

Artificial Intelligence and Its Relation to Nurses' Innovative Behavior: Moderating Role of Job Control

Soha Mamdouh Elkholy¹, Marwa Hassan Ageiz² & Hayam Ahmed El shrief³

¹ Assistant Professors of Nursing Administration, Faculty of Nursing, Menoufia University, Egypt

² Assistant Professors of Nursing Administration, Faculty of Nursing, Menoufia University, Egypt

³ Assistant Professors of Nursing Administration, Faculty of Nursing, Menoufia University, Egypt

Abstract

Background: Nurses need to be supported regarding the extensive spread of Artificial Intelligence technology in health care, where certain tasks may be automated and carried out autonomously with little human control, which can be a threat to job control; therefore, innovative behavior became a must for keeping up with rapid advancements in technology and communications aspects over the past few decades. **Aim:** Determine the relation between artificial intelligence and nurses' innovative behavior and determine the moderating role of Job control. **Design:** A descriptive, correlational research design was used. **Setting:** The current study was conducted in El-Araby Hospital in the Delta region of Egypt. **Study subjects:** A convenience sampling technique was used (n=242) on those working in critical care units and operating rooms. **Instruments:** Three instruments were used namely, artificial intelligence Practice Scale, Innovative Behavior Questionnaire (IBQ), and Job control Scale. **Results:** More than half of the studied subjects had a high level of job control and innovative behavior, while more than two-thirds of them had a moderate level of artificial intelligence. **Conclusion:** The existence of a moderate effect of job control on the relationship between the independent variable (artificial intelligence) and the dependent variable (nurses' innovative behavior) was supported. **Recommendation:** Healthcare leaders should support the career development needs of nurses and the requirement of special certification in the field of healthcare informatics to promote the rapid adoption of healthcare AI innovations and enhance nurses' job control.

Keywords: Artificial intelligence, Job control, Moderating role & Nurses' innovative behavior

Introduction

Artificial intelligence (AI) based on processing will be able to handle the rapid digitization of healthcare and the massive and ever-growing volume of patient data. Therefore, it appears that AI already plays an essential role in our healthcare systems, and its importance will undoubtedly grow (Scott & Coiera, 2020). AI systems already have excellent pattern recognition capacities, that are rooted in 'machine learning' programs that process input data by applying algorithms that iteratively seek patterns, check matches of their outputs to test datasets, and refine their parameters, thereby validating the system (Haenlein & Kaplan, 2019).

In light of the rapidly evolving technological advancements in healthcare, it is important to evaluate the potential applications of AI in nursing practice. In this vein, recent systematic reviews have revealed promising results that AI can offer in the area of diagnosis and prognosis of certain clinical situations, such as cancer or new-onset pathologies in hospitalized patients. However, the application of different types of AI-based support systems in nursing is still limited, despite constituting one of the largest potential users of this type of technology as experts in caregiving (Veldhuis et al., 2022).

From a healthcare perspective, AI brings a paradigm shift to healthcare, powered by the increasing availability of healthcare data and rapid processes of analytic techniques. Already, AI is being used to improve healthcare decision-making, and has been seen as potentially transformative. Additionally, there are more and more applications for patient adherence and engagement. (Diprose et al., 2020).

AI is quickly transforming to change the healthcare system. There is no single definition of AI that is accepted worldwide. The term broadly refers to computing technologies that resemble processes associated with human intelligence, such as reasoning, learning and adaptation, sensory understanding, and interaction (Hassan Zadeh et al., 2018). AI is the ability of machines to simulate human intelligence. Number is the extension of human intelligence through the use of computers to do things, humans used to do but in a more accurate way (Salman et al., 2017).

The use of AI in nursing aims to provide support and improve outcomes. Technology can address certain issues such as lack of expertise or inadequacy in experience, streamline documentation, and provide access to current evidence-based practices to ensure high-quality patient care, thus reducing the feeling of

frustration that professionals have due to the organizational burden. Nurses play a crucial role in the delivery of patient care, and the increasing demand for high-quality, evidence-based practices has put pressure on the nursing workforce to stay up to date with the latest technological advancements. In this regard, AI has the potential to support nursing practices by providing real-time decision support, reducing the time spent on administrative tasks, and facilitating the efficient management of patient data and care (Connor et al., 2023).

AI applied to nursing practice can be a down-to-earth resource for professionals, managers, or supervisors, with positive results in patient care and safety. It has the potential to change current workflow systems and provide support to nursing professionals when making decisions. AI-based systems are flexible tools that can adopt various essential functions in nursing care, such as guiding the patient with personalized instructions or remotely monitoring the patient in real-time. Furthermore, it can be used in community care, remote areas, or in the hospital setting by identifying the possible diagnosis of the user early on, thereby accelerating the healthcare process. The greatest challenge in the development and implementation of this type of technology, however, continues to be the involvement and active participation of healthcare professionals and their commitment to its use (Hong et al., 2018).

In the fields of healthcare and research, artificial intelligence (AI) technologies are being utilized or tested in different tasks, including but not limited to disease discovery, chronic disease management, healthcare delivery, and drug discovery (Buch, et al., 2018). Artificial intelligence technologies can help solve major health problems. However, they may be limited by the quality of available health data and the inability of AI to possess certain human characteristics, such as compassion (Tran et al., 2019). Additionally, AI is being utilized to extend the capabilities of the healthcare staff to address labor shortages, reduce costs, and maximize the quality of service (Cowie, 2018).

Innovative behavior in nursing (IB) is defined as a behavioral process in which new techniques or ways of working are discovered created and used to promote health, prevent disease, and improve the quality of nursing. It consists of three stages: creating an idea, getting support, and implementing the idea. To maximize the effectiveness of AI nursing, nurses think about how AI can be improved or modified based on work experience, patient needs, and current conditions. (Xianmiao, et al., 2022). Numerous aspects play an important role in fostering IB, nonetheless, diversity management, artificial intelligence, and job crafting are supportive

managerial strategies that can be applied to cultivate the innovative capacity of nurses (Irfan & Qadeer, 2020).

Innovative Behavior (IB) of nurses in the workplace is recognized as a key development strategy for organizational competitiveness. In a highly competitive environment, innovation can enhance organizational survival as it can promote organizational competitiveness at both individual and group, even enterprise-wide levels (Liu & Tan, 2022). With AI core users, nurses can better understand the requirements behind medical AI (Martikainen et al., 2020).

Job control refers to an individual's cognition and assessment of the effect of internal factors, such as ability and work performance, that is, the sense of control experienced at work. Job control refers to a nurse's perception of the coping ability and impact of a nurse's job and work environment. In the AI context, job control refers to nurses using AI to complete nursing tasks smoothly (Xianmiao, et al., 2022).

Job control is recognized as a composite of decision authority (e.g., freedom to make decisions) and skill discretion (e.g. opportunity to learn new things and develop new capabilities). Job control refers to the influence that employees possess in determining the execution and planning of their jobs. Job control can only benefit those who believe they can use it effectively (Yan et al., 2020).

Significance of the study:

AI technologies are becoming more and more prevalent in various healthcare organizations, where they have the potential to revolutionize many areas of patient care as well as administrative processes. (Davenport & Kalakota, 2019). Innovation is essential in a highly competitive and technology-driven world. Innovative organizations create a competitive edge in the marketplace through the innovation of individuals. AI-based systems can automate specific tasks and be able to work independently with little human intervention, which can threaten job control (Rosen et al., 2022). From the researchers' observation in varied healthcare settings, there is a continued emphasis on cost, quality, and care outcomes which perpetuated the advancement of AI technology towards additional adoption. AI activated proactive patient care, reduced future risk, and streamlined work processes, therefore, findings and creating new techniques or working ways are vital in adopting and popularizing AI. Moreover, having the internal ability to maintain control over the working environment can help to guide those new techniques in light of embracing new patient care technologies. Thus, this study aims to

determine artificial intelligence and its relation to nurses' innovative behavior and determine the moderating role of Job control.

Conceptual Framework

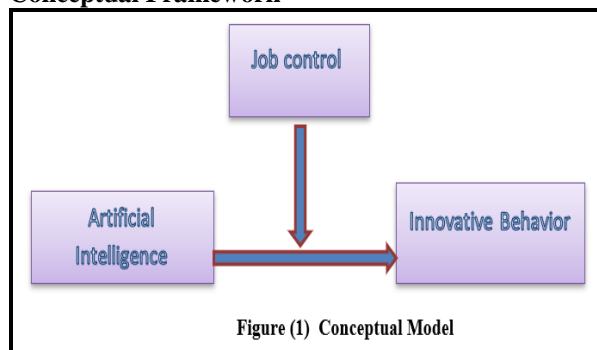


Figure (1): Researchers proposed a conceptual framework of the current study variables artificial intelligence, Innovative Behavior, and Job control as moderating roles.

Aim of the Study:

The current study aimed to determine artificial intelligence and its relation to nurses' innovative behavior and determine the moderating role of Job control.

Research Questions:

- What is nurses' perception level of artificial intelligence, nurses' innovative behavior, and job control?
- What is the relation between artificial intelligence and nurses' innovative behavior and job control?
- Does job control have a moderating effect on the relationship between artificial intelligence and nurses' innovative behavior?

Methods

Research Design:

A descriptive correlational research design was used to conduct this study .

Study Setting:

The present study was carried out in 24 intensive care units and 8 operating rooms of El-Araby Hospital, one of the private hospitals in the Delta region, affiliated with the Ministry of Health. It is the newest medical institution recognized by JCI in the country. It's the biggest hospital in Delta. It provides outstanding healthcare services using the best technology, emphasizing high-quality continuity of care in a way that is convenient for patients, families, and healthcare providers. It meets the needs of the target audience by providing 300 active beds according to the operational plan .

Study subjects:

A convenient sampling technique was used in this study. The sample size was calculated using the program G Power, with power (0.95), alpha (0.05),

and average effect size. The minimum sample size required for the Pearson correlation coefficient analysis was 236 participants. The total sample size was increased to 242 nurses to avoid the negative effects of attrition. The response rate was (100%). The sample was divided into (n = 170) working in 24 intensive care units and (n = 72) working in 8 operating rooms.

Inclusion criteria:

Nurses who had pre-employment training on AI application and working in units that apply AI in the work process (ICU and Operating room). Also, nurses who have at least two years of experience .

Data Collection Instruments:

Three instruments were used in this study namely, Artificial intelligent Practices Scale, Innovative Behavior Questionnaire (IBQ), and Job control Scale. In addition, the personnel data was also included .

The Instrument (I):

Artificial Intelligence Practice scale adopted by **Abdullah & Fakieh, (2020)** to evaluate the levels of the Artificial Intelligence Scale in Nursing, it consists of (25) descriptive questions divided into 3 sub-scales as follows; AI Transformation Work (9 articles); AI transforms service and care (7 items); and AI transformation organizations (9 items). Each item is rated on a five-point Likert scale ranging from "1" (strongly disagree) to "5" (strongly agree). In addition to personnel data, designed by researchers (age, gender, marital status, working units, education level, and years of experience).

Scoring system:

The total score of Artificial intelligence ranged from (25–125). Scores from (25–74) points were considered as "low Artificial intelligence level", scores from (75–99) were denoted as "moderate Artificial intelligence level", and scores from (100- 125) were considered "high Artificial intelligence level".

Instrument (II):

Innovative Behavior Questionnaire (IBQ) was created by **Jong & Hartog (2010)**. It had 26 items and scored on a 5-point numerical with 1 being the strongest disagreement and 5 being the strongest agreement. It had 26 descriptors, including 15 for innovative behavior (evaluated by the supervisor), 6 for participative leadership, and 5 for innovative output (reported by the employee).

Scoring system:

The range of the overall score for innovative behavior was (26–130). Low innovative behavior was defined as scores between 26 and 77, moderate innovation was defined as scores between 78 and 103, and high innovation was defined as scores between 104 -130.

Instrument (III):

The Job Control Scale is an adapted version of the **Pinion et al. (2017)** Job Control Scale. The Job

Control Scale was developed to measure the level of job control of staff nurses in ICUs and operating theaters. There are 16 descriptive items on the Job Control Scale. Each item is scored on a five-point Likert scale (1 = strongly disagree, 5 = strongly agree).

Scoring system:

The overall Job Control score ranges from 16 to 80. A score of 16 to 47 is considered "low Job Control", 48 to 63 is "moderate Job Control" and 64 to 80 is "high Job Control".

Validity of instruments:

The face and content validity of the questionnaire were reviewed by a five-person panel of experts in the nursing administration specialty, as well as the relevance and adequacy of the questionnaire.

Reliability of instruments:

Table (1): Cronbach Alpha Coefficients for Study Variables

Study variable	No. of items	Cronbach's Alpha
Artificial intelligence	25	.946
Innovative behavior	26	.967
Job control	16	.962
Total	67	.957

Cronbach alpha reliability test yielded a reliable coefficient of 0.946 for AIS, 0.967 for IBQ, and 0.962 for the job control scale. See **Table (1)**.

Pilot Study:

A pilot study was conducted on 10% of the nurses (n = 30) who were not part of the study sample to see if the study tools were practical and applicable, if there were any issues, and to estimate the time needed to

complete the questionnaire. Some questions also needed to be modified and clarified.

Ethical Considerations

To adhere to the ethical aspects of the research, the following steps were secured; written approval was obtained from the Ethical and Research Committee at the Faculty of Nursing, Menoufia University. (Ethical approval No 912) on December 21, 2022. Also, written approval was obtained from the hospital administrator and nursing authority in the study setting with an explanation of the purpose and procedures of the study. The respondents' rights were protected by ensuring voluntary participation and oral informed consent was obtained after explaining the purpose, study procedures, and potential benefits of the study. The respondents were assured that the data would be treated as strictly confidential.

Data Collection Procedure

Nurses in intensive care units (ICUs) and operating rooms were interviewed during work hours and given a questionnaire to complete. The researchers informed the nurses that the data would be used only for research purposes. The average time to complete the questionnaire was 15-20 minutes. The study ran from January 1, 2023, to March 31, 2023.

Data Analysis:

The statistical package for the social sciences (SPSS vs. 19) was employed to provide descriptive statistics (means and standard deviations) to describe and summarize the data. The Chi-square test (χ^2) was employed to investigate the relationship between two qualitative variables. The Pearson correlation (Pearson, 2019) was used to demonstrate the relationship between two continuous variables, with a p-value of <0.05 being considered significant.

Results:

Table (2): Personal Characteristics of Studied Subjects (n=242).

	Characteristics items (n=242)	Frequency	Percent
Age	20- <25years	82	33.8
	25- <35years	92	38.1
	≥ 35 years	68	28.1
Gender	Male	107	44.2
	Female	135	55.8
Qualification	Bachelor	216	89.3
	Master	26	10.7
Experience	<5 years	87	35.9
	5- <10years	102	42.2
	> 10 years	53	21.9
Work area	Critical care unit	170	70.2
	Operating Theater	72	29.8

Table (3): Staff Nurses' Response Regarding Artificial Intelligence, Innovative Behavior, and Job Control levels (n=242).

Variable items	Variable level						Mean± SD	Chi-square	p-value
	Low		Moderate		High				
	No.	%	No.	%	No.	%			
Artificial intelligence	27	11.2	161	66.5	54	22.3	3.83±.51	344.661	.000**
• AI transforming work	27	11.2	134	55.4	81	33.5	3.83±.60	265.670	.000**
• AI transforming care and services	81	33.5	80	33.1	81	33.5	3.49±.62	146.196	.000**
• AI transforming organizations	0	0	54	22.3	188	77.7	4.17±.54	180.951	.000**
Innovative behavior	27	11.2	81	33.5	134	55.4	3.83±.79	260.254	.000**
• Innovative behavior (Supervisor Rated)	0	0	27	11.2	215	88.8	4.38±.58	365.670	.000**
• Participative leadership (employee rated)	81	33.5	54	22.3	107	44.2	3.25±1.15	166.196	.000**
• Innovative output (employee rated)	27	11.2	54	22.3	161	66.5	3.87±.84	201.951	.000**
Job control	27	11.2	27	11.2	188	77.7	4.36±.41	334.987	.000**

** Significant at P < 0.005

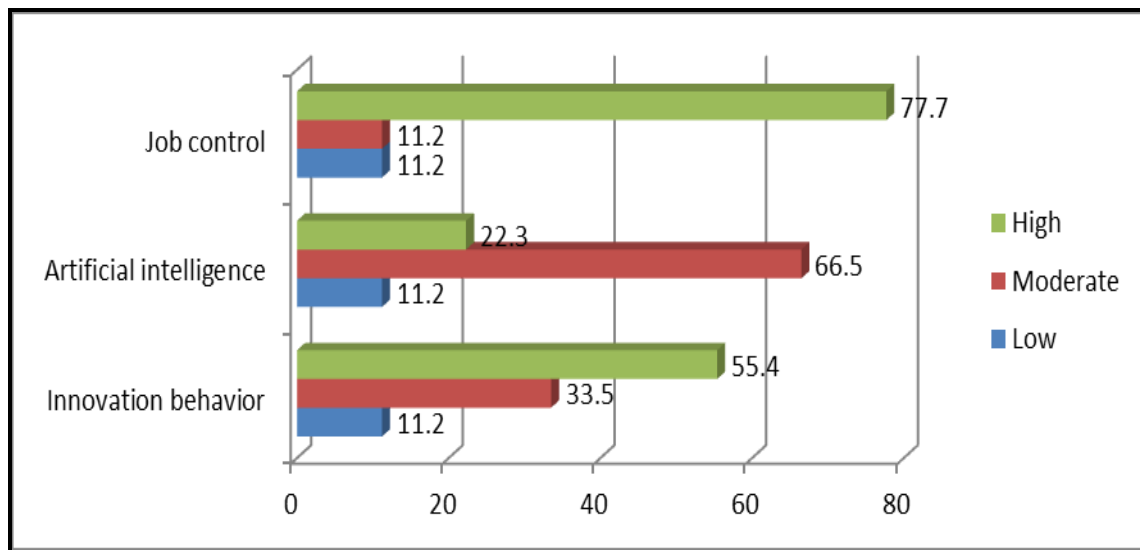


Figure (2): Staff Nurses' Response Regarding Artificial Intelligence, Innovative Behaviour, and Job Control levels (n=242).

Table (4): Pearson Correlation between Artificial Intelligence, Innovative Behavior, and Job Control among Nurses. (n=242)

Study variables of studied nurses		job control	artificial intelligence	innovative behavior
Artificial intelligence	Pearson Correlation(r)	.796**	1	.183**
	Sig. (2-tailed)	.000		.004
Innovative behavior	Pearson Correlation(r)	-.068	.183**	1
	Sig. (2-tailed)	.294	.004	
Job control	Pearson Correlation (r)	1	.796**	-.068
	Sig. (2-tailed)		.000	.294

** Correlation is significant at the 0.01 level (2-tailed).

Table (5): Simple regression analysis for artificial intelligence effect on nurses' innovative behavior (n=242).

ANOVA						
Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	5.077	1	5.077	8.315	.004a
	Residual	146.528	240	.611		
	Total	151.605	241			

a. Predictors: (Constant), artificial intelligence
 b. Dependent Variable: nurses' innovative behavior

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estima
1	.183a	.033	.029	.78137

Coefficients*						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	2.745	.380		7.218	.000
		.284	.098	.183	2.884	.004

*Dependent Variable: nurses' innovative behavior

Table (6): Moderation analysis of job control on the relationship between artificial intelligence and nurses' innovative behavior (n=242)

ANOVA									
Model		Sum of Squares	Df	Mean Square	F	Sig.			
1	Regression	5.077	1	5.077	8.315	.004a			
	Residual	146.528	240	.611					
	Total	151.605	241						
2	Regression	23.956	2	11.978	22.427	.000b			
	Residual	127.649	239	.534					
	Total	151.605	241						

a. Predictors: (Constant), artificial intelligence
 b. Predictors: (Constant), artificial intelligence, job control
 c. Dependent Variable: nurses' innovative behavior

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.183a	.033	.029	.78137	.033	8.315	1	240	.004
2	.398b	.158	.151	.73082	.125	35.348	1	239	.000

a. Predictors: (Constant), artificial intelligence
 b. Predictors: (Constant), artificial intelligence, job control

Table (2): It showed that (38.1%) of participating nurses' ages ranged from 25- < 35 years, and above half of them were female (55.8%). Only (10.7%) of nurses had master's degrees in nursing, while the majority of them had bachelor's degrees in nursing (89.3%). Also, a high percentage of nurses worked at the Critical care unit (70.2%) and nearly half (42.2%) had 5- <10 years of experience.

Table (3): Illustrates the staff nurses' responses to the total levels of AI, innovative behavior, and job control. As noticed from the table, there was a high statistical significance among all levels of three variables (AI, IB, and job control).

Figure (2): Displays that more than half of the studied subjects had a high level of job control and innovative behavior (77.7% and 55.4%) respectively,

while more than two-thirds (66.5%) of the studied sample, had a moderate level of artificial intelligence.

Table (4): Indicates a highly statistically significant positive correlation between artificial intelligence, and job control ($r=.796$, $P\text{-value}=.000$). Also, a statistically significant positive correlation existed between innovative behavior and artificial intelligence ($r=.183$, $P\text{-value}=.004$). However, an insignificant correlation existed between innovative behavior and job control ($P\text{-value}=.294$).

Regression and Moderation Analysis

To answer the research question of whether job control has a moderating effect on the relationship between artificial intelligence and innovative behavior, a hierarchical multiple regression analysis was conducted in two phases.

Phase 1:

Table (5): It showed that there was a statistically significant effect of artificial intelligence on nurses' innovative behavior, $\Delta R^2=.033$, $F(1, 240) = 8.315$, $p < .005$. This means that the existence of a relationship between the independent variable (artificial intelligence) and the dependent variable (nurses' innovative behavior) was supported. Moreover, the model suggests that artificial intelligence explains roughly 3.3% of the variation in nurses' innovative behavior.

Phase 2:

Table (6): It shows a statistically significant impact of the moderative role of job control on the relationship between artificial intelligence and nurses' innovative behavior. In model '1', one variable was included: artificial intelligence. This variable accounted for a significant amount of variance in nurses' innovative behavior, $\Delta R^2=.033$, $F(1, 240) = 8.315$, $p < .005$. While, at model '2', the interaction term between artificial intelligence and job control was added to the regression model, which accounted for a significant proportion of the variance in nurses' innovative behavior, $\Delta R^2 = .158$, $F(2, 239) = 22.427$, $p < .001$.

To sum up, the existence of a moderative effect of job control on the relationship between the independent variable (artificial intelligence) and the dependent variable (nurses' innovative behavior) was supported. Moreover, the model suggests that artificial intelligence and job control explain roughly 15.8% of the variation in nurses' innovative behavior.

Discussion

The use of artificial intelligence (AI) technologies is becoming more widespread across various healthcare organizations. These technologies have the potential to revolutionize not only administrative procedures but also many facets of patient care, in addition to administrative processes (Davenport & Kalakota, 2019). Nurses need to be alert to the widespread use of AI and the impact of its development, implementation, and assessment (Risling & Low, 2019). The acceptance and success of its deployment may be hampered by preconceptions and attitudes toward technology (Elsayed, & Sleem, 2021).

With the recent rapid improvements in communications and technology, innovation has become essential for growth (Steve, 2019). In today's increasingly competitive and technologically advanced world, innovation is essential. Successful organizations use employees' innovations to provide the organization with a competitive advantage (Afsar, et al., 2018). Certain jobs can be automated by AI-based systems, and some of them can even operate independently with little oversight from humans,

which poses a challenge to job control. (Rosen et al., 2022). To ascertain the relationship between artificial intelligence and nurses' innovative behavior, the current study set out to determine the relation between artificial intelligence and nurses' innovative behavior and (Job control as a moderating role).

According to the results of the current study, a high percentage of the nurses had a moderate level of artificial intelligence (AI) perception. This outcome may be explained by the fact that for every change or emergence of new tools, there should be some resistance and that it is unclear who will be held accountable in the event that an AI tool malfunctions. According to Elsayed & Sleem, (2021) findings, 84.6% of nurse managers had a moderate perception of the use of artificial intelligence in nursing settings. This finding is consistent with Abdullah & Fakieh, (2020) who found that healthcare workers' perceptions of AI were generally moderate.

Contrarily, according to Abd El-Monem et al., (2023), over two-thirds (66.1%) of staff nurses had a high level of perception toward artificial intelligence technology. Furthermore, Castagno & Khalifa (2020) reported that the majority of healthcare professionals are concerned about the possible effects of AI's broad application in clinical practice and do not fully understand its underlying concepts. Additionally, Mehdipour (2019) concluded that the majority of nursing managers had a very high level of application of artificial intelligence awareness. Furthermore, Carroll (2018) pointed out that there is still uncertainty regarding the uses and advantages of artificial intelligence for nurses in contexts where care is provided.

The results of the current study revealed that more than half of the staff nurses had high levels of innovative behaviors. From the researcher's point of view; this may be due to human behaviors which are heavily influenced by the working environment. According to this aspect, when nurses work in an innovative work environment, they will positively be affected and as a result, their behaviors will develop to be innovative. Thus, this goes in hand with Abd El Muksoud et al., (2022) who found that more than one-third of staff nurses had such working behaviors. Upon further studies, Abo Shama & Ahmad (2021) found that 81.46% of the studied participants had developed similar work patterns as well. In addition, Ahmed et al., (2019) through their research, revealed that marginally less than half of them had developed a high level of innovative work behaviors. Finally; Kamel & Aref (2017) pointed out that half of the staff nurses had a higher level of innovative behaviors.

On the other hand, a study by Li et al., (2022) disagreed with the previous result and found that

nurses' innovative behavior was average. Furthermore, **Alrefaei et al. (2022)** discovered that the average score of nurses' innovative behavior was at a moderate level. Additionally, **Diab & Eldeeb (2020)** found that the majority of participants in their study had a perception of having a medium level of innovative behavior. Also, **Abd El-Fattah (2017)** found that a high percentage of the participants in the study showed a moderate level of innovative behaviors. In addition, a study by **Jose et al., (2016)** found that hospital-based registered nurses showed a medium level of innovative behavior. The possible explanation for this finding could be ascribed to the fact that the concept of innovative behavior is relatively new and unfamiliar, and related to different environmental variables as justified by the researchers of the current study.

According to the current study findings, the level of job control among the nurses was at a high level. From the researcher's point of view, it was noted that the study setting was honored JCI accreditation certificate which means to a great extent health care teams were operating under international standards and practice guidelines, standards which provide nurses with an opportunity to practice autonomously and have great control over their working environment. Unlike previous research, a recent study by **Al-Hamdan et al. (2019)** found that nurses have a decent amount of control over their work in nursing. Moreover, **Nasabi & Bastani (2018)** discovered that the level of job control was average, with a score of 2.53 ± 0.81 .

To answer the research question of whether job control has a moderating effect on the relationship between artificial intelligence and innovative behavior, a hierarchical multiple regression analysis was conducted in two phases

The research proved that artificial intelligence has a significant impact on innovative behavior, this meant that there was a proven connection between artificial intelligence and the innovative behavior of nurses. Additionally, the model suggested that artificial intelligence can account for about 3.3% of the differences in nurses' innovative behavior.

The previous results may be supported by **Martikainen et al., (2020)**, who claimed that nurses would better comprehend the basic requirements of healthcare artificial intelligence if they were treated as the major users of that technology. In other words, nurses would think about how to enhance or adapt health care artificial intelligence based on their work experience, patients' demands, and medical situations to maximize its usefulness in nursing practice. Therefore, the innovative behavior of nurses is key to health care artificial intelligence adoption and diffusion.

It was illustrated that there was a statistically significant moderation role of job control in the relationship between artificial intelligence and nurses' innovation. In model '1', one variable was included: artificial intelligence. This variable accounted for a significant amount of variance in nurses' innovation, while, in model '2', the interaction term between artificial intelligence and job control was added to the regression model, which accounted for a significant proportion of the variance in nurses' innovation.

To sum up, the existence of a moderation effect of job control on the relationship between the independent variable (artificial intelligence) and the dependent variable (nurses' innovation) was supported. Moreover, the model suggests that artificial intelligence and job control explain roughly 15.8% of the variation in nurses' innovation.

According to the results of the current study, a highly statistically significant positive correlation was found between nurses' perception of artificial intelligence, and job control. From the researcher's point of view, the utilization of AI technology can play an important role, in decreasing the high work demands placed on the shoulders of practicing nurses, and also replacing low support from co-workers or supervisors, which eventually enhances the level of nurses control over their work. In the same line, **Endacott et al., (2021)** concluded that the relationship between perceptions of AI technology used, and nurses' sense of control over their work, depends on the extent to which, AI creates change and whether these technologies pose a threat, to their ability to control their work or support their decisions regarding the performance of their duties. In other words, if nurses' control, is threatened, weakened, or lost, it will upset them. Conversely, if AI creates changes that leverage their control and bring them closer to their ideal jobs, nurses can restructure, adapt, and expand their control over their work.

In addition, **Bajwa et al. (2021)** concluded that AI extends and enhances, rather than replaces, human intelligence. Therefore, when building AI systems in healthcare, it is essential not to replace important elements of human interaction in healthcare delivery, but to focus on it and improve the efficiency and performance of this interaction. Thus, increasing their control over healthcare operations can direct this interaction to make good use of these technologies. The previous results are in contrast to **Rosen et al., (2022)**, who asserted that automation is not equivalent to autonomous activity. AI is used to automate functions to some degree, often following pre-programmed rules that require the operator to be present and perform certain tasks before or after. In addition, automation technologies often take on various human tasks, which leads to a legitimate fear

of losing control over the work environment. Therefore, a higher degree of automation can cause adverse effects such as loss of control.

Also, in the current study statistically significant positive correlation existed between innovative behavior and artificial intelligence. From the researchers' point of view, the great aim of all applications of AI in health care was to transform the practice and the delivery of healthcare which could enhance caregiver experiences and challenge providers to innovate and transform models of healthcare delivery. Concurrently, **Bajwa et al., (2021)** AI innovations in healthcare will require a deep, human-centered understanding of the complexities of the patient journey and path of care. Therefore, motivates them to explore new and innovative approaches to improve quality of care and patient safety.

Surprisingly, an insignificant correlation existed between innovative behavior and job control. It was a surprising result, because, from the researchers' point of view, nurses with a high level of professionalism, in controlling their jobs can create innovative outputs and provide added value for their practice in patient care delivery and general health care services. Previous results were inconsistent with **Zhao et al., (2022)**, who reported that JC had a positive association with IB, as job control is important to employees because it meets their basic psychological needs, thereby facilitating their innovative behavior. In addition, **Yan et al. (2020)** assert that job control provides nurses with access to resources and information, promotes technical innovation, and accumulates nursing experience, which is an important way to promote regulatory nursing care and innovation. Furthermore, according to **(Chen & Zhang, 2019)**, employees with greater control over their work are more likely to develop creative results by trying out creative tasks, putting effort into the process, being creative, and maintaining perseverance in the face of difficulties.

Limitation of the study:

El-Araby Hospital is the first hospital and the only one in the Governorate to apply AI in the work process and provide its staff nurses and healthcare team with an AI training program at international standards plus continuing updated training and follow-up regularly.

Conclusions:

In the light of the present study; it could be concluded that staff nurses' responses to total levels of innovative behavior, and job control were at a high level, while artificial intelligence level was moderate and there were high significant, statistical differences among all three variables. The existence of a

moderate effect of job control on the relationship between the independent variable (artificial intelligence) and the dependent variable (nurses' innovation) was supported. Moreover, the model suggests that artificial intelligence and job control explain roughly 15.8% of the variation in nurses' innovation. According to the results of the current study, a highly statistically significant positive correlation was found between artificial intelligence and job control, and a statistically significant positive correlation existed between innovative behavior and artificial intelligence. However; an insignificant correlation existed between innovative behavior and job control. Therefore, Healthcare executives should assist nurses in realizing their dual roles as technology users and innovators, as this will increase their control over their work and advance the application and innovation of medical AI.

Recommendations:

- Hospital administration should conduct workshops and training programs to promote the culture concerning the implementation of artificial intelligence in healthcare settings.
- Healthcare leaders should support the career development needs of nurses and the requirement of special certification in the field of healthcare informatics to promote the rapid adoption of healthcare AI innovations and enhance nurses' job control.
- Further research is needed to explore nurses' innovative behavior regarding the adoption of artificial intelligence to increase the applicability of the findings in other contexts.

Declaration of Conflicting Interests:

The authors of this paper have not disclosed any potential conflicts of interest related to the research, writing, or publication of this work.

References:

- **Abd El Muksoud, N., Metwally, F., & Ata, A., (2022):** Leadership Behaviors and Innovative Work Behaviors among Nurses. *Zagazig Nursing Journal* , Vol.18, No.2
- **Abd El Fattah, M. (2017):** Innovation Behavior Levels and Its Relation with Tiger-Based Nursing Informatics Competencies among Critical Care Nurses. *Egypt Nurs J* 17]; 14:59-69. Available from: <http://www.enj.eg.net/text.asp?2017/14/2/59/223090>
- **Abd El-Monem, A., Rashed, S., & Hasanin, A., (2023).** Artificial Intelligence Technology and its Relation to Staff Nurses' Professional Identity and Problem Solving Abilities. *International Egyptian Journal of Nursing Sciences and Research*

- (IEJNSR). Vol. 3(2), 144-164. doi: 10.21608/ejnsr.2023.277890.
- **Abdullah, R., & Fakieh, B. (2020).** Health Care Employees' Perceptions of the Use of Artificial Intelligence Applications: Survey Study. *Journal of Medical Internet Research*, 22(5), 1–8. <https://doi.org/10.2196/17620>.
 - **Abo Shama, H., & Ahmad, G., (2021):** The Relationship between Nurse's Innovative Work Behavior and Their Job Satisfaction. *International Journal of Novel Research in Healthcare and Nursing* Vol. 8, Issue 1, pp: (596-606), Available at: www.noveltyjournals.com Page | 596 Novelty Journals.
 - **Afsar, B., Cheema, S., & Bin, B., (2018):** Do Nurses Display Innovative Work Behavior When Their Values Match With Hospitals' Values. *European Journal of Innovation Management*. 21. 10.1108/EJIM-01-2017-0007
 - **Ahmed, A., Ata, A., & Abd Elhamid, Z. (2019):** Relationship between the Leadership Behaviors, Organizational Climate, and Innovative Work Behavior among Nurses. *American Journal of Nursing Research*.2019; 7(5): pp 870-878.
 - **Al-Hamdan, Z., Smadi, E., Ahmad, M., Bawadi, H., & Mitchell, A., (2019).** Relationship between Control Over Nursing Practice and Job Satisfaction and Quality of Patient Care. *Journal of Nursing Care Quality* 34(3):p E1-E6, DOI: 10.1097/NCQ.0000000000000390
 - **Alrefaei, M., Hamouda, GH, & Felemban, O., (2022).** The relation between Nursing Practice Environment and Innovative Behavior in Al-Madinah Region, Saudi Arabia: - A descriptive Study. *Cureus* 14(11): e31603. doi:10.7759/cureus.31603
 - **Bajwa, J., Munir, U., Nori, A., & Williams, B., (2021).** Artificial Intelligence in Healthcare: Transforming the Practice of Medicine. *Future Healthc J.* 8(2):e188-e194. doi: 10.7861/fhj.2021-0095. PMID: 34286183; PMCID: PMC8285156.
 - **Buch, V., Varghese, G., & Maruthappu, M., (2018):** Commentary Artificial Intelligence in Diabetes Care. *Diabetes Med.* 2018; 35: 495-7. PMID: 29368355. <https://doi.org/10.1111/dme.13587>
 - **Carroll, W., (2018):** Artificial Intelligence, Nurses and the Quadruple Aim. *Online Journal of Nursing Informatics.* (OJNI), 22(2). Available at <http://www.himss.org/ojn>
 - **Castagno S., & Khalifa M., (2020):** Perceptions of Artificial Intelligence among Healthcare Staff: A Qualitative Survey Study. *Front. Artif. Intell.* 3:578983. doi: 10.3389/frai.2020.578983.
 - **Chen, Y., & Zhang, L., (2019):** Be Creative as Proactive? The Impact of Creative Self-Efficacy on Employee Creativity: A proactive perspective. *Current Psychology.* 38. 10.1007/s12144-017-9721-6.
 - **Connor, Y., Yan, F., Thilo, H., Felzmann, D., Dowding, J., & Lee, J., (2023):** “Artificial Intelligence in Nursing and Midwifery: A Systematic Review,” *Journal of Clinical Nursing*, vol. 32, no. 13–14, pp. 2951–2968.
 - **Cowie, J., (2018):** Evaluation of a Digital Consultation and Self-Care Advice Tool in J Environ Res Public Health. 15: E896. PMID: 29724040. <https://doi.org/10.3390/ijerph15050896>
 - **Davenport, Th., & Kalakota, R., (2019):** The Potential for Artificial Intelligence in Health Care. *National library of medicine*, 6(2):94-98. doi: 10.7861/futurehosp.6-2-94.
 - **Diab, G., Eldeeb, Gh., (2020):** Effect of Organizational Support and Knowledge Sharing on Nurses' Innovative Behavior. *International Journal of Nursing Science*, 10(3): 51-61 DOI: 10.5923/j.nursing.20201003.01.
 - **Diprose, W., Buist, N., Hua, N., Thurier, Q., Shand, G., & Robinson, R. (2020):** Physician Understanding, Explainability, and Trust in A Hypothetical Machine Learning Risk Calculator. *Journal of the American Medical Informatics Association*, 27(4), 592–600. <https://doi.org/10.1093/jamia/ocz229>
 - **Elsayed, W., & Sleem, W., (2021):** Nurse Managers' perception and Attitudes toward Using Artificial Intelligence Technology in Health Settings. Volume 9, Issue 24.0, March 2021, Page 182-192. DOI: 10.21608/asnj.2021.72740.1159.
 - **Endacott, C., (2021):** The Work Identity Construction in The Age of Intelligent Machines (Doctoral Dissertation, UC Santa Barbara). UC Santa Barbra Electronic Theses and Dissertations.
 - **Haenlein, M., & Kaplan, A. (2019):** A Brief History of Artificial Intelligence: on the Past, Present, and Future of Artificial Intelligence. *California Management Review*, 61(4), 5–14. <https://doi.org/10.1177/0008125619864925>
 - **Hassan zadeh, H., Nguyen, A., & Karimi, S., (2018).** Transferability of Artificial Neural Networks for Clinical Document Classification across Hospitals: A case study on abnormality detection from radiology reports. *J Biomed Inform.* PMID: 30026067. <https://doi.org/10.1016/j.jbi.2018.07.017>
 - **Hong, P., Pluye, S., & Fàbregues. (2018):** “Mixed methods appraisal tool (MMAT): user guide,” McGill, vol. 1–11.

- **Irfan, S., & Qadeer, F. (2020):** Employers Investments in Job Crafting for Sustainable Employability in Pandemic Situation Due To COVID-19: A Lens of Job Demands-Resources Theory. *Journal of Business & Economics*, 12(2), 124–140. <https://doi.org/10.5311/JBE.2020.12.17>
- **Jong, J., & Hartog, D., (2010):** Innovative Work Behavior: Measurement and Validation. *Creativity and Innovation Management Journal*; 3(2): 13.
- **Jose, J., Bunpin, D., Chapman, S., Blegen, M., & Spetz, J., (2016):** Differences in Innovative Behavior among Hospital-Based Registered Nurses. *The Journal of Nursing Administration*. Vol. 46, No. 3 (March 2016), pp. 122-127
- **Kamel, F., & Aref, M., (2017):** Staff Nurses Perception Toward Organizational Culture and Its Relation To Innovative Work Behavior At Critical Care Units. *American Journal of Nursing Science*. 6(3): pp251-260
- **Li, X., Cheng M., & Xu J., (2022):** Leaders' Innovation Expectation and Nurses' Innovation Behavior in Conjunction with Artificial Intelligence: The Chain Mediation of Job Control and Creative Self-Efficacy. *J Nurs Manag.*; 30:3806–3816. <https://doi.org/10.1111/jonm.13749>
- **Liu, P., & Tan, J., (2022):** Creative Leadership, Innovation Climate and Innovation Behavior: The Moderating Role of Knowledge Sharing In Management, *European Journal of Innovation Management*, Vol. 25 No. 4, pp. 1092-1114 © Emerald Publishing Limited 1460-1060
- **Martikainen, S., Kaipio, J., & Lääveri, T. (2020):** End-User Participation in Health Information Systems (HIS) Development: Physicians' and Nurses' Experiences. *International Journal of Medical Informatics*, 137, 104117. <https://doi.org/10.1016/j.ijmedinf.2020.104117>.
- **Mehdipour, Y., (2019):** Nursing Managers' Attitudes towards Using Artificial Intelligence Systems in Nursing Decisions. *J Nurs Health Sci* 8(1):87–90
- **Nasabi, N., & Bastani, P., (2018):** The Effect of Quality of Work Life and Job Control On Organizational Indifferences and Turnover Intention of Nurses: A Cross-Sectional Questionnaire Survey. *Cent Eur J Nurs Midw*;9(4):915–923 doi: 10.15452/CEJNM.2018.09.0024
- **Pallant, A., (2019):** SPSS Survival Manual: A Step By Step Guide to Data Analysis using SPSS for Windows (versions 23): SPSS student version 23 for Windows. Open University; 100-50.
- **Pinion, C., Brewer, S., Douphrate, D., Whitehead, L., Dellifraigne, J., Taylor, W., & Klyza, P., (2017):** The Impact of Job Control on Employee Perception of Management Commitment to Safety. *Safety Science* 93: 70–75.
- **Risling, T., & Low, C. (2019):** Advocating for Safe, Quality and Just Care: What Nursing Leaders Need to Know About Artificial Intelligence in Healthcare Delivery, *Nursing Leadership*, 23(2), 31-45. doi:10.12927/cjnl.2019.25963
- **Rosen, P., Heinold, E., Fries-Tersch, E., Moore, P., & Wischniewski, S., (2022):** Advanced Robotics, Artificial Intelligence and the Automation of Tasks: Definitions, Uses, Policies, Strategies and Occupational Safety, and Health. Report commissioned by the European Agency for Safety and Health at Work (EU-OSHA). DOI: 10.2802/681779.
- **Salman, M., Ahmed, AW, & Khan, A., (2017):** Artificial Intelligence in Bio-Medical Domain an Overview of AI-Based Innovations in Medical. *Int J Adv Comput Sci Appl*. 2017; 8: 319-27. <https://doi.org/10.14569/IJACSA.2017.080842>
- **Scott, I., & Coiera, E., (2020):** Can AI help in the fight against COVID-19? *Medical Journal of Australia*, 213(10), 439–441.e2. <https://doi.org/10.5694/mja2.50821>
- **Steve, B., (2019):** "McKinsey's Three Horizons Model Defined Innovation for Years. Here's Why It No Longer Applies". *Harvard Business Review*. ISSN 0017-8012.
- **Tran, B., Vu, G., & Ha, G., (2019):** Global Evolution of Research in Artificial Intelligence in Health and Medicine: A Bibliometric Study. *Journal of Clinical Medicine*; 8: 360. PMID: 30875745. <https://doi.org/10.3390/jcm8030360>
- **Veldhuis, N., Woittiez, P., Nanayakkara, J., & Ludikhuizen, (2022).** "Artificial Intelligence for The Prediction of in-Hospital Clinical Deterioration: A Systematic Review," *Critical Care Explorations*, vol. 4, no. 9, Article ID e0744.
- **Xianmiao, L., Mengting, M., & Jicheng, D., (2022):** Leaders' Innovation Expectation and Nurses' Innovation Behavior in Conjunction With Artificial Intelligence: The chain mediation of job control and creative self-efficacy, *J Nurse Manag.*; 1–11.
- **Yan, D., Wen, F., Li, X., & Zhang, Y. (2020):** The Relationship between Psychological Capital and Innovation Behavior in Chinese Nurses. *Journal of Nursing Management*, 28(3), 471–479. <https://doi.org/10.1111/jonm.12926>
- **Zhao, G., Luan, Y., Ding, H., & Zhou, Z., (2022):** Job Control and Employee Innovative Behavior: A Moderated Mediation Model. *Front. Psychol.* 13:720654. doi: 10.3389/fpsyg.2022.720654.

This is an open access article under
[Creative Commons by Attribution Non-Commercial \(CC BY-NC 3.0\)](https://creativecommons.org/licenses/by-nc/3.0/)
 (<https://creativecommons.org/licenses/by-nc/3.0/>)