BMJ Open

Comparative survey among paediatricians, nurses and health information technicians on ethics implementation knowledge of and attitude towards social experiments based on medical artificial intelligence at children's hospitals in Shanghai: a cross-sectional study

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To cite: Wang Y, Fu W, Gu Y, *et al*. Comparative survey among paediatricians, nurses and health information technicians on ethics implementation knowledge of and attitude towards social experiments based on medical artificial intelligence at children's hospitals in Shanghai: a cross-sectional study. *BMJ Open* 2023;**13**:e071288. doi:10.1136/bmjopen-2022-071288

► Prepublication history and additional supplemental material for this paper are available online. To view these files, please visit the journal online (http://dx.doi.org/10.1136/bmjopen-2022-071288).

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Received 16 January 2023
Accepted 05 November 2023

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ABSTRACT

Objectives Implementing ethics is crucial to prevent harm and promote widespread benefits in social experiments based on medical artificial intelligence (MAI). However, insufficient information is available concerning this within the paediatric healthcare sector. We aimed to conduct a comparative survey among paediatricians, nurses and health information technicians regarding ethics implementation knowledge of and attitude towards MAI social experiments at children's hospitals in Shanghai.

Design and setting A cross-sectional electronic questionnaire was administered from 1 July 2022 to 31 July 2022, at tertiary children's hospitals in Shanghai.

Participants All the eligible individuals were recruited. The inclusion criteria were as follows: (1) should be a paediatrician, nurse and health information technician, (2) should have been engaged in or currently participating in social experiments based on MAI, and (3) voluntary participation in the survey.

Primary outcome Ethics implementation knowledge of and attitude to MAI social experiments among paediatricians, nurses and health information technicians.

Results There were 137 paediatricians, 135 nurses and 60 health information technicians who responded to the questionnaire at tertiary children's hospitals. 2.4–9.6% of participants were familiar with ethics implementation knowledge of MAI social experiments. 31.9–86.1% of participants held an 'agree' ethics implementation attitude. Health information technicians accounted for the highest proportion of the participants who were familiar with the knowledge of implementing ethics, and paediatricians or nurses accounted for the highest proportion among those who held 'agree' attitudes.

Conclusions There is a significant knowledge gap and variations in attitudes among paediatricians, nurses and health information technicians, which underscore the urgent need for individualised education and training programmes to enhance MAI ethics implementation in paediatric healthcare.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ In this cross-sectional study, less than one-tenth of participants were familiar with ethics implementation knowledge of medical artificial intelligence (MAI) social experiments. More than three-fourths of participants held an 'agree' ethics implementation attitude.
⇒ Health information technicians accounted for the highest proportion of those familiar with the knowledge of implementing ethics, and paediatricians accounted for the highest proportion among those holding 'agree' attitudes.
⇒ The findings indicated a significant knowledge gap and variations in attitudes among paediatricians, nurses and health information technicians, which underscore the urgent need for individualised education and training programmes on MAI ethics implementation within different occupations.
⇒ The limitations included the study being conducted in a specific context, and using online surveys, and self-reporting, self-designed questionnaires.

INTRODUCTION

Medical artificial intelligence (MAI) is rapidly advancing and has the potential

to revolutionise healthcare. China has a large population base, and there is an insufficient distribution of medical resources, particularly in the field of paediatrics. According to the 2021 China Health Statistics Yearbook, the total number of paediatricians in China was reported to be 168 000. These data correspond to a ratio of approximately 0.66 paediatricians per 1000 children aged 0–14 years old, as of the year 2020.[1] The utilisation of algorithms can facilitate the emergence of various artificial intelligence (AI)-driven systems for paediatric clinical practices, including the analysis of radiology imaging in children,[2 3] to enable accurate diagnosis for children with common or rare diseases based on electronic medical records or multimodal clinical data,[4–7] and identify the risk of early deterioration in critically ill children by leveraging medical record data and video materials.[8 9] Robots can also be employed for pre-consultation, triage and referral services for children, further expanding the scope of AI implementation in paediatric healthcare.[10] Therefore, implementing AI in paediatric healthcare in China is indeed a pressing need.

An MAI social experiment refers to a research study or intervention that uses AI technology in the context of social interactions and healthcare. Conducting an MAI social experiment is crucial for exploring the application of MAI and analysing its potential impacts, which helps properly handle the relationship between MAI, humans and society.[11–13] Due to the high level of uncertainty and significant ethical risks associated with MAI, implementing ethics in these social experiments is of utmost importance.[14 15] Research institutions in China and other countries have made significant efforts to establish principles, guidelines and norms for the ethical governance of MAI. Prominent examples include the WHO Guidance of Ethics and Governance of Artificial Intelligence for Health, the UNESCO recommendation on the ethics of AI issued in June and November 2021, respectively,[15 16] the Health Insurance Portability and Accountability Act (HIPAA), the New Generation of Ethical Norms of Artificial Intelligence by the Ministry of Science and Technology of China published in September 2021,[17] and the Guidelines of Strengthening Governance over Ethics in Science and Technology by the General Office of the State Council of China issued in March 2022.[18] There are also helpful regulatory frameworks. In the USA, MAI must be approved by the Food and Drug Administration, which classifies MAI as 'software as a medical device', while the collection, storage and disclosure of personal health information are regulated mainly by the HIPAA issued in 1996. In the European Union, privacy protection is guaranteed by the General Data Protection Regulation, which applies when a processor or controller processes personal data in the context of the activities of its establishment.[19] Their contributions have laid a theoretical foundation for ethical governance in MAI social experiments. Though their focus was on paediatric patients, they also provided valuable suggestions in privacy, safety, fairness and accountability.

Paediatricians, nurses and health information technicians have more opportunities to be potential researchers in MAI social experiments. Their ethics implementation knowledge and attitudes are vital in mitigating ethical risks and may influence decision-making processes and paediatric patient care. However, studies explicitly focusing on paediatricians, nurses and health information technicians, investigating their ethics implementation knowledge of and attitude towards MAI social experiments, are limited.

This cross-sectional study aims to fill this research gap by investigating and comparing ethics implementation knowledge of and attitude towards MAI social experiments among paediatricians, nurses and health information technicians. This study will provide valuable insights into ethics implementation of MAI social experiments in paediatrics. The findings will contribute to developing tailored education and training programmes and inform the formulation of guidelines and policies that promote the responsible and ethical use of AI in children's hospitals.

METHODS

Study design and setting

This cross-sectional study was conducted at two tertiary children's hospitals in Shanghai from 1 July 2022 to 31 July 2022, following the Strengthening the Reporting of Observational Studies in Epidemiology statement.

Patient and public involvement

No patient was involved in this study.

Participants and sampling

Participants in the study were voluntary, and the information was collected anonymously. The inclusion criteria were as follows: (1) should be a paediatrician, nurse or health information technician at the two hospitals, (2) should have been engaged in or currently participating in MAI social experiments, and (3) voluntary participation in the survey. According to the pilot test results, data from the participants were excluded from the final analysis if the recorded answering time for the entire questionnaire was less than 150 s. Additionally, participants who submitted the same response to all items were also excluded from the analysis.

The sample size was estimated using the adjusted Yamane's formula,[20] setting the population size at 1580 based on information obtained from the hospital's human resources department, alpha level at 0.05, ρ at 4 and margin of error at 0.06. We arrived at a sample size of 226. Assuming a 20% attrition rate,[21] 272 participants were finally planned to be recruited for this study.

Measures

A web-based survey was conducted to gather information and collect data through wenjuanxing (https://www.wjx.cn), a professional and widely used website for

conducting surveys in China. The survey consisted of two sections. One is about basic sociodemographic information, including gender, age, educational level (bachelor's diploma, master's diploma, doctor's diploma, others), types of occupation (paediatrician, nurse or health information technician) and levels of professional title (ungraded, junior, intermediate and senior), and the other is a 21-item questionnaire. They were all written in Chinese, and the knowledge–attitude–practice model was used as the conceptual framework to build the structure of the 21-item questionnaire. Detailed information on the questionnaire development and its English version can be found in online supplemental appendices A–C. The response options for the knowledge dimension in the questionnaire were 'familiar', 'uncertain' and 'unfamiliar'. For attitude, response options were 'disagree', 'neutral' and 'agree'. The questionnaire was first pilot-tested through convenience sampling. A sample of 52 individuals was surveyed for reliability and face validity. The items were found to be reliable, with an acceptable Cronbach's alpha coefficient of 0.727.[22] Item-content validity index and scale-content validity index were 0.791 and 0.877, respectively.[23]

Participants could scan the QR code using their cellphones or log in on their computers to access the questionnaire. The purpose of the survey and answering instructions were described on the first page of the online questionnaire. The participants were suggested to complete the questionnaire within 5–10 min. There is a limit on participants' IP addresses to avoid multiple enrolments. A reminder for checking blank answers was set to block the submission of unfinished questionnaires. The QR code and website address of the questionnaire were provided to the medical service departments, nursing departments and medical information centres. The directors of the three departments took responsibility for recruiting all eligible healthcare workers, including eligible medical students, to participate in the study.

Statistical analysis

Microsoft Office Excel V.365 for Windows (Microsoft Corp, Redmond, USA) was used to establish a database. Data were analysed using SPSS V.25.0 for Windows (IBM). The response rate was calculated by the number of final participants divided by recruited participants to the survey. The basic characteristics and responses were described as n (%), and X^2 test was used to test differences of proportions among paediatricians, nurses and health information technicians. No plan for missing data was required since participants could not submit the questionnaire unless they completed it.

RESULTS

Participants' characteristics

Of the 411 recruited individuals, 359 completed questionnaires were returned, with a response rate of 87.3%. In total, 27 questionnaires were excluded (5 with unclear demographic information, 13 with short answering time and 9 with the same answers to all the items). Finally, 332 questionnaires were included in the analysis. The participants' baseline information is shown in table 1. The age of the final participants ranged from 19 to 56 years old (mean=32.4, SD=7.2). Among them, 176 (53.0%) participants were female, 137 (41.2%) were paediatricians, 135 (40.7%) were nurses and 60 (18.1%) were health information technicians. A total of 35.5% held a master's diploma or above, and senior-level professional titles accounted for 46.1%.

Table 1 Basic information of participants

Characteristic	Participants, n (%)
Gender	
Male	156 (47.0)
Female	176 (53.0)
Type of occupation	
Paediatrician	137 (41.2)
Nurse	135 (40.7)
Health information technician	60 (18.1)
Education level	
Other lower	48 (14.5)
Bachelor's diploma	166 (50.0)
Master's diploma	103 (31.0)
Doctor's diploma	15 (4.5)
Level of professional title*	
Ungraded	58 (17.5)
Junior	153 (46.1)
Intermediate	81 (24.4)
Senior	40 (12.0)

*Professional titles symbolise the professionalism of healthcare workers. The evaluation process for these titles is guided by the National Health Commission of the People's Republic of China. Typically, there are four levels that represent the proficiency levels of knowledge and skills within a specific area of specialisation, and individuals holding these titles are often entrusted with leadership responsibilities.

Ethics implementation knowledge of and attitude to MAI social experiments among physicians, nurses and health information technicians in paediatrics

The items within the knowledge dimension were marked as K1–K10. K1 referred to the present status of performing MAI social experiments, K2–K4 pertained to related ethical issues and K5–K10 addressed the requirements for ethics governance in MAI social experiments. There were critical knowledge gaps. K1 received the highest rate of participants selecting 'familiar', but this only accounted for 9.6% of the participants. The number of responses for the option 'familiar' was the lowest in K4, while the same proportion of 2.4% in K6–K8. Most participants responded with 'unfamiliar' and 'uncertain' to the items in the knowledge dimension (table 2).

Table 2 Overall ethics implementation knowledge of MAI social experiments among physicians, nurses and health information technicians in paediatrics (N=332)

Knowledge	Unfamiliar, n (%)	Uncertain, n (%)	Familiar, n (%)
K1 The status quo of conducting MAI social experiments in paediatrics	135 (40.7)	165 (49.7)	32 (9.6)
K2 Common ethical issues in MAI social experiments in paediatrics	208 (62.7)	102 (30.7)	22 (6.6)
K3 Underlying reasons for ethical issues in MAI social experiments in paediatrics	212 (63.9)	102 (30.7)	18 (5.4)
K4 Coping strategies for ethical issues in MAI social experiments in paediatrics	245 (73.8)	79 (23.8)	8 (2.4)
K5 Principles, norms and guidelines for implementing ethics in MAI social experiments in paediatrics	246 (74.1)	72 (21.7)	14 (4.2)
K6 Policies or regulations for implementing ethics in MAI social experiments in paediatrics	258 (77.7)	66 (19.9)	8 (2.4)
K7 Content of ethical review for MAI social experiments in paediatrics	269 (81.0)	55 (16.6)	8 (2.4)
K8 Ethical supervision mechanism for MAI social experiments in paediatrics	274 (82.5)	50 (15.1)	8 (2.4)
K9 Ethical risk management approaches for MAI social experiments in paediatrics	269 (81.0)	53 (16.0)	10 (3.0)
K10 Consequences of ethical violations for MAI social experiments in paediatrics	245 (73.8)	69 (20.8)	18 (5.4)

MAI, medical artificial intelligence.

The items within the attitude dimension were marked as A1–A11. They were all for behaviours towards ensuring ethics implementation in MAI. A1–A3, A5, A6, A8 and A9 received 74.7–86.1% of participants selecting 'agree'. For A4, A10 and A11, 41.9% of the participants held a neutral attitude, respectively (table 3).

Comparison among physicians, nurses and health information technicians in ethics implementation knowledge of and attitude to MAI social experiments in paediatrics

The comparison was conducted among physicians, nurses and health information technicians concerning their ethics implementation knowledge of and attitude to MAI social experiments in paediatrics. It was found that paediatricians, nurses and health information technicians showed significant differences in regard to choosing the options of 'unfamiliar', 'uncertain' and 'familiar' in K1–K3 and K5, where health information technicians accounted for the highest proportion who chose 'familiar', followed by paediatricians, then nurses (online supplemental table 1). Also, significant differences were observed in the proportions of respondents choosing the 'agree', 'neutral' and 'disagree' options in A1–A3, A5, A6, A8 and A9. Among these, paediatricians accounted for the highest proportion who chose 'agree', followed by nurses and health information technicians. However, in A4, A7, A10 and A11, paediatricians, nurses and health information technicians held relatively balanced proportions with regard to choosing 'disagree', 'neutral' and 'agree', indicating that there were debates in the views towards the statements of the four items (online supplemental table 2).

DISCUSSION

This study provided an analysis of paediatricians, nurses and health information technicians' knowledge of and attitude towards ethics implementation of MAI social experiments at children's hospitals in Shanghai. Similar findings were reported regarding medical staff and other professional technicians' familiarity with, attitudes towards and concerns about AI in ophthalmology.[24] However, medical staff encompass a wide range of specialties within healthcare sectors. The current findings devote little to enhancing MAI ethics implementation in paediatric healthcare. Our study focused on paediatricians, nurses and health information technicians working at children's hospitals, and revealed that only 2.4–9.6% of participants at children's hospitals reported being familiar with ethics implementation knowledge of MAI social experiments. Regarding attitudes, the results demonstrated a relatively higher percentage of participants who held 'agree' attitudes, ranging from 31.9% to 86.1%. The findings indicated a significant gap in the understanding, and variations in attitudes towards ethics implementation among healthcare professionals in the context of MAI social experiments in paediatrics.

On the one hand, health information technicians accounted for the highest proportion of participants

Table 3 Overall ethics implementation attitude to MAI social experiments among physicians, nurses and health information technicians in paediatrics (N=322)

Attitude	Disagree, n (%)	Neutral, n (%)	Agree, n (%)
A1 AI experts should be involved in the research ethics committee for MAI social experiments in paediatrics.	18 (5.4)	66 (19.9)	248 (74.7)
A2 Principles, norms and guidelines on implementing ethics in MAI social experiments in paediatrics should be easy to understand and be transformed into a workable process.	5 (1.5)	47 (14.2)	280 (84.3)
A3 Ethical researchers should be involved in MAI social experiments in paediatrics.	4 (1.2)	56 (16.9)	272 (81.9)
A4 A unified ethical review can be a barrier to performing MAI social experiments in paediatrics.	87 (26.2)	139 (41.9)	106 (31.9)
A5 Clarified subjects of ethical responsibility in MAI social experiments in paediatrics can facilitate ethical supervision.	4 (1.2)	59 (17.8)	269 (81.0)
A6 Participating in ethical education and training programmes focusing on MAI social experiments is helpful for ethical supervision.	3 (0.9)	46 (13.9)	283 (85.2)
A7 It is necessary to take children's and guardians' opinions into account while performing MAI social experiments in paediatrics. When children's views are contrary to the guardians', we should adopt the guardians' views.	62 (18.7)	81 (24.4)	189 (56.9)
A8 Establishing an effective supervision mechanism is helpful.	4 (1.2)	42 (12.7)	286 (86.1)
A9 Content of ethical supervision can be dynamically adjusted according to the clinical context.	12 (3.6)	63 (19.0)	257 (77.4)
A10 The number of children or guardians against MAI will increase after having a comprehensive understanding of the ethical risk of MAI social experiments in paediatrics.	73 (22.0)	139 (41.9)	120 (36.1)
A11 Strict ethical risk management can hinder performing MAI social experiments in paediatrics.	79 (23.8)	139 (41.9)	114 (34.3)

AI, artificial intelligence; MAI, medical AI.

who reported being familiar with implementing ethics, suggesting that individuals in this role may have received specialised training or have greater exposure to the ethical considerations related to MAI social experiments. On the other hand, paediatricians accounted for the highest proportion of those with positive attitudes towards ethics implementation of MAI social experiments, which implied that physicians might have a stronger sense of responsibility and awareness of the ethical implications associated with MAI social experiments in the context of paediatric care. It could also suggest that paediatricians, as primary decision-makers, have a more significant influence on implementing ethics within the hospital setting than other medical staff.

In the field of paediatrics, the potential advantages of MAI social experiments are evident in various aspects. These include using decision support systems for precise and personalised diagnosis and nursing interventions, leveraging extensive data sources, such as electronic medical records, examination and laboratory data, as well as dynamic video images of patients, to aid in the identification of disease risks and prognoses. Furthermore, the implementation of robots can optimise the allocation of paediatric nurses' time and efforts, resulting in improved efficiency and patient care.[25–30] Nevertheless, MAI also carries the potential to pose challenges to the core values of medicine, including autonomous decision-making by doctors or nurses, and the safety and privacy of paediatric patients and their caregivers.[31 32] Previous studies on implementing ethics in MAI social experiments have always paid more attention to regulating researchers, programmers, engineers and data scientists in the stages of research, design and development, but failed to notice that ethical issues in healthcare staff are equally important.[33 34] Obtaining their information about ethics implementation knowledge of and attitudes to MAI social experiments may help policymakers make more meaningful decisions which are the premises to promote ethics implementation of MAI experiments.

We particularly observed that 56.9% of the participants had 'agree' attitudes towards considering both children's and guardians' opinions, and giving priority to guardians' opinions while conducting MAI social experiments in paediatrics. Moreover, there were no significant differences among paediatricians, nurses and health information technicians on this topic. This indicated that healthcare staff in China have begun to focus on the best interest of the minor when considering the trade-off between the benefits of MAI in paediatric care and the associated risks. Ethical decision-making in the context of

MAI should prioritise the well-being and welfare of paediatric patients, ensuring that their best interests are upheld throughout the implementation of MAI technologies. This includes carefully assessing the potential risks and harms that MAI products may pose to them, such as data immortality, and developing appropriate safeguards to protect their privacy, autonomy and overall well-being.[35]

Strengths and limitations of this study

The strengths of this study lie in its representative population, multidimensional assessment, quantitative data collection, comparison across professions, focus on ethics implementation, practical implications and recommendations for further research. The limitations of the study were as follows: first, the study was conducted in a specific context of tertiary children's hospitals in Shanghai. Therefore, the findings may not directly apply to medical staff in other regions or different types of healthcare facilities. Second, the data collection relied on online surveys by self-reporting of self-designed questionnaires. Despite efforts to ensure anonymity and confidentiality, there is still a possibility of bias influencing the responses. Third, the study used a cross-sectional design, and it did not capture changes or developments in their knowledge and attitudes over time. Consequently, we intend to broaden the scope of our research in future studies by incorporating patients into our study population and increasing the sample size.

CONCLUSION

The study provides a detailed analysis of the ethics implementation knowledge of and attitudes towards MAI social experiments among medical staff at children's hospitals in Shanghai. The findings reveal a significant knowledge gap and variations in attitudes among paediatricians, nurses and health information technicians, which underscore the urgent need for individualised education and training programmes to enhance MAI ethics implementation in paediatric healthcare. Additionally, interdisciplinary collaboration and dialogue are crucial for developing clear ethical frameworks that guide responsible ethics implementation.

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Acknowledgements The authors thank Rui Wang for her help in polishing the paper.

Contributors WW, WFu, XZ and RF designed the study. YW, WFu, YG, WFa, XG, CY, LT, LS and JW performed the study. YW and WFu drafted the manuscript and performed statistical analyses. YZ, CJ, JY, WW, HX, JF, DW, XZ and RF contributed to interpretation of the results and critically reviewed the manuscript. All authors are in agreement with the content of the manuscript and have provided final approval of the version to be published. XZ and RF are responsible for the overall content as guarantors and accept full responsibility for the finished work, have access to the data and control the decision to publish.

Funding The study was funded by Construction of pediatric disease database and knowledge graph under the National Key Research and Development Program of China (no. 2021ZD0113501), Social Experiment of Clinical Diagnosis Decision Support System under the Science and Technology Commission of Shanghai Municipality (no. 21511104502), and the Application and validation of real scenarios of major pediatric respiratory diseases under the Science and Technology Commission of Shanghai Municipality (no. 22511106001).

Competing interests None declared.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Not required.

Ethics approval This study involves human participants and was conducted according to the guidelines of the Declaration of Helsinki and approved by the Research Ethics Board of Children's Hospital of Fudan University (no. 2022-52). Informed consent was obtained from all participants involved in the study.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available upon reasonable request. Data may be available upon reasonable request from the corresponding author.

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REFERENCES

1 National Health Commission of the People's Republic of China. *2021 China Health Statistics Yearbook*. Beijin: Peking Union Medical College Press, 2022.
2 Schalekamp S, Klein WM, van Leeuwen KG. Current and emerging artificial intelligence applications in chest imaging: a pediatric perspective. *Pediatr Radiol* 2022;52:2120–30.
3 Dillman JR, Somasundaram E, Brady SL, *et al*. Current and emerging artificial intelligence applications for pediatric abdominal imaging. *Pediatr Radiol* 2022;52:2139–48.
4 Liang H, Tsui BY, Ni H, *et al*. Evaluation and accurate diagnoses of pediatric diseases using artificial intelligence. *Nat Med* 2019;25:433–8.
5 Yu G, Li Z, Li S, *et al*. The role of artificial intelligence in identifying asthma in pediatric inpatient setting. *Ann Transl Med* 2020;8:1367.
6 Gurovich Y, Hanani Y, Bar O, *et al*. Identifying facial phenotypes of genetic disorders using deep learning. *Nat Med* 2019;25:60–4.
7 Dhaliwal J, Erdman L, Drysdale E, *et al*. Accurate classification of pediatric Colonic inflammatory bowel disease subtype using a random forest machine learning classifier. *J Pediatr Gastroenterol Nutr* 2021;72:262–9.

8 Daphtary K, Baloglu O. Clinical Informatics and quality improvement in the pediatric intensive care unit. *Pediatr Clin North Am* 2022;69:573–86.
9 Vats V, Nagori A, Singh P, *et al*. Early prediction of hemodynamic shock in pediatric intensive care units with deep learning on thermal videos. *Front Physiol* 2022;13:862411.
10 Qian H, Dong B, Yuan J-J, *et al*. Pre-consultation system based on the artificial intelligence has a better diagnostic performance than the physicians in the outpatient Department of pediatrics. *Front Med (Lausanne)* 2021;8:695185.
11 Asai A, Konno M, Taniguchi M, *et al*. Computational Healthcare: present and future perspectives (review). *Exp Ther Med* 2021;22:1351.
12 Wolff J, Pauling J, Keck A, *et al*. The economic impact of artificial intelligence in health care: systematic review. *J Med Internet Res* 2020;22:e16866.
13 Boonstra A, Laven M. Influence of artificial intelligence on the work design of emergency Department Clinicians a systematic literature review. *BMC Health Serv Res* 2022;22:669.
14 Martinho A, Kroesen M, Chorus C. A healthy debate: exploring the views of medical doctors on the ethics of artificial intelligence. *Artif Intell Med* 2021;121:102190.
15 World Health Organization. Ethics and governance of artificial intelligence for health (WHO guidance) [EB/OL], . 2021Available: https://www.who.int/publications/i/item/9789240029200 [Accessed 21 Jul 2022].
16 United Nations Educational, Scientific and Cultural Organization. *Recommendation on the Ethics of Artificial Intelligence. [EB/OL]. (2021-11-23) [2022-09-01]*.
17 Ministry of Science and Technology of the People's Republic of China. The New Generation of Ethical Norms of Artificial Intelligence, . 2021Available: https://www.most.gov.cn/kjbgz/202109/t20210926_177063.html [Accessed 21 Jul 2022].
18 The state council of the People's Republic of China. The Guidelines of Strengthening Governance over Ethics in Science, Technology [EB/OL], . 2022Available: http://www.gov.cn/zhengce/2022-03/20/content_5680105.htm [Accessed 21 Jul 2022].
19 Oliva A, Grassi S, Vetrugno G, *et al*. Management of medico-legal risks in Digital health era: A Scoping review. *Front Med (Lausanne)* 2021;8:821756.
20 Adam AM. Sample size determination in survey research. *JSRR* 2020;26:90–7.
21 Suresh K, Chandrashekara S. Sample size estimation and power analysis for clinical research studies. *J Hum Reprod Sci* 2012;5:7–13.
22 Minglong W. *Questionnaire statistical analysis practice -SPSS operation and application*. Chongqing: Chongqing University Press, 2018: 158–93.
23 Polit DF, Beck CT, Owen SV. Is the CVI an acceptable indicator of content validity? appraisal and recommendations. *Res Nurs Health* 2007;30:459–67.
24 Zheng B, Wu M-N, Zhu S-J, *et al*. Attitudes of medical workers in China toward artificial intelligence in Ophthalmology: a comparative survey. *BMC Health Serv Res* 2021;21:1067.
25 Görges M, Ansermino JM. Augmented intelligence in pediatric anesthesia and pediatric critical care. *Curr Opin Anaesthesiol* 2020;33:404–10.
26 Otjen JP, Moore MM, Romberg EK, *et al*. The current and future roles of artificial intelligence in pediatric radiology. *Pediatr Radiol* 2022;52:2065–73.
27 Ramesh S, Chokkara S, Shen T, *et al*. Applications of artificial intelligence in pediatric oncology: A systematic review. *JCO Clin Cancer Inform* 2021;5:1208–19.
28 Ferrante G, Licari A, Fasola S, *et al*. Artificial intelligence in the diagnosis of pediatric allergic diseases. *Pediatr Allergy Immunol* 2021;32:405–13.
29 Zhao Y, Hu J, Gu Y, *et al*. Development and implementation of a pediatric nursing-clinical decision support system for hyperthermia: A Pre- and post-test. *Comput Inform Nurs* 2021;40:131–7.
30 Liang H-F, Wu K-M, Weng C-H, *et al*. Nurses' views on the potential use of robots in the pediatric unit. *J Pediatr Nurs* 2019;47:e58–64.
31 Rigby MJ. Ethical dimensions of using artificial intelligence in health care. *AMA J Ethics* 2019;21:E121–124.
32 Price WN 2nd, Cohen IG. Privacy in the age of medical big data. *Nat Med* 2019;25:37–43.
33 Crigger E, Khoury C. Making policy on augmented intelligence in health care. *AMA J Ethics* 2019;21:E188–191.
34 Cawthorne D, Robbins-van Wynsberghe A. An ethical framework for the design, development, implementation, and assessment of drones used in public Healthcare. *Sci Eng Ethics* 2020;26:2867–91.
35 Hauschild MZ, McKone TE, Arnbjerg-Nielsen K, *et al*. Risk and Sustainability: trade-offs and synergies for robust decision making. *Environ Sci Eur* 2022;34:11.