPQ measures four dimensions of individual job performance, including

task performance (TP), adaptive performance (AP), counterproductive behaviors (CWB), and contextual performance (CP) [29]. These dimensions consist of indices that are selected using multi-criteria decision-making methods [30]. The IJPQ comprises 20 items that are scored on a 5-point Likert scale, ranging from one (Never or Low) to five (Always or Very much). The dimensions of CWB, TP, AP and CP consist of 5, 6, 4, and 5 questions, respectively. To calculate the overall IJPQ score, the scores of all items are summed, while the scores of items 5, 8, 11, 18, and 19, which are related to the CWB dimension, must be reversed. Therefore, the IJPQ score ranges from 20 to 100, with higher scores indicating better individual job performance. Also, the CWB, TP, AP and CP dimensions score ranges is 5–25, 6–30, 4–20 and 5–25, respectively. The validity and reliability of this questionnaire have been confirmed in Abbasi et al.'s study [31].

Table 1
Mean ± standard deviation of the studied variables.

Instrument	Variable	Level	Frequency	Percent	Mean	SD
CADS	Covid-19 anxiety	Low	0	0	67.21	07.71
		Moderate	21	9.5		
		High	201	90.5		
IJPQ	Task performance	Low	55	24.8	22.27	02.96
		Moderate	113	50.9		
		High	54	24.3		
	Contextual performance	Low	79	35.6	17.21	02.31
		Moderate	103	46.4		
		High	40	18		
	Counterproductive work behavior	Low	56	25.2	21.87	03.10
		Moderate	80	36		
		High	86	38.7		
	Adaptive performance	Low	69	31.1	13.96	01.77
		Moderate	72	32.4		
		High	81	36.5		
	IJP	Low	77	34.7	75.32	03.48
		Moderate	115	51.8		
		High	30	13.5		
NASA-TLX	Mental Workload	Low	55	24.8	69.67	16.8
		Moderate	128	57.7		
		High	39	17.6		
	Physical Workload	Low	66	29.7	79.32	15.18
		Moderate	105	47.3		
		High	51	23		
	Temporal Workload	Low	64	28.8	73.43	15.64
		Moderate	108	48.6		
		High	50	22.5		
	Performance	Low	169	76.1	63.89	20.33
		Moderate	0	23.9		
		High	53	0		
	Effort	Low	72	32.4	78.13	14.07
		Moderate	96	43.2		
		High	54	24.3		
	Frustration	Low	62	27.9	42.37	23.26
		Moderate	108	48.6		
		High	62	27.9		
WPQ	Ability	Low	14	6.3	09.88	02.22
		Moderate	106	72.1		
		High	48	21.6		
	Clarity	Low	69	31.1	13.43	01.59
		Moderate	66	29.7		
		High	87	39.2		
	Support	Low	104	46.8	12.04	02.13
		Moderate	0	0		
		High	118	53.2		
	Incentive	Low	64	28.8	11.59	01.76
		Moderate	0	0		
		High	142	64		
	Evaluation	Low	24	10.8	12.70	01.02
		Moderate	196	88.3		
		High	2	0.9		
	Validity	Low	75	33.8	11.69	02.01
		Moderate	91	41		
		High	56	25.2		
	Environment	Low	76	34.2	06.36	01.79
		Moderate	62	27.9		
		High	84	37.8		

2.3. NASA Task Load Index (NASA-TLX)

The NASA Task Load Index (NASA-TLX) is a subjective questionnaire widely used to rate individual perceived workload. In other words, it determines the subjective mental workload (MWL) based on the subjective responses. This tool consists of six scale, including mental demand, temporal demand, physical demand, frustration, performance, and effort. To determine the workload of the participants, they were asked to participate in a two-part self-reporting process. Firstly, individuals assessed their work conditions across six distinct dimensions, using a linear scale with 5-point increments to assign a score, or load weight, ranging from 0 to 100. Secondly, the participants conduct a comparative analysis of the dimensions in pairs, selecting the axis that holds greater sway and significance for their personal circumstances or was more closely linked to their activities. The validity and reliability of this questionnaire have been confirmed in Mohammadi et al.'s study [32].

2.4. Workforce Productivity Questionnaire (WPQ)

In 1980, Hersey and Goldsmith introduced a questionnaire on workforce productivity, which was developed using the ACHIEVE model [33]. This questionnaire is validated and reliable in determining seven dimensions, including ability (3 questions), clarity (4 questions), support (4 questions), evaluation (4 questions), validity (4 questions), incentive (4 questions) and environment (3 questions), using 26 items [34]. Each item in the questionnaire is rated on a 5-point Likert scale, with possible responses ranging from 1 (indicating I strongly disagree) to 5 (indicating I strongly agree). To calculate the total score for each dimension, the scores of the items that correspond to that particular dimension are summed.

2.5. Statistical analysis

After completing the data collection process, statistical tests were conducted using SPSS software version 26 and descriptive statistics were calculated [35]. This study utilized Bayesian Networks (BNs), which are probabilistic and graphical models introduced by Pearl [36]. Bayesian networks (BNs) demonstrate systems as a network of interactions between variables from primary cause to final consequence, with all cause–effect assumptions made explicit. BNs are often considered suitable for modelling cause–effect systems due to their ability to integrate multiple issues, interactions and outcomes and investigate tradeoffs. Furthermore, they are appropriate for utilising data and knowledge from different sources and manage missing data. BNs are based on a relatively normal causal graphical structure, meaning they can be built without highly technical modelling skills and be understood by non-technical users and stakeholders. This is a very valuable characteristic of BNs [36].

GeNIe software version 2.0 was used to analyze the Bayesian network. After constructing the BN graphical structure, a Conditional Probability Table (CPT) was obtained [37]. Delta p sensitivity analysis was performed to rank the variables [38]. Sensitivity analysis was conducted on GeNIe2.0 software modelling to examine the effects of the variables. This method is direct, more comprehensive, and user-friendly. In the sensitivity analysis on GeNIe, a node is set as the target node. GeNIe performs a complete set of updated probability distribution derivatives on target nodes using any of the probability parameters.

3. Results

This cross-sectional study was conducted in 2021 among nurses of Imam Reza Hospital affiliated with the Aja University of Medical Sciences. Of the total number of nurses employed, 222 (126 women and 96 men) nurses fully completed the questionnaires. Out of
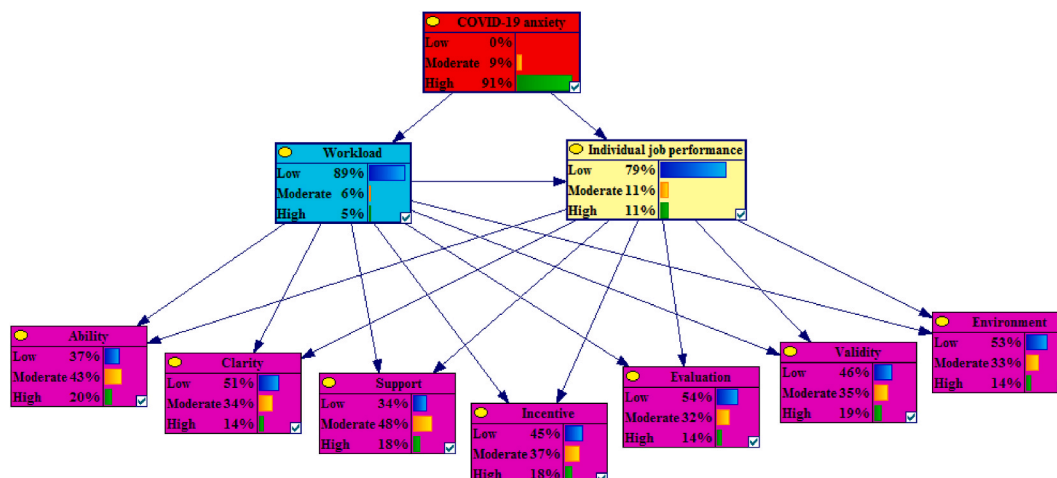

Fig. 1. The dependencies among the marginal probabilities of the studied variables based on the Bayesian network model.

these, 140 individuals were married and 82 were single. The mean ± standard deviation (SD) of the age and experience were 28.56 ± 5.78 and 8.49 ± 6.50, respectively.

The mean ± SD of the workload, individual job performance, productivity and anxiety of COVID-19 for all nurses were 76.49 ± 45.09, 75.32 ± 3.48, 77.72 ± 8.61 and 67.21 ± 7.71, respectively. Moreover, the mean ± SD of the dimensions of abovementioned variables is presented in Table 1.

Fig. 1 shows the dependencies among the marginal probabilities of the studied variables based on the Bayesian network model.

Table 2 represents the Marginal probability distribution (final results of the Conditional Probability Tables (CPT)) of the studied variables. CPTs describes the coefficients between variables.

In order to update the created model, the desired node was considered as evidence, and the probabilities of all variables in the model were updated. The results of updating the BN model are shown in Table 3.

At a high level of anxiety caused by COVID-19, with a probability of 100 %, the probability of changes in the studied variables was very low (Fig. 2).

Furthermore, with a probability of 100 % for both COVID-19 anxiety and workload, the probability of high evaluation, high environment, and high support variables increased by 16.6 %, 16.3 %, and 12.4 %, respectively. In contrast, the probabilities of low environment and low evaluation decreased by 22.4 % and 22 % (Fig. 3).

Among the variables of productivity in the state of high COVID-19 anxiety (High 100 %) and IJP (Low 100 %), the most significant changes were related to the high ability (6 % increase), moderate ability and low evaluation (3.9 % increase), high incentive (3.8 % increase), low ability (4.6 % decrease), moderate incentive (3.8 % decrease), moderate evaluation and validity (2.4 % decrease) (Fig. 4).

Regarding productivity variables for the state of COVID-19 anxiety (high 100 %), workload (high 100 %) and IJP (low 100 %), the most significant increases were related to the high environment and high evaluation, with an increase of 17.3 and 17.2 %, respectively. Additionally, the value of low evaluation and low environment was reduced by 24 and 23.4 %, respectively (Fig. 5).

Table 4 also reports the sensitivity analysis for the studied variables, where a positive sign indicates an increase, and a minus sign indicates a decrease.

To determine the most effective states of the variables (COVID anxiety, workload and IJP) in determining the probabilities of organizational productivity variables (low, moderate and high states), a target node was considered from the organizational productivity variables and sensitivity analysis was conducted using Bayesian Networks (BN). Since all organizational productivity variables are influenced by COVID-19 anxiety with the mediation of workload and individual job performance, only the ability node was considered as the target node to obtain the most effective state of the variables. The results obtained can be generalized to other organizational productivity variables. The most effective states of the variables for all variables of organizational productivity can be seen in Figs. 6 and 7, respectively. As shown in Figs. 6 and 7, the most effective state for all organizational productivity variables in

Table 2
The marginal probability distribution for the studied variables.

Variable	Level	Marginal probability distribution
Covid-19 anxiety	Low	0
	Moderate	0.095
	High	0.905
Workload	Low	0.894
	Moderate	0.055
	High	0.049
IJP	Low	0.786
	Moderate	0.108
	High	0.105
Ability	Low	0.371
	Moderate	0.429
	High	0.199
Clarity	Low	0.514
	Moderate	0.342
	High	0.142
Support	Low	0.338
	Moderate	0.480
	High	0.180
Incentive	Low	0.451
	Moderate	0.366
	High	0.181
Evaluation	Low	0.540
	Moderate	0.320
	High	0.138
Validity	Low	0.458
	Moderate	0.349
	High	0.191
Environment	Low	0.534
	Moderate	0.328
	High	0.137

Table 3
The updating marginal probability distribution for the studied variables.

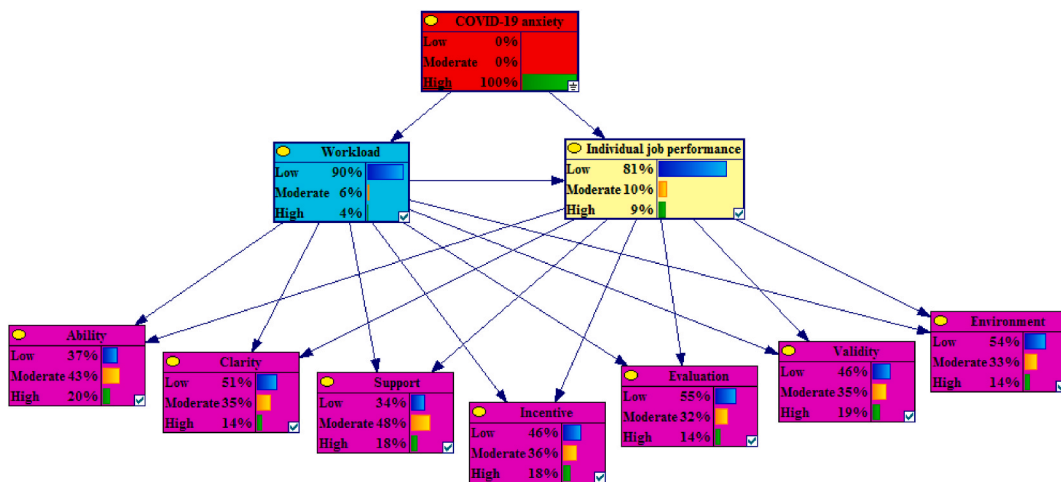| Variable	Level	COVID-19 anxiety (High 100 %)	COVID-19 anxiety and Workload (High 100 %)	COVID-19 anxiety (High 100 %) and IJP (Low 100 %)	COVID-19 anxiety, workload (High 100 %) and IJP (Low 100 %)
COVID-19 anxiety	Low	0	0	0	0
	Moderate	0	0	0	0
	High	1	1	1	1
Workload	Low	0.9	0	0.891	0
	Moderate	0.056	0	0.058	0
	High	0.044	1	0.049	1
IJP	Low	0.807	0.9	1	1
	Moderate	0.1	0.1	0	0
	High	0.092	0	0	0
Ability	Low	0.366	0.435	0.325	0.45
	Moderate	0.433	0.38	0.468	0.35
	High	0.199	0.185	0.205	0.2
Clarity	Low	0.513	0.41	0.495	0.4
	Moderate	0.345	0.442	0.373	0.45
	High	0.141	0.148	0.131	0.15
Support	Low	0.339	0.32	0.341	0.3
	Moderate	0.482	0.376	0.497	0.39
	High	0.178	0.304	0.160	0.31
Incentive	Low	0.456	0.42	0.489	0.4
	Moderate	0.362	0.374	0.328	0.39
	High	0.181	0.206	0.182	0.21
Evaluation	Low	0.545	0.32	0.579	0.3
	Moderate	0.318	0.376	0.296	0.39
	High	0.136	0.304	0.123	0.31
Validity	Low	0.461	0.51	0.485	0.5
	Moderate	0.347	0.307	0.325	0.33
	High	0.191	0.183	0.189	0.17
Environment	Low	0.538	0.31	0.564	0.3
	Moderate	0.326	0.39	0.310	0.39
	High	0.135	0.3	0.125	0.31

Fig. 2. Sensitivity analysis on high anxiety of COVID-19.

high and low state is high COVID-19 anxiety, low workload and individual job performance. Additionally, the next 9 effective states can be seen.

4. Discussion

This study was conducted to predict the effect of COVID-19 anxiety on productivity determinants through perceived workload and individual job performance among nurses during the peak of the coronavirus outbreak in Iran. A Bayesian networks prediction analysis was used, and the studied data were modeled in four conditions. The initial model presented in Fig. 2 revealed that COVID-19 anxiety, with a 100 % probability at high level, had a negligible impact on both perceived workload and IJP, although IJP was slightly more
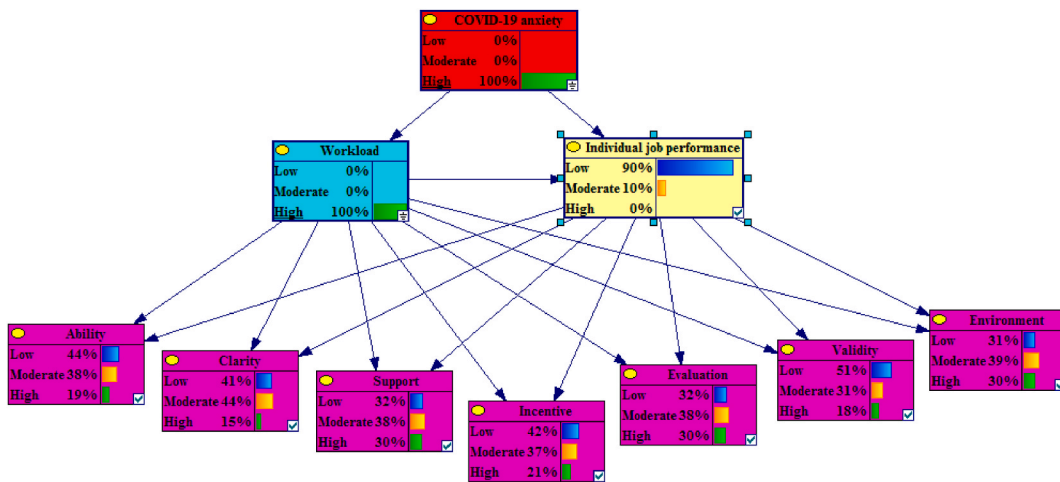
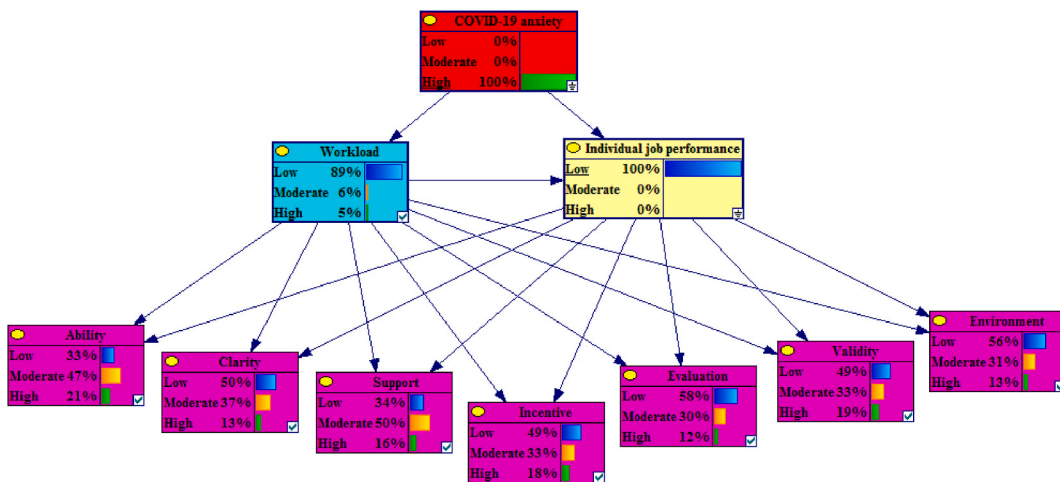**Fig. 3.** Sensitivity analysis on high COVID-19 anxiety and workload.

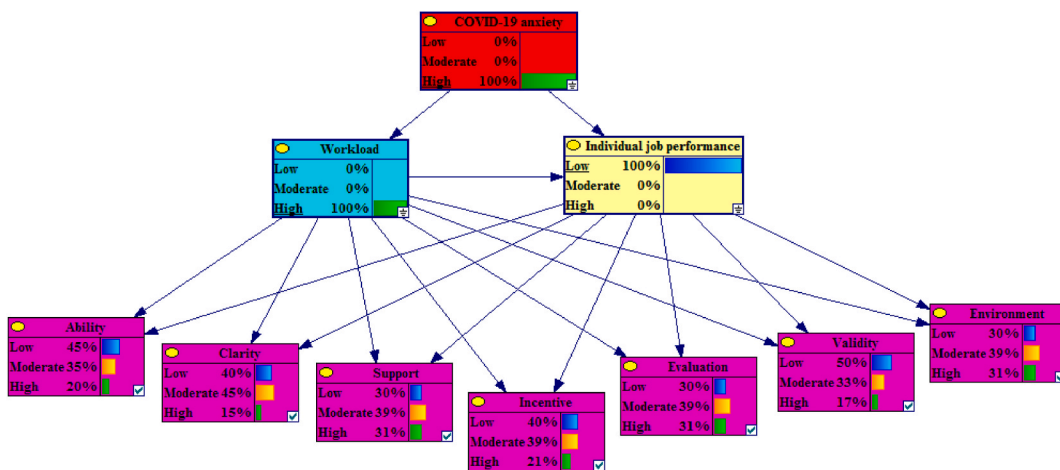**Fig. 4.** Sensitivity analysis on high anxiety of COVID-19 and low IJP.

Fig. 5. Sensitivity analysis on high COVID-19 anxiety, high workload and low IJP.

Table 4
Sensitivity analysis for the studied variables.

| Variable	Level	COVID-19 anxiety (High 100 %)	COVID-19 anxiety and Workload (High 100 %)	COVID-19 anxiety (High 100 %) and IJP (Low 100 %)	COVID-19 anxiety, workload (High 100 %) and IJP (Low 100 %)
COVID-19 anxiety	Low	–	–	–	–
	Moderate	–	–	–	–
	High	–	–	–	–
Workload	Low	+0.6 %	–	−0.3 %	–
	Moderate	+0.1 %	–	+0.3 %	–
	High	−0.5 %	–	0	–
IJP	Low	+2.1 %	+11.4 %	–	–
	Moderate	−0.8 %	−0.8 %	–	–
	High	−1.3 %	−10.5 %	–	–
Ability	Low	−0.5 %	+6.4 %	−4.6 %	+7.9 %
	Moderate	+0.4 %	−4.9 %	+3.9 %	−7.9 %
	High	0	−1.4 %	+0.6 %	+0.1 %
Clarity	Low	−0.1 %	−10.4 %	−1.9 %	−11.4 %
	Moderate	+0.3 %	+10 %	+3.1 %	+10.8 %
	High	−0.1 %	+0.6 %	−1.1 %	+0.8 %
Support	Low	+0.1 %	−1.8 %	+0.3 %	−3.8 %
	Moderate	+0.2 %	−10.4 %	+1.7 %	−9 %
	High	−0.2 %	+12.4 %	−2 %	+13 %
Incentive	Low	+0.5 %	−3.1 %	+3.8 %	−5.1 %
	Moderate	−0.4 %	+0.8 %	−3.8 %	+2.4 %
	High	0	+2.5 %	+0.1 %	+2.9 %
Evaluation	Low	+0.5 %	−22 %	+3.9 %	−24 %
	Moderate	−0.2 %	+5.6 %	−2.4 %	+7 %
	High	−0.2 %	+16.6 %	−1.5 %	+17.2
Validity	Low	+0.3 %	+5.2 %	+2.7 %	+4.2 %
	Moderate	−0.2 %	−4.2 %	−2.4 %	−1.9 %
	High	0	−0.8 %	−0.2 %	−2.1 %
Environment	Low	+0.4 %	−22.4 %	+3 %	−23.4 %
	Moderate	−0.2 %	+6.2 %	−1.8 %	+6.2 %
	High	−0.2 %	+16.3 %	−1.2 %	+17.3 %
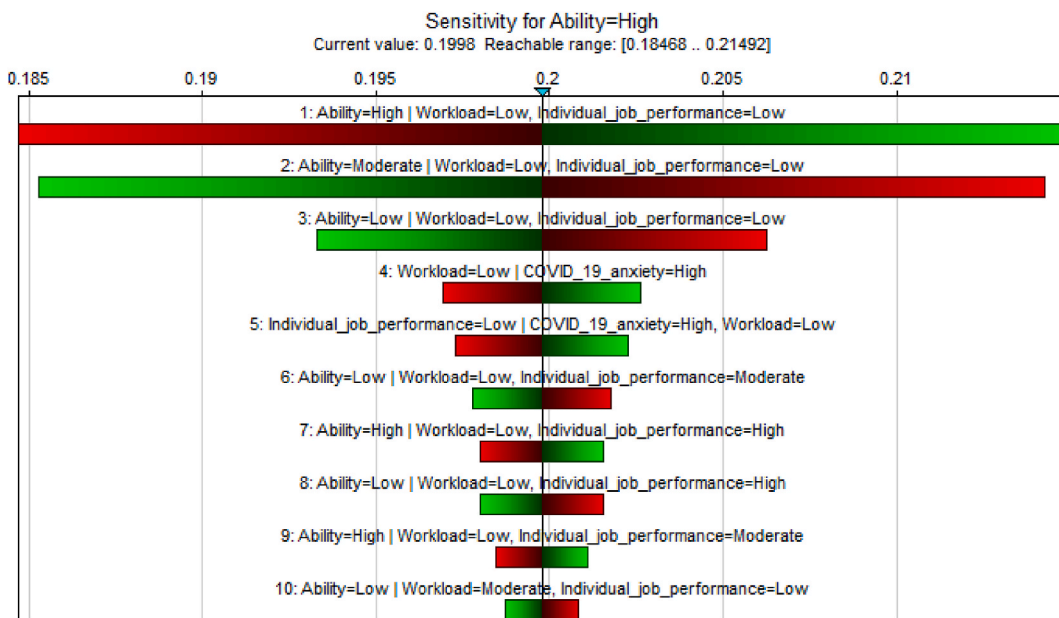
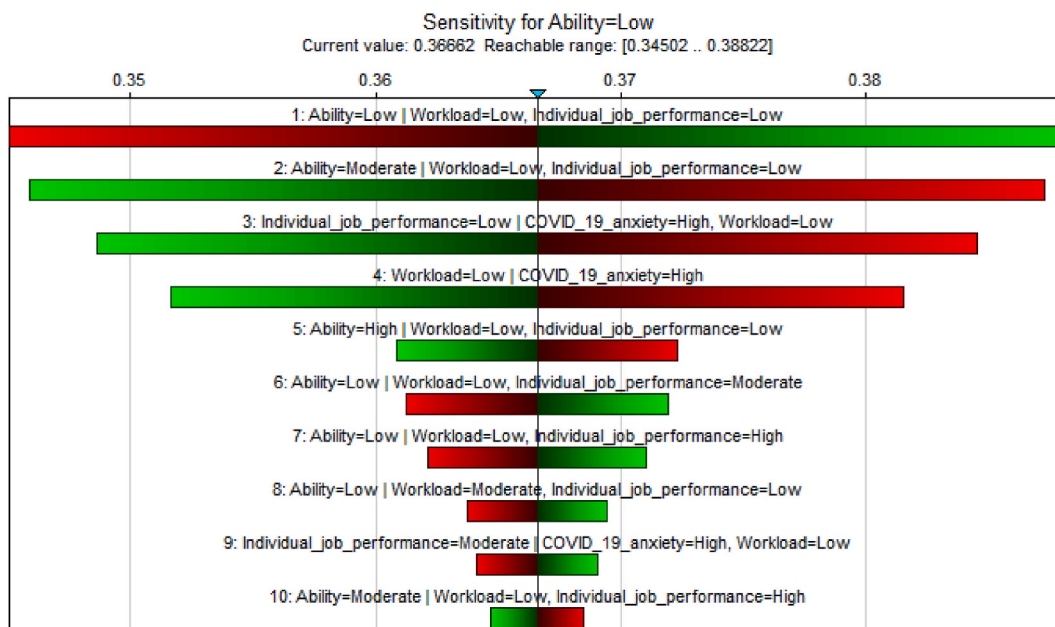**Fig. 6.** Tornado sensitivity analysis chart for high state ability.

Fig. 7. Tornado sensitivity analysis chart for low state ability.

affected. Additionally, slight significant effects were observed on productivity parameters. Study conducted by Yousaf et al. reported that Covid-19 anxiety had a significant effect on nurse's performance through job stress [14]. The effect of Covid-19 anxiety on IJP can manifest in various ways, such as impairing constructing indices of IJP, including individual's ability to plan and organize, reducing self-efficacy, hindering problem-solving skills, decreasing perseverance and motivation, causing conflicts or arguments with co-workers, leading to unsafe behaviors, and resulting in inappropriate actions [39,40]. Cooperation, helping others, and effective communication are essential components of IJP. When nurses experience anxiety related to Covid-19 infection, their ability to cooperate and communicate with colleagues may be reduced because they may be frightened of disease transmission to oneself and family members, which can lead to a decline in job performance. This is particularly true in the nursing profession, where collaboration and communication play a vital role in enhancing productivity [41]. The anxiety induced by Covid-19 infection has a significant impact on nurses' burnout. In other words, similar to the findings of the present study, the motivation of nurses decreased during the Covid-19 pandemic due to increased burnout, which can affect their productivity [42,43].

In the second model, where Covid-19 anxiety and workload were both adjusted to a 100 % probability at a high level, the findings revealed a significant reduction in IJP. Among the productivity parameters, there was a decrease in ability, clarity, and validity, while other parameters including support, evaluation, and environment also showed an increase. Maghsoud et al. conducted a study among nurses and found that an excessive workload during the Covid-19 pandemic was associated with decreased performance and quality of care [44]. Other studies have also demonstrated a link between high workload and decreased job performance among nurses, which could result from excessive work stress, demands, physical workplace conditions, and relationship issues between nurses [45,46]. Due to the increase of the parameters of support, evaluation, and environment increase, it can be inferred that an increase in Covid-19 anxiety and workload leads nurses to expect support from their organization's managers to cope with the increased workload. As a result, their evaluation of the situation will improve and they will be more compatible with the environmental atmosphere, as they hope that their conditions will be better supported by the organization. This finding is consistent with the study conducted by Asamani et al. which also found that excessive workload can improve nurses' performance [47]. Furthermore, this can be attributed to the crisis situation, where nurses feel a greater sense of responsibility and increase their morale and efforts to cope with the condition. Additionally, support and encouragement from the administration and general population, as well as creating a positive perception of the nursing profession as heroic, can motivate nurses to improve their performance even when the workload is excessive [48].

In the third model, where Covid-19 anxiety was adjusted to a 100 % probability at a high level and IJP was adjusted to a 100 % probability at a low level, the findings revealed a decrease in support, incentive, evaluation, validity, and environment while ability also showed an increase. Compared to the second model, this model demonstrated that when IJP was adjusted to a 100 % probability at a low level, it had a greater impact on productivity parameters than when the workload was adjusted to a 100 % probability at a high level. Therefore, it can be concluded that the behavioral aspect of nurses plays a more significant role in influencing productivity parameters than the workload. This is a logical outcome since in the second model, three parameters decreased and three parameters increased, which neutralized each other. However, in the third model, five parameters decreased and only one parameter increased.

In the fourth model, Covid-19 anxiety and workload were adjusted to a 100 % probability at a high level and IJP was adjusted to a 100 % probability at a low level. The results indicate a decrease in ability and validity, and an increase in clarity, support, incentive, evaluation, and environment. Based on these findings, it is reasonable to conclude that the productivity of nurses has risen during the

COVID-19 pandemic, as most of the factors that influence productivity in this model have increased. However, this outcome contradicts the results of previous studies [49,50]. There are several reasons that can account for the increase in productivity following an increase in workload. According to Munandar et al.'s study, a very low workload not only fails to boost productivity but can also lead to a decline in productivity [51]. Furthermore, workload can positively impact productivity by encouraging individuals to perform better and be more productive [51]. Support and environment are two productivity components that largely hinge on an organization's approach. During the COVID-19 pandemic, many organizations, particularly hospitals, have prioritized supporting their workforce and enhancing the work environment, resulting in a boost in employee incentive. In addition, the increased motivation, enthusiasm, and sense of responsibility among nurses during the Covid-19 pandemic, as they grappled with the crisis, may be the primary driver of their productivity surge [52]. The findings of this study may be influenced by certain limitations. The cross-sectional nature of the study made it challenging to examine the causality relationship of the variables under investigation. Additionally, since the study focused solely on nurses from a single hospital, the results may not be generalizable due to the unique circumstances of that hospital. Moreover, while a behavior-based tool was used to assess job performance, its ability to evaluate the behaviors of nurses under critical and pandemic conditions may be limited, despite its confirmed validity and reliability. This study was conducted during the COVID-19 pandemic, and given the unique role of nurses during this period, their performance and workload may differ from normal conditions. Intervening factors such as the influence of media in shaping the perception of nurses, the heightened sense of responsibility in crisis management, hospital administration under special circumstances, and changes in management style may impact the obtained results. Additionally, the use of personal protective equipment can be regarded as an intervening factor, as it disrupts nurses' usual work routines and may influence the results. Therefore, it is suggested that this study be replicated under normal, non-pandemic conditions to validate the accuracy of the obtained results. Additionally, future researchers are advised to employ objective tools to assess the studied variables, thereby obtaining more precise results. Furthermore, conducting longitudinal follow-up studies instead of cross-sectional research and considering additional intervening variables can contribute to the attainment of more accurate results.

5. Conclusion

The study's findings confirm that nurses have been more productive during the COVID-19 pandemic, despite facing high workloads and the anxiety of contracting the virus. The improvement in their productivity can be attributed to the support measures provided by managers and community members, as well as the nurses' dedication, responsibility sense, and effort beyond capacity.

Data availability statement

Data will be made available on request.

CRediT authorship contribution statement

Maryam Rafiee: Writing – review & editing, Visualization. **Tahereh Eskandari:** Supervision, Project administration, Conceptualization. **Evan Abdulkareem Mahmood:** Supervision, Validation, Writing – review & editing. **Mojtaba Zokaei:** Investigation. **Mohsen Falahati:** Investigation. **Mohammad Hossein Khalilzadeh Naghneh:** Investigation.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.heliyon.2024.e34099.

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