"The Winding Journey of Human-Machine Symbiosis": Nurse Researchers' Experiences and Perceptions of Generative Artificial Intelligence: Qualitative Study

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Abstract

Background: With the rapid development and iteration of generative artificial intelligence, the growing popularity of such groundbreaking tools among nurse researchers, represented by ChatGPT, is receiving passionate debate and intrigue. Although there has been qualitative research on generative artificial intelligence in other fields, little is known about the experiences and perceptions of nurse researchers, and this study seeks to report on the subject.

Objective: This study aimed to describe the experiences and perceptions of generative artificial intelligence among Chinese nurse researchers. Provide a reference for the application of generative artificial intelligence in nursing research in the future.

Methods: Semi-structured interviews were used to collect data in this qualitative study. Data were analyzed employing inductive content analysis.

Results: Five themes and twelve sub-themes were categorized from 27 original interview documents as follows: (1) Diverse reflections on human-machine symbiosis, which includes the interplay between substitution, researchers shaping the potential space of generative artificial intelligence, and researchers accepting generative artificial intelligence with alacrity; (2) Heterogeneity of groups and experiences, including diversity in experiences of using and heterogeneity in the perception and use among different groups; (3) Research paradigm reshaping in the infancy stage, which involves a groundbreaking auxiliary tool in nursing research and the incubation of innovative research paths; (4) Ethical concerns and application challenges, considering insight into the public opinion around generative artificial intelligence, academic integrity and medical ethical challenges, and limitations on application in nursing research; (5) Future development and capacity reinforcement, which concerns reinforcement needs for utilization competency and collaboration and exploration in future nursing research. In this context, the first four themes form the rocket of the human-machine symbiosis journey. Only when humans fully leverage the advantages of machines (generative artificial intelligence) and overcome the shortcomings of them, can this human-machine symbiosis journey reach towards the correct future direction (fifth theme).

Conclusions: This study explored the experiences and perceptions of nurse researchers interacting with generative artificial intelligence, which was a "symbiotic journey" full of windings. The human-machine interaction process relentlessly moves nurse researchers to improve scientific literacy, digital literacy, and prompt skills. Meanwhile, the potential hazards and concerns of this topic for nurse researchers became apparent, with an emphasis on academic integrity, drafting relevant specifications, and the accuracy of generated content. Collaboration with interdisciplinary professionals, utilizing supervised fine-tuning, knowledge graphs, and retrieval augmented generation techniques, to develop nursing research-specific multimodal artificial general intelligence was expected to meet the individual needs of nurse researchers.

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Keywords: generative artificial intelligence; large language model; nurse researcher; nursing research; qualitative study

Introduction

GenAI holds great potential in nursing research as a tool

Nursing research, an integral part of the nursing profession, enhances the knowledge base of nursing practice, refines the methodologies used, and ultimately supports the health of whole human lifecycle, develops health strategies for specific populations, and establishes needs-focused healthcare systems [1]. At each stage of nursing research, appropriate research tools are essential. Over time, information technologies have increasingly penetrated the field of nursing research, with mature tools such as online databases and statistical software having a profound influence on nursing scientific research [2]. Representing a new technological era, artificial intelligence (AI) has been repeatedly mentioned in recent scientific advances. For instance, AI tools have emerged in evidence-based research for semi-automated literature screening and data extraction [3]. These tools allow researchers to extricate themselves from the tedious and monotonous aspects of research, and instead focus on more innovative elements, thereby enhancing the efficiency of evidence-based studies. Generative artificial intelligence (GenAI) [4], as a cutting-edge form of AI, has attracted widespread attention and discussion among scientific researchers worldwide following the release of the chat generative pre-trained transformer (ChatGPT) on November 30, 2022.

GenAI introduction

GenAI refers to an AI capable of generating various data types, such as text, images, videos, and audio. GenAI learns from large amounts of data to capture intrinsic patterns to generate similar new data [5]. Currently, there is much discussion about text-to-text GenAI and text-to-image GenAI in scientific research. Text-to-text GenAI is the earliest and best known. It can respond to or generate textual content according to human requests. Based on large language models (LLMs), its representative products include the aforementioned ChatGPT, ERNIE Bot, and Gemini (Google Bard) [6–8]. Another is text-to-image GenAI, which can produce images that match the user's textual descriptions; notable examples include Stable Diffusion, Midjourney, and DALL-E [9–11]. Additionally, there is GPT-4o, a powerful multimodal GenAI capable of processing various types of information such as text and images individually [12]. These GenAI generate text and images based on text and are capable of some degree of expansion and "creativity" on the text provided by users. The "creativity" of GenAI, which distinguishes them from other artificial intelligence, suggests that they have the potential to become groundbreaking new research tools in scientific work [13]. Researchers have extensively explored and discussed the application of GenAI in scientific research, focusing mainly on high-performance LLMs and text-to-image GenAI.

Advantages of GenAI

One of the key advantages of GenAI is its ability to learn from massive amounts of data, making it highly scalable and adaptable to different situations. It can generate easy-to-understand natural language and exquisite images in real-time through simple text prompts. In addition, GenAI also can be fine-tuned for specific domains, making it more knowledgeable in certain areas [14]. For example, ChatGPT can pass the nursing licensure exam in Chinese Taiwan [15]. Moreover, ChatGPT can answer complex questions, provide reliable information about diseases, and answer medical queries. It has the potential to complement the expertise of healthcare providers to improve clinical decision-making and patient care [16]. In the field of research, ChatGPT has proven to have the ability to generate scientific papers that resemble authentic papers written by human researchers [17]. The literature review generated by Google Bard seems promising overall [18]. There is a research which used Midjourney to generate scientific illustrations on tornado dynamics and found that text-to-image GenAI has great potential for creating scientific illustrations despite its limitations [19]. These all demonstrate the powerful capabilities of GenAI in academic research.

Limitations of GenAI

At the same time, GenAI also has some shortcomings. On one hand, GenAI includes the inability to

access real-time information and issues with the accuracy of information. The information contained within the model itself still depends on the cutoff time of training. Therefore, its inability to access new information or the Internet in real-time makes the timeliness of the information a concern [20]. The accuracy issue is manifested in the case of fabricating answers that are "AI hallucinations", a phenomenon that exists with GPT-4 [21]. On the other hand, as GenAI is used in nursing research, nurse researchers are beginning to worry that using GenAI (such as ChatGPT) as an author promotes academic dishonesty and allows students to generate research papers without doing their research by themselves [22]. Although ChatGPT has been published as a co-author in a peer-reviewed academic paper (ChatGPT Generative Pre-trained Transformer and Zhavoronkov, 2022). Most journals all agreed that ChatGPT cannot be listed as an author in academic papers, arguing that including it as an author contradicts academic ethics [23–25]. Some researchers have argued that the practice of writing using GenAI undermines ethical integrity in nursing and that reliance on ChatGPT in nursing education may produce nurses who do not adhere to ethical values, lack or have no sense of trustworthiness, and are overconfident in handling complex cases [26].

GenAI’s flaws do not overshadow its strengths

Despite these limitations, GenAI's ability to analyse large amounts of data was several times faster than humans, so it could be used for cursory searches to quickly familiarize itself with the literature quickly, thus helping researchers save more time [27]. Furthermore, ChatGPT can help find scientific references, write the methods section of a research paper, and suggest appropriate statistical analyses, among other things [28]. Copilot (Bing AI) can automate data extraction for systematic reviews, providing additional verification for novice researchers [29]. Nature reported that scientists used ChatGPT as a research assistant to help them organize their thoughts, get feedback, write code, and summarize research literature [30]. Scientific researchers’ widespread use of GenAI in their daily work is evident. Using GenAI rationally can enhance scientific research efficiency [31].

The purpose and significance of the research

Hence, the judicious use of GenAI will help nurse researchers be more efficient in their research work and benefit them by facilitating learning, improving digital literacy, and encouraging critical thinking about the integration of GenAI for nurse researchers. Therefore, it is necessary to explore nurse researchers' subjective experiences and perceptions of GenAI to promote the rational use of GenAI in nursing research. However, there is currently no such research available. This study aimed to describe nurse researchers' experiences and perceptions of the use of GenAI in nursing research as well as to explore the distress and concerns about using GenAI via qualitative research methods to

provide a reference for the ethical use and development of GenAI in the nursing research.

Methods

Design

This study employed a qualitative descriptive approach to obtain detailed descriptions of participants' experiences via semi-structured, face-to-face, and video calls with Tencent Meeting (The most widely used online meeting application in China) interviews. The reason for choosing this approach was to enrich the phenomena and obtain credible data that closing the true inner thoughts of Chinese nurse researchers, given how little we know about the experiences and perceptions of applying GenAI to nursing research.

Setting and participants

Purposive and snowball sampling were used to select the participants from two hospitals and four nursing institutions in China for five months, from August 2023 to December 2023. Inclusion criteria for clinical nurse researchers were, i) over 1 year of nursing research experience, ii) at least a bachelor’s degree, and iii) at least a mid-level professional title. The criteria for nursing faculty researchers were: i) over 1 year of nursing research experience, ii) a minimum of a master’s degree, and iii) at least a mid-level professional title. Nursing graduate students were included if they: i) had over 1 year of nursing research experience, and ii) were currently enrolled in a MSc or Ph.D. program in nursing. All recruited participants volunteered to participate in our study and could communicate in Mandarin. To confirm that the targeted participants were sufficiently interested in this study, the first author contacted them via WeChat (the most popular social application in China) to briefly introduce the purposes and methods of this study. The authors have experience learning or practicing in the participants' workplaces, so the interviews were based on mutual trust, which improved the trustworthiness of the data [32].

Data collection

For participants in Beijing, data were collected through face-to-face interviews with two first authors, postgraduate students who have taken qualitative research courses and have experience in interviewing. They are a man and a woman engaged in nursing informatics research. For those outside Beijing or physically constrained, online interviews were conducted through Tencent Meeting. Based on the research team discussion and consultation with qualitative experts, the main interview outline was determined, including 1) what have you done with GenAI in nursing research?

2) what do you feel about using GenAI in nursing research? 3) what factors influence nurse researchers to use GenAI, and what are the difficulties and barriers? 4) What do you think about GenAI-assisted writing or co-authoring articles with GenAI for publication? 5) What are your requirements for GenAI, and what is your perspective on its future development? The interviews were conducted in a quiet and undisturbed environment to ensure authors' and participants' continuity of thought. Before the interviews, the researchers reiterated the research purpose and interview contents to the participants, who signed the informed consent on the spot. During the interviews, the authors used responsive, interpretative, summarizing, and repeating methods to encourage the participants to share their experiences and needs in using GenAI in nursing research, thereby minimizing the impact of the authors' personal views influencing participants' thinking. The content of the interviews was recorded anonymously using the recording function of Tencent Meeting or a voice recorder [33]. The two authors had different responsibilities during the interviews, with two co-first authors communicating and transcribing the interviews. Data collection was stopped when no new themes were generated [34]. Then, one additional interview was continued until sampling was stopped after no new themes emerged from the analysis of information from the additional interviews.

Data analysis

In this study, an inductive content analysis approach [35] was employed to scrutinize the data and attain an in-depth comprehension of the experiences and perceptions of nurse researchers in GenAI. Initially, the first author utilized the speech-to-text platform to automatically transcribe the raw data, which was then double-checked by two authors to generate 27 Word documents. These Word documents were imported into NVivo 14 software for further analysis. The authors read the documents repeatedly in detail to understand and get a holistic sense of the interview data. In this process, they naturally formulated a preliminary inductive framework based on the research objectives. The authors meticulously searched the data for answers to the research questions, selecting a single concept or sentence as a unit of meaning. After identifying the original expressions, the authors simplified and coded them, grouping codes with similar meanings and assigning them descriptive labels; any conflicts during this process were discussed between the two authors, and they listened to the original recordings. The supervising researcher, another author, evaluated the credibility of the entire coding and generalization process, joining the data analysis at random times to ensure consistency. These categories were subsequently merged to form new ones, constantly ensuring their alignment with the research questions. This process continued until no additional categories could be formed. The researchers conducted separate analyses for each research question,

and the incremental findings were disseminated for discussion and proposed modifications at the weekly meetings, with all authors recognizing the final results.

Ethical considerations

The study received ethical approval from the appropriate ethics committee. Informed consent was obtained from all participating pairs. All participants were notified that study involvement was voluntary and they could withdraw at any time without repercussions. All original interview data and participants' information was anonymized and stored on an encrypted cloud drive to maintain confidentiality.

Results

A total of 27 nurse researchers participated in this study, including clinical nurse researchers (n=10), nursing graduate students (n=10), and nursing faculty researchers (n=7), all with varying degrees of research responsibilities, from hospitals and nursing institutions in five provinces of China. The quotations were labelled with "C", "S" and "F" to represent "clinical nurse researchers", "nursing graduate students" and "nursing faculty researchers", respectively, followed by the number of participants. The total length of the interviews was 1881 minutes, ranging from 24 to 131 minutes, with an average of 70 minutes per participant. Detailed demographic characteristics of the nurse researchers are shown in Table 1. The mean ages of the clinical nurse researchers, nursing graduate students, and nursing faculty researchers were 33.7 years (27 to 42 years), 25.1 years (23 to 32 years), and 34.7 years (28 to 49 years), respectively. All participants were recruited, of whom 81.5% (n=22) were female, 44.4% (n=12) were intermediate title, and the remaining PhD (n=5) and MSc (n=5) students accounted for 18.5% each.

Table 1

Demographic characteristics of nurse researchers (n=27)

No.	Gender	Age	Educational background	Professional title	Department
C1	Female	40	Master	Nurse-in-charge	Neurology department
C2	Female	38	Master	Nursing-in-charge	Rehabilitation department
C3	Female	35	Master	Nurse-in-charge	Nursing department
C4	Male	42	Bachelor	Deputy nurse director	Neurology department
C5	Female	30	Master	Nurse-in-charge	Intensive care unit
C6	Female	29	Master	Nurse-in-charge	Intensive care unit
C7	Female	35	Master	Nurse-in-charge	Neurosurgery department
C8	Female	32	Master	Nurse-in-charge	Intensive care unit
C9	Male	29	Master	Senior nurse	International department
C10	Female	27	Master	Nurse-in-charge	Neurology department

No.	Gender	Age	Educational background	Professional title	Department
S1	Female	23	Master degree candidate	NA	School of nursing
S2	Female	23	Master degree candidate	NA	School of nursing
S3	Female	26	Master degree candidate	NA	School of nursing
S4	Female	32	Doctoral candidate	NA	School of nursing
S5	Female	23	Master degree candidate	NA	School of nursing
S6	Female	27	Doctoral candidate	NA	School of nursing
S7	Male	24	Master degree candidate	NA	School of nursing
S8	Female	23	Doctoral candidate	NA	School of nursing
S9	Female	26	Doctoral candidate	NA	School of nursing
S10	Female	24	Doctoral candidate	NA	School of nursing
F1	Female	49	Master	Associate professor	School of nursing
F2	Female	30	PhD	Lectorate	School of nursing
F3	Male	35	PhD	Associate professor	School of nursing
F4	Male	29	PhD	Lectorate	School of nursing
F5	Female	28	PhD	Lectorate	School of nursing
F6	Female	30	PhD	Associate professor	School of nursing
F7	Female	42	PhD	Lectorate	School of nursing

[a] NA: Not applicable

The step-by-step process of theme generation is illustrated in Fig. 1. All findings presented in this section were translated from the original language into English by two co-first authors, while another author, who was involved in the data analysis and had extensive experience of studying English abroad, ensured that the findings accurately reflected the participants' semantics.

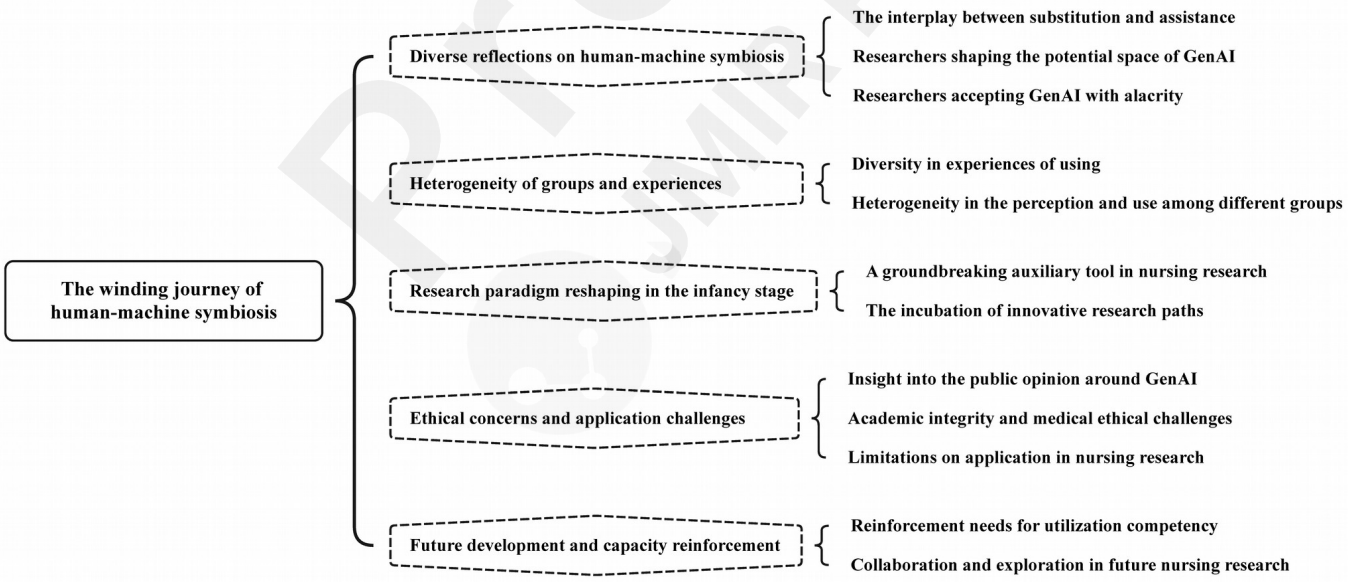

Fig. 1**.** Inductive analysis procedure

Theme 1 Diverse reflections on human-machine symbiosis

This theme encompasses the participants' deep reflections triggered by the application of GenAI to nursing research. On the other hand, this theme also aims to appeal to nurse researchers to make the best use of its convenience while maintaining a critical vision and self-active thinking and treating the run-in between humans and machines with a peaceful mind.

The interplay between substitution and assistance

This subtheme highlights the different perspectives of nurse researchers on the work that was replaced or supported by GenAI. GenAI performed mechanical tasks well and completed many intellectual tasks, such as innovation and planning, which the participants recognized. Some participants feared being replaced by GenAI in the future because they felt insignificant in the face of its intelligence.

"I have a sense of crisis. Because I have seen a lot published in the Lancet... if one-day GenAI surpasses my ideas and it quickly completes the work I have been doing for a long time, which is a shock to me, and I would feel anxious." [C7]

Conversely, another group of participants was optimistic, believing that the power of GenAI could inspire researchers to work tirelessly to continuously improve themselves, resulting in a positive relationship between reciprocal promotion and achievement.

"I hope that one day the content generated by GenAI can be an inspiration or source for me to continue to learn and improve my competitiveness. I think so." [S10]

Researchers shaping the potential space of GenAI

This subtheme implies that the accumulation of knowledge and experience by nurse researchers and the performance of GenAI usually go hand-in-hand. More than half of the participants reported that users with a solid scientific foundation and strong logical thinking are more likely to inspire better academic performance in GenAI. Convers4ely, if the user has inadequate skills or lacks self-discipline, this can play a negative role. Therefore, GenAI is a double-edged sword, depending on how nurse researchers use it.

"If you already can think spontaneously and have some basic skills in reading literature, such as

understanding logical structure, writing style, persuasiveness of the data, and so on, GenAI will be a valuable tool." [F2]

"I think GenAI is like a buff (an extra toolkit of gainful effects) in games, but it is hard to rely on it to achieve your goals if you are not skilled enough. ... It is like a sword, and how much effect you can get out of it depends on your skill." [F6]

Researchers accepting GenAI with alacrity

Participants recalled their first experience with GenAI, either being recommended to experience it or actively exploring it after noticing media coverage, which demonstrated a strong exploratory desire to explore and an openness of nurse researchers to new things. Next, they shared their feelings and attitudes at the time and were pleasantly surprised by the capabilities of GenAI, stating that it was worth promoting and becoming an integral part of the work, which expressed their high affirmation.

"I learned about GenAI at a school reunion where someone told me about the tool. That is when GenAI was in a blaze of publicity, so I started using it. ... I think we should accept it with an open and cooperative mind because it was a creature of The Time; we should keep up with the development of the information era.… Yes, I see it as part of my work and life, and I feel good about it... I think that most people taste the benefits of GenAI and then indulge in it." [C8]

Theme 2 Heterogeneity of groups and experiences

As the participants in our study were divided into three groups, their working environment, educational background, and research experience differed. In addition, their position and distinctive characteristics within the group also gave different symbolic meanings to GenAI. As a result, the heterogeneity of their perceptions, acceptance, and experiences of using GenAI represented that the diverse group of nurse researchers created the personalized experience and demand.

Diversity in experiences of using

In this subtheme, participants objectively described their experiences of research assignments using GenAI, such as analysing statistical data, providing the latest developments, and asking about the worldly wisdom of the research process. Additionally, they stated that it was critical to consider whether the time and learning costs were commensurate with the return, as changing habits required considerable effort for some people.

“I asked GenAI about research developments in the field, such as new terminologies and new statistical methods, when I read the literature, and then it helped me organize the relevant knowledge in the field.” [S3]

“The brain can determine whether the cost of habit change is proportional to the benefit; if someone learns quickly, then the input cost is low, but I have not transferred this habit (using GenAI).… If once I find it works, even though I am not comfortable sitting on this seesaw, but if one day the benefits are big enough, I might be able to swing over, you know?” [F6]

Heterogeneity in the perception and use among different groups

Nurse researchers in our study included clinical nurse researchers, nursing graduate students, and nursing faculty researchers. They differ in age, background, and educational experience, resulting in different perceptions and experiences of GenAI. The minority of participants reported that the inherent female predominance of the nursing profession was a likely reason for this group being less sensitive to GenAI information, possibly due to perceived differences in digital literacy, with women believed to have lower levels than their male counterparts.

“It is a fact that boys are more interested in technology. I know a male teacher in our college who uses ChatGPT to write articles for the official account. ... It is not that all girls do not like technology, but the sensitive part by nature due to gender is really different.” [F2]

Some nursing faculty were aware of the prevalence of GenAI use among graduate students, who used it to sort literature, modify abstracts, and polish English papers, which may be attributed to young people's heightened inclination to explore and learn new things.

“When I was the headteacher of first-year students, I knew that many undergraduate and graduate students were actively learning these technologies (using GenAI), and their learning ability is surprisingly good. For example, they used it to sort literature, polish papers and even consider it as Baidu (the world's largest Chinese search engine).” [F4]

Theme 3 Research paradigm reshaping in the infancy stage

Taken as a whole, the majority of participants gave an objective evaluation of the effects and contributions of GenAI applied to nursing research. They believed that GenAI had progressively become the right hand of nurse researchers, undeniably simplifing the scientific research process. It

can be argued that the research process of nurse researchers was unconsciously influenced by GenAI, although in the infancy stage, it was also conceivable to reshape the paradigm of nursing research in the long run.

A groundbreaking auxiliary tool in nursing research

This subtheme considers GenAI-boosting nursing research as the core concept and explores its capacity for satisfactory academic support. Most participants reported its benefits as an innovative tool to improve research methods, efficiency, quality, and most importantly, to provide researchers with refreshing ways to inspire and expand their ideas.

"It addresses the knowledge gap at home and abroad. For example, I recently had to review some math-oriented articles, but I don't understand these formulas, which looks daunting, so I have to rely on GenAI." [F3]

"I think it's wonderful that it thinks more holistically than we do. For example, sometimes we are limited by fixed thinking, which reminds us to think from a different perspective, and you may be inspired." [F5]

The incubation of innovative research paths

Participants felt that GenAI had moulded new paths for nursing research, which could be understood as an incubation process for innovative research directions. It was greatly beneficial to nurse researchers in offering unexpected inspiration and broadening study ideas, thus demonstrating an appealing ability to break down knowledge barriers. Even, some participants expressed their high praise for GenAI, claiming that its emergence was epoch-making and, to some extent, an alternative to traditional nursing research paradigms.

"I think it is good and still necessary in the development of artificial intelligence, a landmark product, which is the progress of human civilization. Especially in English communication, generative features may be better." [C4]

"You can really feel this development, it was very shocking at the very start. Because you find that people need to spend a lot of time and energy to do some things, for it may be a few seconds, or even a second." [F2]

Theme 4 Ethical concerns and application challenges

The academic integrity and ethical considerations of using GenAI in research were mentioned by most participants, who had different attitudes towards this issue under discussion. It is undeniable that GenAI has indeed provided great convenience in writing papers. However, there was a lack of explicit regulations on using GenAI in research papers in China, so the definition and perception of how to use it was vague. Further, participants who interacted frequently with GenAI also identified some common deficiencies and limitations on application, which could be a potential reason for decreasing user viscosity or abandonment.

Insight into the public opinion around GenAI

This subtheme drew nurse researchers' attention to public perceptions of GenAI, such as the popularity and negative press surrounding academic integrity, from which some participants provided forward-looking insights into the urgent need for GenAI detection tools. They hoped that the use of GenAI would be normatively constrained to some extent by GenAI detection tools, thereby reducing concerns about academic misconduct.

"If a researcher has used GenAI but has not declared it, and therefore does not know about the development of tools to identify GenAI content...Nevertheless, fighting AI with AI is a good idea." [S7]

Moreover, participants raised the issue of feeling out of control over the content generated by GenAI due to its hidden operating logic, thus questioning its interpretability.

"When the database was built, we were asked not to use unverified data, and even if we reluctantly accepted, we could only see the final result, but did not know the logic behind it... We still need to see a professional judge." [C3]

Academic integrity and medical ethical challenges

Most participants commented that the potential for scientific misconduct and medical ethical dilemmas were the primary scruple in using GenAI. Sticking to the bottom line of science and academic integrity was a prerequisite for their commitment to collaborate with novel tools or technologies to support scientific research. As awareness of GenAI in nursing research gradually improved, participants were concerned that it might disrupt the research environment and allow

poor-quality academic work to be disseminated by the right of convenience of GenAI. Meanwhile, deeper issues arose regarding whether GenAI could be author-compliant and the attribution of responsibility for GenAI-authored works. Most participants agreed that the decision was made depending on the actual contribution of GenAI and the target journal's detailed requirements.

"My concern is that if someone does not have their heart in the right place, they might take advantage of the convenience of GenAI to step on the red line, so for the sake of the overall ecology of the academic circle, I tend not to use it." [S10]

With these concerns in mind, some participants argued that researchers should capitalize on the positive aspects of GenAI and not be banned for its negative.

"I know that most universities discourage its use. Otherwise, they would not develop anti-AI plugins because writing papers in GenAI is inherently opportunistic. ... But we should see the positive side of it; after all, GenAI is a convenient tool, so why not use it?" [F2]

Limitations on application in nursing research

All participants reported that when they wanted to interact with GenAI smoothly, the complexity and time-consuming "upfront preparation" was a typical barrier, and a more accessible model substituted the alternative, but its performance was also compromised.

"If the model was more accessible, I would be more willing to use it and use it more often, but now I cannot find a channel or link. As far as paying for access is concerned, it does not matter." [C10]

For another, the student-dominated participants felt that the advanced version of GenAI, although very attractive, was expensive and not cost-effective for current usage needs. Thus, the high cost was another barrier, especially for low-income students.

"The fourth generation of this model (GPT-4) has to be paid for and is quite expensive. It is not necessary to pay for my current needs; at least, I do not rely on it very much at the moment." [S5]

Furthermore, participants recognized that GenAI would produce misleading information, requiring them to spend more time verifying the authenticity of responses, leading to a loss of trust and even irritation. They also identified shortcomings in data security, cross-cultural debugging, political hurdles, and timeliness of responses.

"I think the primary drawback of GenAI is inaccurate content. Even when looking for objective information, sometimes what GenAI says seems reasonable, but I am not sure, I have to check the literature myself." [S7]

Theme 5 Future development and capacity reinforcement

The final theme to emerge from the interview data was the need for participants to improve their capacity to use GenAI in nursing research, which also gives free rein to their imagination for the future development and exploration of GenAI. It reflected the willingness of the participants to integrate the wisdom of GenAI into research to promote the advancement of nursing research.

Reinforcement needs for utilization competency

There was a significant need for GenAI training in nursing research in China. Participants agreed that nurse researchers need comprehensive training in GenAI, including principles, functions, and interactive skills, which can help them improve efficiency and clarify the correct application concepts. They also provided valuable suggestions on the details of the training curriculum.

"I think the training should teach us how to explore the value of GenAI fully. Very often, I felt like I was interacting with a teacher in class because questions could be answered step by step, so it would be useful to learn how to optimise call words to interact with it." [S7]
"I prefer to do a case study.…You gave me a statistical method for quantitative research, and I learn how to use GenAI step by step until the article is completed. It is like a workshop with hands-on activities." [C6]

Collaboration and exploration in future nursing research

The participants expressed well-informed opinions about the future development of GenAI, including an ambiguous future that considers users' unique requirements and the significant idea that the value generated by GenAI should benefit clinical practice. As the field of nursing becomes more extensive and deeply intertwined with other disciplines, participants expressed a desire to create a nursing-specific GenAI, developed by a multidisciplinary team, based on the academic achievements of GenAI combined with pragmatic needs to meet the needs of nurse researchers for multiple knowledge and personalized learning.

"I think that the scientific and educational outcomes of GenAI, when put into practice, will bring

benefits to patients and society that can be said to be immeasurable, and I am very optimistic about this." [F4]

"Is there a corpus for the nursing profession, or some database, that would allow us to search more accurately for future nursing research knowledge for nurses? That way, the information nurses receive will be more reliable." [C3]

Summary of results

The results revealed five key themes in the winding journey of human-machine symbiosis. Among these five themes, "heterogeneity of groups and experiences" belongs to the human aspect, while "research paradigm reshaping in the infancy stage" and "ethical concerns and application challenges" pertain to the machine (GenAI) aspect. Humans and machines, through "diverse reflections on human-machine symbiosis," together form the rocket that propels this journey. In this journey, humans steer the direction from the rocket's head, while GenAI serves as the engine driving the rocket. Only by humans fully leveraging the advantages of GenAI and overcoming its shortcomings can this journey of human-machine symbiosis ultimately head in the right direction ("future development and capacity reinforcement") (Fig. 2).

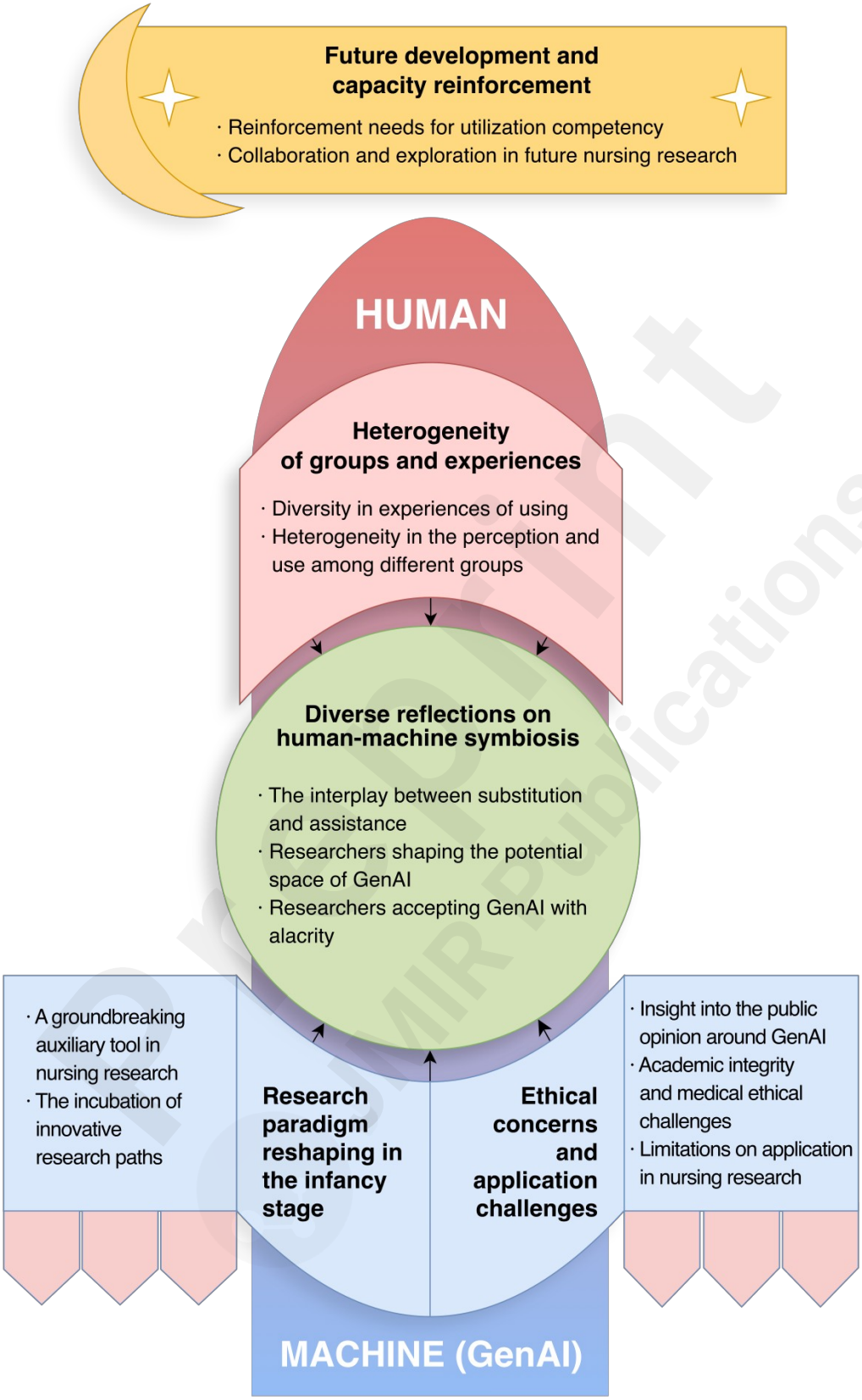

Fig. 2 Nurse researchers' experiences and perceptions of GenAI

Discussion

Summary of results

The findings of this study genuinely reflect the multidimensional experiences, perceptions, and future development regarding the use of GenAI in nursing research by nurse researchers in China. In general, nurse researchers and GenAI have a close to a symbiotic relationship. At present, Chinese nurse researchers have rich experiences in using GenAI, covering many aspects of nursing research, and their perceptions of GenAI vary. Despite the controversies surrounding GenAI as an emerging tool, including potential ethical risks, benefits, and limitations of its use, nurse researchers still hold a generally positive attitude towards the use of GenAI in nursing research. In the future, GenAI should be developed for the nursing research and enhance the GenAI usage capabilities of nurse researchers.

GenAI is an enhancer not a replacer

Overall, nurse researchers have shown a high interest and held a positive attitude toward GenAI. On the specific level of user experience, the nurse researchers included in this study widely regarded GenAI as a groundbreaking auxiliary tool for nursing research. This view is based on two dimensions of thought: one is "groundbreaking", and the other is "auxiliary". Groundbreaking in the sense that applying GenAI to nursing research is an irresistible trend and its emergence has epoch-making significance. Compared to traditional research tools such as search engines and statistical software, GenAI boasts advantages such as simple interaction, convenience and speed, and rapid iteration, which is consistent with the views of existing research [36]. Researchers also acknowledged that GenAI can transcend linguistic barriers and enhance the efficiency of their writing process, which is in line with another research [37]. The "auxiliary" nature is the prerequisite for the "groundbreaking" existence, meaning that GenAI plays a groundbreaking role in auxiliary scientific research tasks, such as knowledge acquisition, inspiring ideas, and aiding those with insufficient research capabilities as an "ability enhancer", rather than an "ability replacer". Through the "enhancement" of nursing research, nurse researchers and GenAI are expected to pioneer a new research path, ultimately reshaping the nursing research paradigm.

Current technological limitations and ethical concerns of GenAI

While GenAI has shown significant advantages in nursing research, it still faces various limitations at the current level of technological development. Among these, a criticized issue by nurse researchers is the fabricating by GenAI. This issue arises because GenAI fundamentally relies on advanced statistical models to predict responses to user input, without actual thinking [38]. Hence, its responses might not be true in real-world scenarios [39]. On the other hand, it is a challenge for

GenAI to shoulder the burden of fully assuring the accuracy in nursing research. The training corpus behind GenAI mainly comes predominantly from the Internet, therefore its accuracy within the field of nursing research cannot be guaranteed. Moreover, there are some additional scruples put forward by participants, such as poor interaction methods, and barriers related to the internet and economics, yet it also represented areas where they hoped to witness the growth of GenAI in the future.

From an ethical perspective, the writing of academic research reports, which primarily rely on textual and visual presentation, is facing multiple challenges due to the powerful generative capabilities of GenAI [23,40]. On one hand, some nurse researchers who lack self-discipline may use GenAI to generate false research results and reports. Studies have shown that humans are unable to distinguish between research reports written by humans and those generated by GenAI [41], turning inherent advantages of GenAI into hotbeds for academic misconduct. Consequently, these research findings are likely to be translated into evidence and ultimately applied in clinical settings, leading to a series of nursing ethical issues and endangering patient life and health, the similar concern is consistent with another study [42].

On the other hand, researchers have different views on whether GenAI should be recognized as an author. Currently, it is widely accepted across most academic structures and publishing organizations that "GenAI cannot be accredited as an author" [25], and some nurse researchers introduced somewhat progressive thoughts, arguing that GenAI should be perceived and endowed with rights akin to human authorship. This could be attributed to a potential unfamiliarity with the technical capabilities and underlying principles of GenAI, and it also reflects nurse researchers' recognition of GenAI capabilities. However, these controversies should not lead to the prohibition of the legitimate use of GenAI in nursing research. Some research teams have developed tools for detecting AI-generated content [43], which helps to mitigate the ethical issues associated with GenAI.

Sense of urgency among nurse researchers

Moreover, participants had varied opinions on whether GenAI could replace their jobs in the future. The majority of participants believed that GenAI can merely serve as an auxiliary tool in nursing research, nonetheless, it cannot supersede researchers in terms of creative tasks such as topic selection and making research protocol, a viewpoint that coincides with existing studies [44]. However, some nurse researchers expressed concerns that GenAI might replace their jobs in the future. There are multiple reasons for this phenomenon: Media portrayals have exaggerated the capabilities of GenAI, and many nurse researchers have not delved into the principles and limitations

of GenAI's capabilities, mistakenly believing that GenAI has become a thinking-intelligent entity, thus leading to current anxieties. However, the anxieties of some nurse researchers stem from their awareness of the rapid development of AI technology, believing that it will replace them in the future. This is another kind of long-term anxiety.

Enhancing the overall competence is key

Within another understanding of human-machine interplay by nurse researchers, the efficacy of GenAI is intimately tied to the proficiency of the user. Firstly, people who lack scientific literacy and information discernment ability may be misled by GenAI's answers, which could be consistent with another study [45], contrary to the expectation that it can provide valid information and increase the efficiency of research. Secondly, nurse researchers' grasp of GenAI application techniques (prompt engineering) fundamentally influences the quality of study utilizing GenAI [46]. This enlightens us that the enrichment of the nurse researchers' basic scientific literacy is key to achieving the full potential of GenAI, which should be complemented by training prompt skills. Another noteworthy point is different nursing research groups exhibited variations in their perceptions and utilizations of GenAI. The reasons behind these distinctions relate to the participants’ internal characteristics as well as external factors such as their field of study and work pressure. Essentially, people who have higher digital literacy demonstrate greater awareness of using GenAI than those with lower levels. To encourage more nurse researchers to understand and use GenAI in the future, the core goal should revolve around enhancing digital literacy like other other digital tools [47].

In addition to scientific and digital literacy, there is a real need for training on the use of GenAI in nursing research, with related suggestions being made. Future training should focus on practical learning, target different populations according to their digital literacy, develop GenAI prompt templates for different nursing research scenarios, complemented by teaching the principles of GenAI, and ensure compliant use of GenAI by users. At present, the development speed of GenAI is astonishing. Nurse researchers must continuously learn, and enhance their scientific research literacy, digital literacy, and the ability to utilize GenAI to reduce unnecessary anxiety and better allow GenAI to serve their scientific research work. In this process, scientific literacy and digital literacy are the "spirit" while the prompt skills are the "body". Only by enriching the spirit and strengthening the body can GenAI truly drive the development of nursing research efficiently.

Future development direction

Participants in this study have identified a diverse range of specific application scenarios for GenAI

within nursing research and a survey conducted by *Nature* has also confirmed this phenomenon [48]. This diversity aligns with the future development directions of GenAI which is towards artificial general intelligence (AGI) [49]. However, GenAI still performs poorly or cannot be applied in some nursing research scenarios at this stage. Therefore, the ideal development for GenAI's application in nursing research is to achieve an AGI that covers general needs. From another perspective, for GenAI to be widely accepted and used in nursing research, it is necessary to develop a GenAI specifically for the nursing research. To achieve this goal, the subjects of this study believe that nursing personnel need to work closely with the technicians who develop GenAI. To concretize this collaboration: nurse researchers are responsible for the selection and tagging of the nursing professional corpus, and for exploring and surveying the needs of stakeholders in the nursing research; based on the construction of the professional corpus and needs exploration, technicians can optimize the performance of nursing research GenAI through techniques such as supervised fine-tuning [50] , knowledge graph [51] and retrieval augmented generation (RAG) [52], reducing the occurrence of "AI hallucinations", enhancing its timeliness, interpretability and developing a multimodal GenAI that meets the diverse needs of nurse researchers [53]. This kind of nursing research can empower the improvement of the efficiency and quality of nursing research, which will also enhance the quality of nursing, ultimately benefiting patients.

Strengths and limitations

This study is relatively innovative that adopting a qualitative research method to explore the different nursing research groups' experiences of using GenAI in nursing research, which can deeply explore the nurse researchers' experiences and perceptions of GenAI as an emerging phenomenon. Meanwhile, this study selected three groups participants which cover the common segments of the nursing research community, ensuring the comprehensiveness of the data. The research was limited by some constraints that might influence the outcomes. The study's subjects primarily hail from academic and medical institutions in Beijing and Shanghai, China. On the one hand, the economic affluence of these two developed cities may not mirror the realities of other developing regions and countries. On the other hand, there are certain thresholds to using high-performance GenAI such as ChatGPT in China, leading to a general shortfall in advanced GenAI experiences among the researchers.

Implications of research findings for policy and future research

The findings of this research reflected the current state of GenAI usage among nurse researchers in China, clarifying their experiences and perceptions with GenAI. These insights are poised to

facilitate rational application and positive evolution of GenAI within nursing research, offering guidance for policy-making and future research directions. The key points are as follows:

1. *Establishing norms for the use of GenAI*- Norms for the use of GenAI should be swiftly established, ensuring it adheres to academic and nursing ethics while fully leveraging GenAI's strengths to enhance research efficiency and bridge language gaps, accompanied by the introduction of relevant academic standards and policies.
2. *Training the utilization of GenAI*- In the future, systematic GenAI training tailored for nurse researchers with individual characteristics should be conducted, enabling them to utilize GenAI correctly and effectively in nursing research.
3. *Interdisciplinary cooperation to develop nursing research GenAI*- Nurse researchers need to collaborate closely with technology professionals. Nurse researchers are responsible for corpus control, user needs assessment, and efficacy validation, while technical staff are tasked with model training, to create high-performance AGI tools specifically for nursing research.
4. *Improving scientific literacy and digital literacy*- Stressing the importance of improving digital literacy among nursing personnel, as this is fundamental to driving the application of GenAI in nursing research. Moreover, nursing educators should also focus on advancing the scientific literacy of their students, fostering human-led breakthroughs in maximizing the potential of GenAI.

Conclusions

The application of GenAI in nursing research is beginning to emerge, but given the different reasons, this "symbiotic journey" between GenAI and nurse researchers is unlikely to be smooth sailing. In this journey, nurse researchers should continuously learn to enhance their scientific literacy, digital literacy, and prompt skills. They should join hands with academic and publishing institutions to leverage the advantages of GenAI fully and avoid GenAI misuse. Collaborating with technicians to develop GenAI that meets the diverse needs of the nursing research community is also necessary. Ultimately, nurse researchers will join hands with GenAI, improving the efficiency and quality of nursing research.

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Conflicts of Interest

None declared.

Abbreviations

ChatGPT: chat generative pre-trained transformer

AI: artificial intelligence

GenAI: generative artificial intelligence

AGI: artificial general intelligence

RAG: retrieval augmented generation

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Supplementary Files

TOC/Feature image for homepages

In the picture, there is a caregiver using generative artificial intelligence for nursing research work to improve the research efficiency.