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Perceptions of patient safety cultures among medical students: A cross-sectional investigation in Heilongjiang Province, China

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Perceptions of patient safety cultures among medical students: A cross-sectional investigation in Heilongjiang Province, China

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Abstract

Objectives: Medical school education plays an important role in promoting patient safety. The present study investigated medical students' perspectives regarding a general patient safety culture, identifying students' educational needs across different institutions and cohorts. The ultimate goal of this assessment was to reveal evidence regarding how to promote patient safety in medical school curricula.

Method: A cross-sectional study was conducted within each of the four medical universities in Heilongjiang province. First through fifth-year medical students completed an anonymous questionnaire—the Attitudes toward Patient Safety Questionnaire III (APSQ-III). Differences in responses across the four universities and cohorts were analyzed.

Results: Overall perceptions of patient safety cultures across the four medical universities were positive. The highest positive response rate was for, "I have a good understanding of patient safety issues as a result of my undergraduate medical training" (range: 58.4%–99.8%), while the lowest positive response rate was for, "medical errors are a sign of incompetence" (14.7%–47.9%).

Younger cohorts had a better awareness of working hours and teamwork. However, fourth and fifth-year students had a better awareness of error inevitability. The lowest positive scores between cohorts included items related to "professional incompetence as an error cause" and "disclosure responsibility."

Conclusions: Perceptions of a patient safety culture among students from various medical schools were positive, suggesting a willingness to learn about this important issue. Policy makers should place a greater focus on varied educational needs across schools and cohorts in order to establish proper curricula.

Keywords: hidden curriculum, medical student, patient safety culture

Strengths and limitations of this study

1. Medical student opinions/evaluations regarding patient safety cultures are rather positive.
2. Positive perceptions of the patient safety culture tended to decrease from younger to older cohorts.
3. The APSQ-III is a new instrument that has yet to be subjected to re-testing for reliability and predictive validity.

1. Introduction

Hippocrates, who is considered the "father of medicine," proposed the "Hippocratic Oath." This proclamation is made by tens of thousands of medical students worldwide in order to promote a rigorous and enthusiastic attitude toward medical education. Here, the maintenance and promotion of human safety is of utmost importance.

However, as noted a decade ago by the Institute of Medicine (IOM), accountability for patient safety requires a multilayered approach—one that addresses system errors as well as human ones—to help prevent medical errors [1-3]. Advancements in patient safety require a fundamental culture change in healthcare. Reducing harm through an improved safety culture is a global priority [2]. Policy makers, payers, and groups (such as the Agency for Healthcare, Research, and Quality (AHRQ), National Patient Safety Agency, and World Health Organization) have resulted in numerous safety initiatives at the national and institutional level [4]. However, most measures have targeted doctors, managers, and other health care professionals. Less attention has been paid to medical students, the next generation of medical scientists [5].

The clinical practice stage is key for acquiring practical skills among medical students, at which point the student begins to shift roles from "student" to "doctor." To protect the legitimate rights of teachers and medical students and the interests of patients, and to ensure the quality of medical education, the National Health and Family Planning Commission and the Ministry of Education of the People's Republic of China develop a clear regulatory requirements for medical students and medical graduates in clinical trial practice. They point out that the clinical teacher bear the corresponding legal responsibility, if the medical disputes due to the clinical teacher incorrectly guidance. In case the medical students conducting clinical treatment activities without the permission from clinical teacher, individuals will bear the corresponding legal responsibility.

There is now a growing awareness that students are influenced not only by what is taught in a formal curriculum but also by unspoken, powerful messages conveyed through interactions with superiors and educators during students' clinical practice [6-8]. For example, although students are taught before interacting with patients to wash their hands, it is not until they witness doctors engaging in this behavior within a clinical setting that this requirement is truly understood.

One of the medical teachers from Harbin Medical University said that the main purpose of clinical practice is to form proper of "clinical thinking." This lays a solid foundation for the student's

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3 future work. My teachers not only provided us with knowledge but exemplars of a proper work
4 ethic and style. Thus, I am attempting to pass on these characteristics onto students.
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7 Thus, medical school curricula need to be strengthened to help comprehensively advocate safety
8 training. Work within this “hidden curriculum” can deal with students who may deliver or be
9 taught messages that oppose content from the formal curriculum, professional values, and even
10 practices for safe patient care. During pressure situations, such as those experienced during
11 emergencies, doctors can be challenged with making proper decisions in a timely fashion, which
12 could be an enormous threat to patient safety [9].
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15 Therefore, the nation’s medical schools, teaching hospitals, and health systems recognize that
16 achieving greater patient safety requires more than a brief course in an already crowded medical
17 school curriculum. There is a need for a fundamental culture change across all phases of medical
18 education. [10].
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21 Some scholars have addressed issues related to improved patient safety. For instance, we
22 previously observed that open communication, non-punitive responses to errors, and
23 professionalism are key areas of concern regarding medical students’ perceptions of the patient
24 safety culture [11]. Leung investigated perspectives of the patient safety culture among medical
25 students in Hong Kong and Singapore and compared students’ educational needs. However only a
26 single cohort was surveyed; they did not consider differences in educational need across cohorts
27 [12].
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30 Patient safety education in areas with low medical standards and high medical risks, as is the case
31 within developing countries like China, are just getting started [13]. There are a few reports
32 exploring safety education content and teaching methods in China [14]. However, patient safety
33 education has not been fully implemented within curricula and clinical practice. Lack of
34 knowledge regarding patient safety remains a common reason for medical errors [15]. The first
35 important question, then, is to determine what knowledge medical students are specifically lacking.
36 Additionally, information is needed regarding cognitive components of students’ perceptions of
37 the patient safety culture. Finally, we need to assess students’ explicit educational needs and what
38 should be focused upon within a patient safety curriculum. Understanding these various
39 components are the first steps in providing patient safety education.
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42 Low levels of hospital management, limited personal technology, and other issues are prevalent in
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developing countries. Thus, patient safety problems tend to be more serious than what is observed in developed countries [16]. Addressing safety education for medical students in developing countries is particularly urgent. The WHO Director General, Margaret Chan, highlighted patient safety as a key task going forward [17]. This led to the publication of a Chinese version of the "WHO Patient Safety Course Guide" in July 2012 in support of a resolution from the Ministry of Health (National Health and Family Planning Commission of the People's Republic of China).

Heilongjiang province, as the healthcare center of Northeast China, has the largest area and availability of health resources. Harbin Medical University has the best educational reputation level with the most stringent entrance requirements. Qiqihar Medical University, Mudanjiang Medical University, and the Medical College of Jiamusi University are also prominent (along with their three-level hospitals) in Heilongjiang province. The China Health Statistics Yearbook (2014) revealed that there are 21,158 medical and health institutions in the Heilongjiang region, with medical services covering about 3,813 thousand people from the local population [15]. This is equivalent to three times the population of Beijing and half of the UK population. Understanding the baseline patient safety culture, and identifying important and urgent educational needs, is critical for the effective design and successful implementation of education programs at Heilongjiang's medical institutions [15]. Thus, the present paper evaluated the patient safety culture from students' perceptions. This was done to explore factors critical to transforming patient safety perspectives and address students' educational needs.

2. Methods

2.1 Sampling and Data collection

We conducted a cross-sectional survey within the four, aforementioned medical universities in Heilongjiang province. This was done to determine undergraduate students' perceptions of their patient safety culture and educational needs. All medical universities in the province were assessed. None of the students had received any prior formal teaching on patient safety, enabling the assessment of any baseline safety culture among these students. Cooperation was obtained from managers in the student offices. We randomly selected 726 (response rate: 90.8%) students from Harbin Medical University, 631 (78.9) students from QiQihar Medical University, 459 (57.4) students from Mudanjiang Medical University, and 682 (85.3) students from the Medical College of Jiamusi University. First through fifth-year students were sampled. With this procedure, we obtained 2,498 valid questionnaires (total response rate: 78.1%).

2.2 Questionnaire

The survey instrument used was the Attitudes toward Patient Safety Questionnaire III (APSQ-III)[12,18-21], specifically designed for students and covered nine key factors of patient safety culture. The APSQ-III assesses students on various factors regarding a patient safety culture, rather than examining differences in their actual education. Therefore, this measure can more accurately reflect realistic educational needs [12].

The questionnaire consists of 26 items covering nine key patient safety factors:

- (a) patient safety training received (items 1–3);
- (b) error reporting confidence (items 4–6);
- (c) working hours as an error cause (items 7–9);
- (d) error inevitability (items 10–12);
- (e) professional incompetence as an error cause (items 13–16);
- (f) disclosure responsibility (items 17–19);
- (g) team functioning (items 20 and 21);
- (h) patient involvement in reducing error (items 22 and 23);
- and (i) importance of patient safety in the curriculum (items 24–26).

2.3 Data analyses

Responses were recorded on a five-point Likert scale, with 5 = strongly agree and 1 = strongly

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3 disagree. Responses were grouped into agree (i.e., 4 or 5) and disagree (i.e., 1 or 2), and overall
4 percentages were obtained [12]. We compared percent positive responses between schools and
5 cohort subgroups using a chi-square test. We excluded unanswered questions from the analyses.
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7 Level of significance was set at $p < .05$.
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10 **2.4 Ethics approval**

11 The study protocol was reviewed and approved by the Research Ethics Committee of Harbin
12 Medical University. Before the survey, approval was also obtained from each school. All
13 participants voluntarily and anonymously participated and provided their written informed
14 consent.
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3. Results

Of the Year 1-5 students who responded to the demographic questions, 1,055 (42.4%) were male, and 1,435 (57.4%) were female. Response rates varied between cohorts (from first to fifth-years): 399 (16%); 483 (19.3%); 587 (23.5%); 746 (29.9%); 283 (11.3%).

Table 2 summarizes safety culture perceptions, by survey domain, for the combined group and the four subgroups. The overall highest scores were for, “patient safety training received,” “patient involvement in reducing errors,” “I have a good understanding of patient safety issues as a result of my undergraduate medical training,” and “patients have an important role in preventing medical errors.” The lowest average domain scores were for, “professional incompetence as an error cause,” “disclosure responsibility,” “medical errors are a sign of incompetence,” and “it is not necessary to report errors, which do not result in adverse outcomes for the patient.”

Specific to each medical institution, the highest level of positive safety perceptions was from Mudanjiang Medical College, with the highest score for the “patient safety training received” domain. Jiamusi Medical College was second with their highest domain score for “working hours as an error cause.” Qiqihar Medical University reported their highest score for “patient involvement in reducing errors.” The lowest score among these three institutions was for “professional incompetence as an error cause.” The lowest positive patient safety perceptions came from Harbin Medical University, with their highest domain score for “patient safety training received,” and their lowest score for “error reporting confidence.” There was a statistically significant difference between schools on responses to all nine key patient safety factors.

Table 3 summarizes safety culture perceptions based on survey domain for the combined group and for the five subgroups. The table displays results sorted by safety domain score. Perceptions of patient safety culture varied based on cohort. All five cohorts had a positive perception of “patient safety training received” and “patient involvement in reducing errors.” Moreover, first and second-year students’ perceptions of “working hours as an error cause” were high. Third-year students had a better awareness of “team functioning.” In addition to the aforementioned domains, fourth and fifth-year students also had a deep understanding of “error inevitability.” The lowest scores were in the “professional incompetence as an error cause” and “importance of patient safety in the curriculum” domains for all cohorts. There was a statistically significant difference between cohorts on responses to all items.

4. Discussions

Since patient safety is a top health care priority, all medical undergraduates should have the necessary capacity to ensure minimal patient harm as they embark on their future career. Education and training are key to achieving this goal. New patient safety curricula across various medical colleges will need to adjust their teaching methods according to students' focal needs. As medical students are an integral part of our future health care systems, their experiences during school (and their perceptions of the patient safety culture) have an important influence on their attitudes toward patient safety and their behaviors within this domain [22]. Screening perceptions in key areas regarding patient safety is an opportunity to improve clinical acumen and future medical education. The present findings provide explicit medical student perspectives relevant to critical clinical services. Such information can be utilized by medical directors and clinical service supervisors for real-time assessment while promoting a safety culture. The APSQ-III has a stable factor structure and criterion validity; it can also distinguish between different student subgroups [12]. We conducted the present study to demonstrate how the APSQ-III can identify differences between different cohorts across several medical universities in Northeastern China.

Overall, our study highlights that medical student opinions/evaluations regarding patient safety cultures are rather positive [23]. It was interesting to observe that although none of our participants had received any formal teaching on the subject, students from all four universities were more likely to report good training on the subject (84.9%). This is the same with a previous study from Gilberto Ka Kit Leung in HongKong[12].The good training evaluation on the subject in our study may be due to a common psychological phenomenon of escape responsibility of student in China and a misunderstanding of what should be taught and the difference with mass media teaching.Many of them do not want to face the errors or defects, suggesting that we are likely to exist professionalism within the organization.Students who experience professional behavior may be unwilling to report things they believe are wrong in order to avoid poor evaluations and to fit in with their teams[4].We may should be more vigilant to prevent the students to misunderstood of the patient safety education course for fear of exposing deficiencies.

A few study limitations should be noted. First, despite good criterion validity, the APSQ-III is a new instrument that has yet to be subjected to re-testing for reliability and predictive validity.

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Nevertheless, the APSQ-III was first used to compare patient safety cultures in different schools and cohorts within Mainland China. While the present sample was taken from only one region in China, we covered all of the medical colleges within a rather large province. Thus, the present study represents an important first step toward patient safety education in China. We believe that educators can help create a sense of hidden patient safety curricula by building on our findings.

Schools could use percent positive scores to determine where to prioritize improvement efforts[4]. Compared with results from Leung, their three highest scores were for “working hours as an error cause,” “error inevitability,” and “importance of patient safety in the curriculum.” “Patient involvement in reducing error” and “team functioning” received the lowest overall scores in that previous study [12]. In the present study, “patient involvement in reducing errors” and “patient safety training received” were the most positively endorsed domains, while “professional incompetence as an error cause” and “disclosure responsibility” were strong barriers to positive student patient safety perceptions.

Our study found that responses to the “professional incompetence as an error cause” domain were negative, especially for the following items: “medical errors are a sign of incompetence” (32.5%), “medical students generally consider errors as inevitable” (74.9), and “even the most experienced and competent doctors make errors” (84.3%); however, the students lack a proper understanding regarding the reasons for errors. Our results are similar to a study in the US by Moskowitz et al., which revealed that students are uncertain as to what defines an error and what leads to a medical error [19].

Medical students generally agreed that medical errors are human-caused and that medical errors are a sign of incompetence (32.5%). This shows that the present sample of medical students lack awareness regarding systematic errors. Long working hours and medical staff incompetence were noted by several students as important reasons for errors. This may indicate that the students are placing an emphasis on human factors resulting in errors. This is in line with findings from a previous study involving Hong Kong students in which a majority of students reported that “if they work hard, they can eliminate errors” as an effective strategy for preventing future errors [25]. These findings could suggest a need for emphasizing the potential roles of other factors (e.g. system errors and procedural complexity) during the occurrence of medical errors.

Several students reported positive evaluations of their error reporting confidence but a punitive

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evaluation surrounding their responsibility in reporting (i.e., what and how to report when witnessing a problem with patient care). Medical students' high confidence in reporting medical errors (74.9%) is similar with results from a Turkish study conducted by Karaoglu et al. They found that 60.7% (n = 147) of students stated that they would report an error to the hospital committee if they, themselves, made a medical error. Furthermore, 68.6% (n = 166) of the students stated that they would report a medical error they witnessed [26-27].

In Flin et al.'s study, the majority of students stated they would speak up about an error. However, this result was a bit confusing, since students also endorsed the item, "it is not necessary to report errors that do not result in adverse outcomes for the patient" (60.8%). More than 50% of students from the Medical College at Jiamusi University agreed with this statement, as well. All members of the medical team, including medical students, should be able to recognize unsafe conditions, report errors, and improve error disclosure if not sufficiently conducted. This persistent cultural change should contribute to the eradication of errors and reduce patient safety concerns [28-31].

Several students agreed with the following statements: "my training is preparing me to understand the causes of medical errors" (84.8%) and "I have a good understanding of patient safety issues as a result of my undergraduate medical training" (85.2%). This illustrates that medical students have high expectations regarding patient safety education, which is in line with a study from Madigosky et al. This US-based study revealed that an awareness of patient safety and medical errors can be increased and sustained through the use of an experiential curriculum, which students rated as a valuable experience [32-33].

Insights can also be gained from the similarities observed between the four medical schools. The descending order of positive perceptions regarding patient safety cultures from the four universities are as follows: Mudanjiang Medical University, the Medical College of Jiamusi University, Qiqihar Medical University, and Harbin Medical University. There was no evidence of different reporting practices between the four medical schools. Yet, differences in local patient safety cultures, as well as differences in students' social and cultural backgrounds, may be significant contributing factors[29]. However, the present study design did not enable an exploration of these factors. We could only determine aspects of a future teaching focus. Mudanjiang Medical University, the Medical College of Jiamusi University, and Qiqihar Medical University would likely target education toward the classification, and underlying mechanisms, of

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3 medical errors. Harbin Medical University might target confidence in error reporting as an area for
4 improvement.
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7 Our results also revealed that positive perceptions of the patient safety culture tended to decrease
8 from younger to older cohorts. The first-year students held the highest perceptions, while the
9 third-year students are the focus of concern. Results revealed a shift in this cohort, which may be
10 due to third-year students entering into clinical practice. Thus, this stage could be a proper target
11 for intervention in terms of improving future practice and behaviors among clinicians [32-33].
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14 Our results are counter to those from other countries. For example, Flin et al.'s study in the UK
15 found that the majority first year students reported "medium low" or "average" levels of
16 knowledge regarding errors and patient safety issues [34-38].
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19 In conclusion, our study builds on prior research assessing student experiences with the impact of
20 "hidden curricula" on patient safety in China. Our results further suggest that medical students'
21 perceptions regarding patient safety cultures can provide a tool for guiding medical education.
22 Institutions should have an increased emphasis on issues related to the reasons behind medical
23 errors and error reporting. Shifts in patient safety cultures should be based on situations affecting
24 different schools and cohorts, especially among third-year medical students. Longitudinal studies
25 using a validated instrument should also be conducted to better evaluate patient safety education
26 programs and their relative impact on local healthcare development. Further studies should
27 explore the culture of reporting errors and how students in nursing and healthcare profession
28 programs address these errors.
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Mingli Jiao, Qunhong Wu, Ying Li and He Liu. designed the study; Jinghua Liu, Limin Liu, Yanming Zhao, Kexin Jiang, Huiying Fang, Peihang Sun, Peng Li, Yameng Wang, Haonan Jia and Yan Lu collected the data; He Liu, Ying Li, and Yuming Wu analysed the data; He Liu, Ying Li, Mingli Jiao, Siqi Zhao drafted the manuscript; and Mingli Jiao contributed to the manuscript's revision. All authors approved the final manuscript for publication.

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Table 1. Participant demographic characteristics.

subgroups	No. (%) of respondents							Overall
	Gender		Level					
	M	F	First Year	Second Year	Third year	Fourth year	Fifth Year	
A [□]	322 (44.4)	404 (55.6)	111 (15.3)	132 (18.2)	154 (21.2)	245 (33.7)	84 (11.6)	726 (29.1)
B [□]	261 (41.7)	366 (58.3)	186 (29.5)	146 (23.1)	117 (18.5)	100 (15.8)	82 (13)	631 (25.3)
C [□]	167 (36.4)	292 (63.6)	36 (7.8)	115 (25.1)	110 (24)	131 (28.5)	67 (14.6)	459 (18.4)
D [□]	305 (45)	377 (55)	66 (9.7)	90 (13.2)	206 (30.2)	270 (39.6)	50 (7.3)	682 (27.3)
Total	1055 (42.4)	1435 (57.4)	399 (16)	483 (19.3)	587 (23.5)	746 (29.9)	283 (11.3)	2498

[□]A = Harbin Medical University.

[□]B = Qiqihar Medical University.

[□]C = MuDanJiang Medical University.

[□]D = Medical College of Jiamusi University.

Table 2. Items from the APSQ-III that demonstrated significant differences between the four medical universities.

Domain	Positive responses (%) [‡]				
	Overall	Between schools			
		A*	B*	C*	D*
Patient safety training received	84.9	57.3	90	99.4	98.5
1. My training is preparing me to understand the causes of medical errors.	84.8	56.6	89.7	99	99
2. I have a good understanding of patient safety issues as a result of my undergraduate medical training.	85.2	58.4	90.2	99.8	97
3. My training is preparing me to prevent medical errors.	84.7	56.8	90.1	99.3	99.4
error reporting confidence	74.9	53.1	75.8	85.6	88.1
4. I would feel comfortable reporting any errors I had made, no matter how serious the outcome had been for the patient.	71.6	52.9	68.5	80.5	85.7
5. I would feel comfortable reporting any errors other people had made, no matter how serious the outcome had been for the patient.	76.7	53.4	79.8	88.1	89.5
6. I am confident I can talk openly to my supervisor about an error I had made, even if it resulted in potential or actual harm to my patient.	76.5	53.1	79	88.1	89.2
working hours as an error cause	83.4	56.2	88.2	98	98.7
7. Shorter shifts for doctors will reduce medical errors.	81.7	53.9	85.9	97.1	97.3
8. By not taking regular breaks during shifts, doctors are at an increased risk of making errors.	84.7	57.8	89.8	98.9	99.5
9. The number of hours doctors work increases the likelihood of making medical errors.	83.8	56.8	89	97.9	99.4
error inevitability	74.9	55.2	80.9	87.1	82.2
10. Even the most experienced and competent doctors make errors.	84.3	56.7	89.4	99.8	98.7
11. A true professional does not make mistakes or errors.	68.9	53	79.3	86.1	64.8
12. Human error is inevitable.	71.6	56	73.9	75.4	83.2
professional incompetence as an error cause	58.4	53.25	59.6	61	60
13. Most medical errors result from careless nurses [†]	68.1	56.8	79	79.3	62.1
14. If people paid more attention at work, medical errors would be avoided [†]	67.2	53.2	62.5	72.8	80.1
15. Most medical errors result from careless doctors [†]	65.8	55.1	74.2	77.1	61.4
16. Medical errors are a sign of incompetence [†]	32.5	47.9	22.7	14.7	36.5
disclosure responsibility	69.4	55.1	72.6	78.4	74.8
17. It is not necessary to report errors which do not result in adverse outcomes for the patient [†]	60.8	57.6	70.7	69.8	48.8
18. Doctors have a responsibility to disclose errors to patients only if the errors result in patient harm.	80.8	55	85.2	93.8	94.5
19. All medical errors should be reported.	66.7	52.6	61.9	71.6	81
team functioning	76.9	55.7	77.5	87.6	91.8
20. Better multidisciplinary teamwork will reduce medical errors.	69.2	54.9	64.5	75.4	84.5

21. Teaching students teamwork skills will reduce medical errors.	84.7	56.6	90.5	99.8	99.1
patient involvement in reducing errors	84.7	56.7	90.2	99.4	98.7
22. Patients have an important role in preventing medical errors.	85.1	56.1	90.5	99.5	98.6
23. Encouraging patients to be more involved in their care can help to reduce the risk of medical errors occurring.	84.5	57.3	90	99.3	98.8
importance of patient safety in the curriculum	71.6	56.4	78.5	82.4	74.4
24. Teaching students about patient safety should be an important priority in medical students' training.	84.1	55.9	89.5	99.1	98.6
25. Patient safety issues cannot be taught; they can only be learned through clinical experience, which is gained when one is qualified.	46.6	55.8	55.4	50	25.3
26. Learning about patient safety issues before I qualify will enable me to become a more effective doctor.	85	57.5	90.7	99.3	99.4
Overall	678.8	498.9	713.3	778.9	767.2

□ A = Harbin Medical University.

□ B = Qiqihar Medical University.

□ C = MuDanJiang Medical University.

□ D = Medical College of Jiamusi University.

‡ Positive responses are those with "agree" or "strongly agree." The denominator for each question may vary because not every student responded to every question in the survey.

† Negatively worded item, where the percent positive response is based on those who responded, "strongly disagree" or "disagree."

Table 3. Items on the APSQ-III that demonstrated significant differences between the five cohorts.

S c h o o l s	Grades	Positive responses (%) [†]									
		Overall	Pati ent safet y traini ng recei ved	Error reportin g confide nce	Workin g hours as an error cause	Error inevitabi lity	Professional incompetence as an error cause	Discl osure respo nsibili ty	Team functi oning	Patient involvement in reducing errors	Importance of patient safety in the curriculum
A	first	632	78.6	73.4	79.7	71.9	56.6	66.4	73.9	80.8	50.7
	second	591.3	74.3	62.9	74.4	71.4	56	66.6	64	71.9	49.8
	third	176.4	57.1	52.9	56.2	52.8	51.9	51.4	57.5	55.1	41.5
	fourth	391	43.1	40	40.5	45.4	51.1	48.7	42.7	42.8	37.6
	fifth	401	45.2	46.4	42.6	41.1	51.8	46.6	51.2	42.7	33.7
B	first	751.2	99.4	84.7	95.8	86	61.5	78.2	84.1	98.9	62.6
	second	760.8	97.2	86.8	95	91.1	66.3	78.5	87	99.1	59.8
	third	717.8	98	72.7	95.9	83.8	59.2	63.3	81.3	100	63.5
	fourth	745.1	98.9	86.5	97.3	84.4	60.9	77.5	78.8	97.3	63.5
	fifth	507	61.4	51.9	61.2	61.6	51.5	57.4	56.1	58.7	47.2
C	first	771.6	99.1	90.3	96.1	91.9	62	84.1	86.4	98.2	63.5
	second	761	99.6	90.3	98.3	84.2	63.6	81.2	81.1	99.5	63.2
	third	757.6	100	83.4	97.9	87.1	60.7	78.2	91	100	59.3
	fourth	743.3	97	77.9	96.9	86.9	60	75.2	87.2	95.7	66.5
	fifth	744.4	99.7	79.9	99.4	85.2	58.5	70.9	92.6	100	58.2
D	first	751.4	99.1	87.1	99.2	86	63.3	72.7	90.2	97.1	56.7
	second	752.2	98.5	88.7	99.2	83.2	61.3	77.5	91	98.2	54.6
	third	745.4	97.1	87.2	97.2	82.9	59.9	74.8	89.3	99.2	57.8
	fourth	739.7	100	96.1	100	74.2	52.3	67	97.7	100	52.4
	fifth	738.3	100	78	100	79.3	41	74.9	100	100	65.1

[□]A = Harbin Medical University.

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3 **1 Perceptions of patient safety culture among medical students: A cross-sectional**
4 **2 investigation in Heilongjiang Province, China**
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39 Abstract

40 **Objectives:** Medical school education plays an important role in promoting patient
41 safety. The present study aimed to assess medical students' perceptions of patient
42 safety culture, and also to identify the educational needs of these students and provide
43 evidence on the most important content for a curriculum relating to patient safety.

44 **Method:** A cross-sectional study was conducted within each of the four medical
45 universities in Heilongjiang province. First through fifth-year medical students
46 completed an anonymous questionnaire—the Attitudes toward Patient Safety
47 Questionnaire III (APSQ-III). Differences in responses across the four universities
48 and cohorts were analysed.

49 **Results:** Overall perceptions of patient safety cultures across the four medical
50 universities were positive. The highest positive response rate was for, 'I have a good
51 understanding of patient safety issues as a result of my undergraduate medical
52 training' (range: 58.4%–99.8%), while the lowest positive response rate was for,
53 'medical errors are a sign of incompetence' (14.7%–47.9%).

54 Younger cohorts had a better awareness of working hours and teamwork. However,
55 fourth and fifth-year students had a better awareness of error inevitability. The lowest
56 positive scores between cohorts included items related to 'professional incompetence
57 as an error cause' and 'disclosure responsibility'.

58 **Conclusions:** Perceptions of patient safety culture among students from various
59 medical schools were positive, suggesting a willingness to learn about this important
60 issue. Policy makers should place a greater focus on varied educational needs across
61 schools and cohorts to establish proper curricula.

62 **Keywords:** medical education, patient safety, medicine students

64 Strengths and limitations of this study

65 Strengths:

- 66 ● This is the first use of the APSQ-III to compare patient safety in different schools
67 and cohorts within a developing country (China)
- 68 ● We covered almost all of the medical colleges within a rather large province

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3 ● This study provides the necessary evidence for educators to design future
4 interventions and create a sense of focus on patient safety in medical education
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7 Limitations:

- 8 ● APSQ-III is a new instrument, the reliability and validity of which have not yet
9 been retested
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11 ● Our study is limited by the potential for non-response bias. Students who
12 responded to the survey may have been more likely than their peers to be
13 interested in patient safety, which may have led to inflation of the attitude ratings
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18 1. Introduction

19 Hippocrates, who is considered the ‘father of medicine’, proposed the ‘Hippocratic
20 Oath’. This oath is taken by medical students worldwide to promote a rigorous and
21 enthusiastic attitude toward medical education. Hence, the maintenance and promotion
22 of human safety is of utmost importance.
23

24 However, as noted a decade ago by the Institute of Medicine (IOM), accountability
25 for patient safety requires a multi-layered approach—one that addresses system errors
26 as well as human ones—to help prevent medical errors [1-3]. Advancements in patient
27 safety require a fundamental culture change in healthcare. Reducing harm through an
28 improved safety culture is a global priority [2]. Policy makers, payers, and groups
29 (such as the Agency for Healthcare, Research, and Quality (AHRQ), National Patient
30 Safety Agency, and World Health Organization) have resulted in numerous safety
31 initiatives at the national and institutional level [4]. However, most measures have
32 targeted doctors, managers, and other health care professionals. Less attention has
33 been paid to medical students, the next generation of medical scientists [5].
34

35 The clinical practice stage is key for acquiring practical skills among medical students,
36 at which point the student begins to shift roles from ‘student’ to ‘doctor’. To protect
37 the rights of teachers and medical students and the interests of patients, and to ensure
38 the quality of medical education, the National Health and Family Planning
39 Commission and the Ministry of Education of the People’s Republic of China develop
40 clear regulatory requirements for medical students and medical graduates in clinical
41 trial practice. While clinical teachers bear legal responsibility for medical disputes due
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3 99 to incorrect guidance, when medical students conduct clinical treatment activities
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5 100 without the permission of the clinical teacher, individuals bear the corresponding legal
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7 101 responsibility.

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9 102 There is now a growing awareness that students are influenced not only by what is
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11 103 taught in the formal curriculum, but also by unspoken, powerful messages conveyed
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13 104 through interactions with superiors and educators during students' clinical practice
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15 105 [6-8]. For example, although students are taught to wash their hands before interacting
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17 106 with patients, it is not until they witness doctors engaging in this behaviour within a
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19 107 clinical setting that this requirement is truly understood.

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21 108 One of the medical teachers from Harbin Medical University said that the main
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23 109 purpose of clinical practice is to form proper 'clinical thinking'. This lays a solid
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25 110 foundation for the student's future work. My teachers not only provided us with
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27 111 knowledge but exemplars of proper work ethic and style. Thus, I am attempting to
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29 112 pass on these characteristics to students.

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31 113 Medical school curricula need to be strengthened to comprehensively advocate safety
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33 114 training. Work within this 'hidden curriculum' can deal with students who may engage
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35 115 in or be taught practices that oppose content from the formal curriculum, professional
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37 116 values, and even safe patient care. During pressure situations, such as those
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39 117 experienced during emergencies, doctors can be challenged with making proper
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41 118 decisions in a timely fashion, which could be an enormous threat to patient safety [9].

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43 119 Therefore, the nation's medical schools, teaching hospitals, and health systems
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45 120 recognize that achieving greater patient safety requires more than a brief course in an
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47 121 already crowded medical school curriculum. There is a need for a fundamental culture
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49 122 change across all phases of medical education. [10].

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51 123 Some scholars have addressed issues related to improved patient safety. For instance,
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53 124 we previously observed that open communication, non-punitive responses to errors,
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55 125 and professionalism are key areas of concern regarding medical students' perceptions
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57 126 of the patient safety culture [11]. Leung investigated perspectives of the patient safety
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59 127 culture among medical students in Hong Kong and Singapore and compared students'
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128 educational needs. However, only a single cohort was surveyed; this study did not

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3 129 consider differences in educational need across cohorts [12].
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5 130 Patient safety education in areas with low medical standards and high medical risks,
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7 131 as is the case in developing countries like China, is in its infancy [13]. While a few
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9 132 reports have explored safety education content and teaching methods in China [14],
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11 133 patient safety education has not been fully implemented within curricula and clinical
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13 134 practice. Lack of knowledge regarding patient safety remains a common reason for
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15 135 medical errors [15]. The first important question, then, is to determine what
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17 136 knowledge medical students are specifically lacking. Additionally, information is
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19 137 needed regarding cognitive components of students' perceptions of patient safety
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21 138 culture. Finally, we need to assess students' explicit educational needs and what
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23 139 should be focused upon within a patient safety curriculum. Understanding these
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25 140 various components are the first steps in providing patient safety education.
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27 141 Low levels of hospital management, limited personal technology, and other issues are
28
29 142 prevalent in developing countries. Thus, patient safety problems tend to be more
30
31 143 serious than what is observed in developed countries [16]. Addressing safety
32
33 144 education for medical students in developing countries is particularly urgent. The
34
35 145 WHO Director General, Margaret Chan, highlighted patient safety as a key task going
36
37 146 forward [17]. This led to the publication of a Chinese version of the 'WHO Patient
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39 147 Safety Course Guide' in July 2012 in support of a resolution from the Ministry of
40
41 148 Health (National Health and Family Planning Commission of the People's Republic
42
43 149 of China).
44
45 150 Heilongjiang province, as the healthcare centre of Northeast China, has the largest
46
47 151 area and availability of health resources, while Harbin Medical University has the best
48
49 152 educational reputation with the most stringent entrance requirements. Qiqihar Medical
50
51 153 University, Mudanjiang Medical University, and the Medical College of Jiamusi
52
53 154 University are also prominent (along with their three-level hospitals) in Heilongjiang
54
55 155 province. The China Health Statistics Yearbook (2014) revealed that there are 21,158
56
57 156 medical and health institutions in the Heilongjiang region, with medical services
58
59 157 covering about 3,813 thousand people from the local population [15]. This is
60 158 equivalent to three times the population of Beijing and half of the UK population.

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3 159 Understanding the baseline patient safety culture, and identifying important and
4
5 160 urgent educational needs, is critical for the effective design and successful
6
7 161 implementation of education programs at Heilongjiang's medical institutions [15].
8
9 162 Thus, the present study evaluated patient safety culture from students' perspectives.
10
11 163 This was done to explore factors critical to transforming patient safety perspectives
12
13 164 and address students' educational needs.

14 165 **2. Methods**

15 16 166 **2.1 Sampling and Data collection**

17
18 167 We conducted a cross-sectional survey within the four, aforementioned medical
19
20 168 universities in Heilongjiang province. Cooperation was obtained from managers in the
21
22 169 student offices. Some schools offered courses in doctor-patient relations and
23
24 170 evidence-based medicine, but there was no dedicated and systematic patient safety
25
26 171 course. None of the students had received any prior formal teaching on patient safety,
27
28 172 enabling a baseline assessment of safety culture among these students. We used
29
30 173 systematic random sampling to select 800 medical students from a roster of all
31
32 174 medical undergraduates at each school. We provided these students with detailed
33
34 175 explanations of the objective of this investigation; some students expressed interest in
35
36 176 participating in the survey, while others declined to participate. Students who were
37
38 177 willing to participate in the investigation were given two days to complete the
39
40 178 questionnaire anonymously; they were asked to then return it to a box provided in the
41
42 179 counselor's office. Respondents' names and other identifiers were not collected. Using
43
44 180 this procedure, we obtained 2489 valid questionnaires (total response rate: 78.1%). Of
45
46 181 the students who participated, 726 (response rate: 90.8%) came from Harbin Medical
47
48 182 University, 631 (78.9%) from Qiqihar Medical University, 459 (57.4%) from
49
50 183 Mudanjiang Medical University, and 682 (85.3%) from the Medical College of
51
52 184 Jiamusi University.

53 185 **2.2 Questionnaire**

54 186 The survey instrument used was the Attitudes toward Patient Safety Questionnaire III
55 187 (APSQ-III) [12,18-21], which was specifically designed for students and covers nine
56 188 key factors related to patient

189 safety culture. The APSQ-III assesses various factors regarding patient safety culture,
190 rather than examining differences in patient safety education. Therefore, this measure
191 can more accurately reflect realistic educational needs [12].

192 The questionnaire consists of 26 items covering nine key patient safety factors:

- 193 (a) patient safety training received (items 1–3);
- 194 (b) error reporting confidence (items 4–6);
- 195 (c) working hours as an error cause (items 7–9);
- 196 (d) error inevitability (items 10–12);
- 197 (e) professional incompetence as an error cause (items 13–16);
- 198 (f) disclosure responsibility (items 17–19);
- 199 (g) team functioning (items 20 and 21);
- 200 (h) patient involvement in reducing error (items 22 and 23);
- 201 and (i) importance of patient safety in the curriculum (items 24–26).

202 **2.3 Data analyses**

203 Responses were recorded on a five-point Likert scale, with 5 = strongly agree and 1 =
204 strongly disagree. Responses were grouped into agree (i.e. 4 or 5) and disagree (i.e. 1
205 or 2), and overall percentages were obtained [12]. The chi-square test was used to
206 compare the rate of positive responses between schools and cohort subgroups. We
207 also excluded unanswered questions from the analyses. Level of significance was set
208 at $p < 0.05$.

209 **2.4 Ethics approval**

210 The study protocol was reviewed and approved by the Research Ethics Committee of
211 Harbin Medical University. Before the survey, approval was also obtained from each
212 school. All participants voluntarily and anonymously participated and provided their
213 written informed consent.

214 **3. Results**

215 Of the Year 1–5 students who responded to the demographic questions, 1,055 (42.4%)
216 were male, and 1,435 (57.4%) were female. Response rates varied between cohorts
217 (from first to fifth-years): 399 (16%); 483 (19.3%); 587 (23.5%); 746 (29.9%); 283
218 (11.3%) (Table 1).

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2
3 219 Table 2 summarizes safety culture perceptions, by survey domain, for the combined
4
5 220 group and the four subgroups. The overall highest scores were for, ‘patient safety
6
7 221 training received’, ‘patient involvement in reducing errors’, ‘I have a good
8
9 222 understanding of patient safety issues as a result of my undergraduate medical
10
11 223 training’, and ‘patients have an important role in preventing medical errors’. The
12
13 224 lowest average domain scores were for, ‘professional incompetence as an error cause’,
14
15 225 ‘disclosure responsibility’, ‘medical errors are a sign of incompetence’, and ‘it is not
16
17 226 necessary to report errors, which do not result in adverse outcomes for the patient’.

18 227 Specific to each medical institution, the highest level of positive safety perceptions
19
20 228 was from Mudanjiang Medical College, with the highest score for the ‘patient safety
21
22 229 training received’ domain. Jiamusi Medical College was second with their highest
23
24 230 domain score for ‘working hours as an error cause’. Qiqihar Medical University
25
26 231 reported their highest score for ‘patient involvement in reducing errors’. The lowest
27
28 232 score among these three institutions was for ‘professional incompetence as an error
29
30 233 cause’. The lowest positive patient safety perceptions came from Harbin Medical
31
32 234 University, with their highest domain score for ‘patient safety training received’, and
33
34 235 their lowest score for ‘error reporting confidence’. There was a statistically significant
35
36 236 difference between schools on responses to all nine key patient safety factors.

37 237 Table 3 summarizes safety culture perceptions based on survey domains for the
38
39 238 combined group and for the five subgroups. The table displays results sorted by safety
40
41 239 domain score. Perceptions of patient safety culture varied based on cohort. All five
42
43 240 cohorts had a positive perception of ‘patient safety training received’ and ‘patient
44
45 241 involvement in reducing errors’. Moreover, first and second-year students’ perceptions
46
47 242 of ‘working hours as an error cause’ were high. Third-year students had a better
48
49 243 awareness of ‘team functioning’. In addition to the aforementioned domains, fourth
50
51 244 and fifth-year students also had a deep understanding of ‘error inevitability’. The
52
53 245 lowest scores were in the ‘professional incompetence as an error cause’ and
54
55 246 ‘importance of patient safety in the curriculum’ domains for all cohorts. There was a
56
57 247 significant difference ($p < 0.05$) between cohorts on responses to the factors ‘patient
58
59 248 safety training received’, ‘error reporting confidence’, ‘working hours as an error

249 cause', 'error inevitability', 'team functioning', 'patient involvement in reducing
250 errors', and 'importance of patient safety in the curriculum'.

251 **4. Discussion**

252 As patient safety is a top health care priority, all medical undergraduates should have
253 the necessary capacity to ensure minimal patient harm as they embark on their future
254 career. Education and training are key to achieving this goal [4]. As medical students
255 are an integral part of our future health care systems, their experiences during school
256 (and their perceptions of patient safety culture) have an important influence on their
257 attitudes toward patient safety and their behaviours within this domain [22]. Screening
258 perceptions in key areas regarding patient safety is an opportunity to improve clinical
259 acumen and future medical education. The present findings provide explicit medical
260 student perspectives relevant to critical clinical services. Such information can be
261 utilized by medical directors and clinical service supervisors for real-time assessment
262 while promoting a safety culture. The APSQ-III has a stable factor structure and
263 criterion validity; it can also distinguish between different student subgroups [12]. We
264 conducted the present study to demonstrate how the APSQ-III can identify differences
265 between different cohorts across several medical universities in Northeast China.

266 Overall, our study highlights that medical student opinions/evaluations regarding
267 patient safety cultures are positive [23]. Interestingly, although none of our
268 participants had received any formal teaching on the subject, students from all four
269 universities were more likely to report having been trained well in the subject (84.9%).
270 This finding is similar to that of a previous study by Gilberto Ka Kit Leung in Hong
271 Kong [12], and may be due to a common psychological phenomenon of escaping
272 responsibility among students in China, which refers to the notion that students in this
273 culture are struggling to cope with and protect themselves in an intensely hierarchical
274 environment. This means that not only are they afraid to tell the truth, but they also
275 fear the effects of doing so on teachers' evaluations of them. Many students do not
276 want to acknowledge errors or defects, and may be unwilling to report problems to
277 avoid poor evaluations or to fit in with their teams [4]. Thus, we may need to be more
278 vigilant to prevent this fear of exposing deficiencies.

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2
3 279 Compared with results from Leung, their three highest scores were for ‘working hours
4 280 as an error cause’, ‘error inevitability’, and ‘importance of patient safety in the
5 281 curriculum’. ‘Patient involvement in reducing error’ and ‘team functioning’ received
6 282 the lowest overall scores in that previous study [12]. In the present study, ‘patient
7 283 involvement in reducing errors’ and ‘patient safety training received’ were the most
8 284 positively endorsed domains, while ‘professional incompetence as an error cause’ and
9 285 ‘disclosure responsibility’ were strong barriers to positive student patient safety
10 286 perceptions. In contrast with students in Hong Kong, mainland students responded
11 287 positively to items relating to ‘patient involvement in reducing errors’. A possible
12 288 reason for this is that patients in Hong Kong must follow the arrangements made by
13 289 public medical institutions with regard to waiting lists, hospitalisation, and surgery, in
14 290 accordance with the process established for their illness. They can’t choose their
15 291 doctors for themselves, but are generally trusting of doctors and hospitals. In
16 292 mainland China, however, the patient’s understanding of their diagnosis and treatment
17 293 has been continuously improving, and the traditional medical model has gradually
18 294 been replaced by active patient participation [24]. The process of medical
19 295 decision-making is undertaken by the doctor and patient together, and the patient has
20 296 the right to choose their doctor independently. In addition, medical staff often
21 297 encourage patients and their families to participate in procedures relating to diagnosis
22 298 and treatment [25]. This may include encouraging patients or family members to
23 299 participate in examining the label on an infusion bottle for the name of the drug,
24 300 reading drug information, and so on. Furthermore, previous work has shown that
25 301 patient participation can reduce the occurrence of medical errors [26]. Therefore,
26 302 Chinese medical students have positive attitudes on the item.
27 303 Our study found that responses to the ‘professional incompetence as an error cause’
28 304 domain were negative, especially for the following items: ‘medical errors are a sign of
29 305 incompetence’ (32.5%), ‘medical students generally consider errors as inevitable’
30 306 (74.9%), and ‘even the most experienced and competent doctors make errors’ (84.3%);
31 307 however, the students lack a proper understanding regarding the reasons for errors.
32 308 Our results are similar to those of Moskowitz et al., who found that students in the US

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2
3 309 were uncertain what defined an error and what led to medical errors [19].
4
5 310 Medical students generally agreed that medical errors are caused by humans and a
6
7 311 sign of incompetence (32.5%). This shows that the present sample of medical students
8
9 312 lacked awareness regarding systematic errors. Long working hours and medical staff
10
11 313 incompetence were noted by several students as important reasons for errors. This
12
13 314 may indicate that the students were placing an emphasis on human factors resulting in
14
15 315 errors. This is in line with findings from a previous study involving Hong Kong
16
17 316 students in which a majority of students reported that ‘if they work hard, they can
18
19 317 eliminate errors’ was an effective strategy for preventing future errors [27]. These
20
21 318 findings could suggest a need for emphasizing the potential role of other factors (e.g.
22
23 319 system errors and procedural complexity) during the occurrence of medical errors.
24
25 320 Several students reported positive evaluations of their error reporting confidence, but
26
27 321 a punitive evaluation surrounding their responsibility in reporting (i.e. what and how
28
29 322 to report when witnessing a problem with patient care). Medical students’ high
30
31 323 confidence in reporting medical errors (74.9%) is similar to the results of a Turkish
32
33 324 study conducted by Karaoglu et al [28-29]. They found that 60.7% (n = 147) of
34
35 325 students stated that they would report an error to the hospital committee if they,
36
37 326 themselves, made a medical error. Furthermore, 68.6% (n = 166) of the students stated
38
39 327 that they would report a medical error they witnessed.
40
41 328 In Flin et al.’s study, the majority of students stated they would speak up about an
42
43 329 error. However, this result was a bit confusing, since students also endorsed the item,
44
45 330 ‘it is not necessary to report errors that do not result in adverse outcomes for the
46
47 331 patient’ (60.8%)[30]. More than 50% of students from the Medical College at Jiamusi
48
49 332 University agreed with this statement, as well. All members of the medical team,
50
51 333 including medical students, should be able to recognize unsafe conditions, report
52
53 334 errors, and improve error disclosure if not sufficiently conducted. This persistent
54
55 335 cultural change should contribute to the eradication of errors and reduce patient safety
56
57 336 concerns [31-33].
58
59 337 Several students agreed with the following statements: ‘my training is preparing me to
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338 understand the causes of medical errors’ (84.8%) and ‘I have a good understanding of

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2
3 339 patient safety issues as a result of my undergraduate medical training' (85.2%). This
4
5 340 illustrates that medical students have high expectations regarding patient safety
6
7 341 education, which is in line with the findings of Madigosky et al [34]. This US-based
8
9 342 study revealed that awareness of patient safety and medical errors can be increased
10
11 343 and sustained through the use of an experiential curriculum, which students rated as a
12
13 344 valuable experience [34-35].

14 345 Insights can also be gained from the similarities observed between the four medical
15
16 346 schools. The descending order of positive perceptions regarding patient safety cultures
17
18 347 from the four universities were as follows: Mudanjiang Medical University, the
19
20 348 Medical College of Jiamusi University, Qiqihar Medical University, and Harbin
21
22 349 Medical University. There was no evidence of different reporting practices between
23
24 350 the four medical schools. Yet, differences in local patient safety cultures, as well as
25
26 351 differences in students' social and cultural backgrounds, may be significant
27
28 352 contributing factors [31]. However, the present study design did not enable an
29
30 353 exploration of these factors; we could only determine focal aspects of future teaching.
31
32 354 For example, Mudanjiang Medical University, the Medical College of Jiamusi
33
34 355 University, and Qiqihar Medical University would likely target education toward the
35
36 356 classification, and underlying mechanisms of medical errors. In contrast, Harbin
37
38 357 Medical University might target confidence in error reporting as an area for
39
358 improvement.

40 359 Our results are counter to those from other countries. For example, Flin et al.'s study
41
42 360 in the UK found that the majority of first-year students reported 'medium low' or
43
44 361 'average' levels of knowledge regarding errors and patient safety issues [36-40]. Our
45
46 362 results revealed that positive perceptions of patient safety culture tended to decrease
47
48 363 from younger to older cohorts. As seen in Table 3, more senior students appeared to
49
50 364 have less positive perceptions of 'error reporting confidence' and 'the importance of
51
52 365 patient safety in the curriculum'. Possible reasons include their experience of working
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54 366 in strong clinical hierarchies, which is known to have a negative influence on error
55
56 367 reporting and disclosure of medical errors [41]. It is likely that this decrease in
57
58 368 medical error disclosure emerges as result of the increasing awareness and more

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3 369 realistic self-assessment that students develop during the process of medical education
4
5 370 [42]. It could also be the result of inadequate training and preparation of young
6
7 371 doctors. Additionally, more senior students appeared to have less positive perceptions
8
9 372 of 'the importance of patient safety in the curriculum'. A possible reason for this is
10
11 373 that from the first grade to the fifth grade in the university, with the increasing number
12
13 374 of courses and pressure of examinations, students do not want to add new courses to
14
15 375 the curriculum. However, the underlying reason for this state remains to be
16
17 376 established.

18 377 One of the limitations of this study is a possible non-response bias. Students who
19
20 378 agreed to respond to the survey may have been more likely than their non-responding
21
22 379 peers to be interested in patient safety. This greater level of interest may have led to
23
24 380 inflation of attitude ratings. Another limitation is that the study made use of a
25
26 381 non-standardised survey instrument. Nevertheless, this is the first use of the APSQ-III
27
28 382 to compare patient safety cultures in different schools and cohorts within mainland
29
30 383 China. While the present sample was taken from only one region in China, we
31
32 384 covered almost all of the medical colleges within a rather large province. Furthermore,
33
34 385 we recruited a cohort of medical students across five years of their programs. Thus,
35
36 386 the present study represents an important first step toward patient safety education
37
38 387 research in China. We believe that our findings can help educators develop curricula
39
40 388 for patient safety education.

41 389 In conclusion, our study researched perceptions of patient safety culture among
42
43 390 medical students in China. Our results further suggest that medical students'
44
45 391 perceptions regarding patient safety cultures can provide a tool for guiding medical
46
47 392 education. Institutions should have an increased emphasis on issues related to the
48
49 393 reasons behind medical errors and error reporting. Shifts in patient safety cultures
50
51 394 should be based on situations affecting different schools and cohorts, especially
52
53 395 among third-year medical students. Longitudinal studies using a validated instrument
54
55 396 should also be conducted to better evaluate patient safety education programs and
56
57 397 their relative impact on local healthcare development. Further studies should explore
58
59 398 the culture of reporting errors and how students in nursing and healthcare profession

399 programs address these errors.

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523
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525 Mingli Jiao, Qunhong Wu, Ying Li and He Liu. designed the study; Jinghua Liu, Limin
 526 Liu, Yanming Zhao, Kexin Jiang, Huiying Fang, Peihang Sun, Peng Li, Yameng Wang,
 527 Haonan Jia and Yan Lu collected the data; He Liu, Ying Li, and Yuming Wu analysed
 528 the data; He Liu, Ying Li, Mingli Jiao, Siqi Zhao drafted the manuscript; and Mingli
 529 Jiao contributed to the manuscript's revision. All authors approved the final
 530 manuscript for publication.

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532 **Data sharing statement:** Data are available from the corresponding author upon
 533 request.

534
 535 Table 1. Participant demographic characteristics.

subgroups	No. (%) of respondents							Overall
	Gender		Level					
	M	F	First Year	Second Year	Third year	Fourth year	Fifth Year	
A*	322 (44.4)	404 (55.6)	111 (15.3)	132 (18.2)	154 (21.2)	245 (33.7)	84 (11.6)	726 (29.1)
B*	261 (41.7)	366 (58.3)	186 (29.5)	146 (23.1)	117 (18.5)	100 (15.8)	82 (13)	631 (25.3)
C*	167	292	36	115	110	131	67	459

	(36.4)	(63.6)	(7.8)	(25.1)	(24)	(28.5)	(14.6)	(18.4)
	305	377	66	90	206	270	50	682
D*	(45)	(55)	(9.7)	(13.2)	(30.2)	(39.6)	(7.3)	(27.3)
	1055	1435	399	483	587	746	283	
Total	(42.4)	(57.4)	(16)	(19.3)	(23.5)	(29.9)	(11.3)	2498

536 *A = Harbin Medical University.

537 *B = Qiqihar Medical University.

538 *C = MuDanjiang Medical University.

539 *D = Medical College of Jiamusi University.

540

541 Table 2. Items from the APSQ-III that demonstrated significant differences between
542 the four medical universities.

Domain	Positive responses (%) [†]				
	Over all	Between schools			
		A*	B*	C*	D*
Patient safety training received	84.9	57.3	90.4	99.4	98.5
1. My training is preparing me to understand the causes of medical errors.	84.8	56.6	89.7	99	99
2. I have a good understanding of patient safety issues as a result of my undergraduate medical training.	85.2	58.4	90.2	99.8	97
3. My training is preparing me to prevent medical errors.	84.7	56.8	90.1	99.3	99.4
error reporting confidence	74.9	53.1	75.8	85.6	88.1

4. I would feel comfortable reporting any errors I had made, no matter how serious the outcome had been for the patient.	71.6	52.	68.	80.	85.7
		9	5	5	
5. I would feel comfortable reporting any errors other people had made, no matter how serious the outcome had been for the patient.	76.7	53.	79.	88.	89.5
		4	8	1	
6. I am confident I can talk openly to my supervisor about an error I had made, even if it resulted in potential or actual harm to my patient.	76.5	53.	79	88.	89.2
		1		1	
working hours as an error cause	83.4	56.	88.	98	98.7
		2	2		
7. Shorter shifts for doctors will reduce medical errors.	81.7	53.	85.	97.	97.3
		9	9	1	
8. By not taking regular breaks during shifts, doctors are at an increased risk of making errors.	84.7	57.	89.	98.	99.5
		8	8	9	
9. The number of hours doctors work increases the likelihood of making medical errors.	83.8	56.	89	97.	99.4
		8		9	
error inevitability	74.9	55.	80.	87.	82.2
		2	9	1	
10. Even the most experienced and competent doctors make errors.	84.3	56.	89.	99.	98.7
		7	4	8	
11. A true professional does not make mistakes or errors.	68.9	53	79.	86.	64.8
			3	1	
12. Human error is inevitable.	71.6	56	73.	75.	83.2
			9	4	
professional incompetence as an error cause	58.4	53.	59.	61	60
		25	6		
13. Most medical errors result from careless nurses [†]	68.1	56.	79	79.	62.1
		8		3	

14. If people paid more attention at work, medical errors would be avoided [†]	67.2	53.	62.	72.	80.1
		2	5	8	
15. Most medical errors result from careless doctors [†]	65.8	55.	74.	77.	61.4
		1	2	1	
16. Medical errors are a sign of incompetence [†]	32.5	47.	22.	14.	36.5
		9	7	7	
disclosure responsibility	69.4	55.	72.	78.	74.8
		1	6	4	
17. It is not necessary to report errors which do not result in adverse outcomes for the patient [†]	60.8	57.	70.	69.	48.8
		6	7	8	
18. Doctors have a responsibility to disclose errors to patients only if the errors result in patient harm.	80.8	55	85.	93.	94.5
			2	8	
19. All medical errors should be reported.	66.7	52.	61.	71.	81
		6	9	6	
team functioning	76.9	55.	77.	87.	91.8
		7	5	6	
20. Better multidisciplinary teamwork will reduce medical errors.	69.2	54.	64.	75.	84.5
		9	5	4	
21. Teaching students teamwork skills will reduce medical errors.	84.7	56.	90.	99.	99.1
		6	5	8	
patient involvement in reducing errors	84.7	56.	90.	99.	98.7
		7	2	4	
22. Patients have an important role in preventing medical errors.	85.1	56.	90.	99.	98.6
		1	5	5	
23. Encouraging patients to be more involved in their care can help to reduce the risk of medical errors occurring.	84.5	57.	90	99.	98.8
		3		3	
importance of patient safety in the curriculum	71.6	56.	78.	82.	74.4
		4	5	4	

24. Teaching students about patient safety should be an important priority in medical students' training.	84.1	55.9	89.5	99.1	98.6
25. Patient safety issues cannot be taught; they can only be learned through clinical experience, which is gained when one is qualified.	46.6	55.8	55.4	50.4	25.3
26. Learning about patient safety issues before I qualify will enable me to become a more effective doctor.	85.5	57.7	90.3	99.3	99.4

543 *A = Harbin Medical University.

544 *B = Qiqihar Medical University.

545 *C = MuDanJiang Medical University.

546 *D = Medical College of Jiamusi University.

547 ‡ Positive responses are those with 'agree' or 'strongly agree'. The denominator for
548 each question may vary because not every student responded to every question in the
549 survey.

550 † Negatively worded item, where the percent positive response is based on those who
551 responded, 'strongly disagree' or 'disagree.'

552

553 Table 3. Items on the APSQ-III that demonstrated significant differences between the
554 five cohorts.

S	Positive responses (%) [†]									
	h	Patient	Error	Work	Professi	Disc	Tea	Patient	Importa	
o	des	safety	reportin	ing	onal	losu	m	involve	nance of	
o	l	training	g	hours	inevi	re	fun	ment in	patient	
s	l	received	confide	as an	tabil	respo	ctio	reducin	safety	
		*	nance*	error	ty*	ansi	nin	g errors*	in the	
				cause	an error	bilit	g*		curricul	
				*	cause	y			um*	
A	first	78.6	73.4	79.7	71.9	56.6	66.4	73.	80.8	50.7

							9			
	second	74.3	62.9	74.4	71.4	56	66.6	64	71.9	49.8
	third	57.1	52.9	56.2	52.8	51.9	51.4	57.5	55.1	41.5
	fourth	43.1	40	40.5	45.4	51.1	48.7	42.7	42.8	37.6
	fifth	45.2	46.4	42.6	41.1	51.8	46.6	51.2	42.7	33.7
	first	99.4	84.7	95.8	86	61.5	78.2	84.1	98.9	62.6
	second	97.2	86.8	95	91.1	66.3	78.5	87	99.1	59.8
B	third	98	72.7	95.9	83.8	59.2	63.3	81.3	100	63.5
	fourth	98.9	86.5	97.3	84.4	60.9	77.5	78.8	97.3	63.5
	fifth	61.4	51.9	61.2	61.6	51.5	57.4	56.1	58.7	47.2
	first	99.1	90.3	96.1	91.9	62	84.1	86.4	98.2	63.5
	second	99.6	90.3	98.3	84.2	63.6	81.2	81.1	99.5	63.2
C	third	100	83.4	97.9	87.1	60.7	78.2	91	100	59.3
	fourth	97	77.9	96.9	86.9	60	75.2	87.2	95.7	66.5
	fifth	99.7	79.9	99.4	85.2	58.5	70.9	92.6	100	58.2

								90.		
	first	99.1	87.1	99.2	86	63.3	72.7	2	97.1	56.7
	second	98.5	88.7	99.2	83.2	61.3	77.5	91	98.2	54.6
D	third	97.1	87.2	97.2	82.9	59.9	74.8	89.	99.2	57.8
	fourth	100	96.1	100	74.2	52.3	67	97.	100	52.4
	fifth	100	78	100	79.3	41	74.9	100	100	65.1
O	first	93.5	82.5	91.7	82.7	60.4	74.4	82.	93.5	58.1
	second	91.9	81.6	90.9	82.6	61.9	75.8	79.	91.5	56.9
r	third	87.4	74.6	86.4	76	57.8	67	79.	87.9	54.9
a	fourth	80.7	73.2	79.5	68.2	54.4	63.9	75.	80	51.5
l	fifth	72.4	61.8	71.7	64.7	51.6	60.4	71	71	49.1

555 *P<0.05

556 *A = Harbin Medical University.

557 *B = Qiqihar Medical University.

558 *C = MuDanJiang Medical University.

559 *D = Medical College of Jiamusi University.

560 † Positive responses are those who responded, 'agree' or 'strongly agree.' The
 561 denominator for each question may vary because not every student responded to every
 562 question in the survey.

STROBE Statement—Checklist of items that should be included in reports of *cross-sectional studies*

	Item No	Recommendation	Reported on page #
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	1
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3-6
Objectives	3	State specific objectives, including any prespecified hypotheses	6
Methods			
Study design	4	Present key elements of study design early in the paper	6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants	6
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6
Data sources/measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	6-7
Bias	9	Describe any efforts to address potential sources of bias	6
Study size	10	Explain how the study size was arrived at	6
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6-7
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	7
		(b) Describe any methods used to examine subgroups and interactions	6
		(c) Explain how missing data were addressed	6
		(d) If applicable, describe analytical methods taking account of sampling strategy	6
		(e) Describe any sensitivity analyses	
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	7-8, 18-19
		(b) Give reasons for non-participation at each stage	
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	7
		(b) Indicate number of participants with missing data for each variable of interest	6, 18-19
Outcome data	15*	Report numbers of outcome events or summary measures	6-9
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted	

		estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	
		(b) Report category boundaries when continuous variables were categorized	
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	
Discussion			
Key results	18	Summarise key results with reference to study objectives	9-12, 18-24
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	13
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	13
Generalisability	21	Discuss the generalisability (external validity) of the study results	13
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	17-18

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Perceptions of patient safety culture among medical students: A cross-sectional investigation in Heilongjiang Province, China

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3 **1 Perceptions of patient safety culture among medical students: A cross-sectional**
4 **2 investigation in Heilongjiang Province, China**
5

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1
2
3 **Abstract**
4

5 **Objectives:** Medical school education plays an important role in promoting patient
6 safety. The present study aimed to assess medical students' perceptions of patient
7 safety culture, and to identify the educational needs of these students and provide
8 evidence on the most important content for a curriculum relating to patient safety.
9
10

11 **Method:** A cross-sectional study was conducted within each of the four medical
12 universities in Heilongjiang province. First through fifth-year medical students
13 completed an anonymous questionnaire—the Attitudes toward Patient Safety
14 Questionnaire III (APSQ-III). Differences in responses across the four universities
15 and cohorts were analysed.
16
17

18 **Results:** Overall perceptions of patient safety cultures across the four medical
19 universities were positive. The highest positive response rate was for, 'I have a good
20 understanding of patient safety issues because of my undergraduate medical training'
21 (range: 58.4%–99.8%), while the lowest positive response rate was for, 'medical
22 errors are a sign of incompetence' (14.7%–47.9%).
23
24

25 Younger cohorts had a better awareness of working hours and teamwork. However,
26 fourth and fifth-year students had a better awareness of error inevitability. The lowest
27 positive scores between cohorts included items related to 'professional incompetence
28 as an error cause' and 'disclosure responsibility'.
29
30

31 **Conclusions:** Students' self-assessment of patient safety culture were positive,
32 although none of students had received any formal curriculum content on patient
33 safety. Policy makers should place a greater focus on varied educational needs across
34 schools and cohorts to establish proper curricula.
35
36

37 **Keywords:** medical education, patient safety, medicine students
38
39

40 **Strengths and limitations of this study**
41

42 Strengths:
43

- 44
- 45 ● This is the first use of the APSQ-III to compare patient safety in different schools
46 and cohorts within a developing country (China)
 - 47 ● We covered almost all of the medical colleges within a rather large province
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3 ● This study provides the necessary evidence for educators to design future
4 interventions and create a sense of focus on patient safety in medical education
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7 Limitations:

- 8 ● APSQ-III is a new instrument, the reliability and validity of which have not yet
9 been retested
10
11 ● Our study is limited by the potential for non-response bias. Students who
12 responded to the survey may have been more likely than their peers to be
13 interested in patient safety, which may have led to inflation of the attitude ratings
14
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17

18 1. Introduction

19 Hippocrates, who is considered the ‘father of medicine’, proposed the ‘Hippocratic
20 Oath’. Medical students take this oath worldwide to promote a rigorous and
21 enthusiastic attitude toward medical education. Hence, the maintenance and promotion
22 of patient safety is of utmost importance.
23

24 However, as noted a decade ago by the Institute of Medicine (IOM), accountability
25 for patient safety requires a multi-layered approach—one that addresses system errors
26 as well as human ones—to help prevent medical errors [1-3]. Advancements in patient
27 safety require a fundamental culture change in healthcare. Reducing harm through an
28 improved safety culture is a global priority [2]. Policy makers, payers, and groups
29 (such as the Agency for Healthcare, Research, and Quality (AHRQ), National Patient
30 Safety Agency, and World Health Organization) have developed numerous safety
31 initiatives at the national and institutional level [4]. However, most measures have
32 targeted doctors, managers, and other health care professionals. Less attention has
33 been paid to medical students, the next generation of medical scientists [5].
34

35 The clinical practice stage is key for acquiring practical skills among medical students,
36 at which point the student begins to shift roles from ‘student’ to ‘doctor’. To protect
37 the rights of teachers and medical students and the interests of patients, and to ensure
38 the quality of medical education, the National Health and Family Planning
39 Commission and the Ministry of Education of the People’s Republic of China develop
40 clear regulatory requirements for medical students and medical graduates in clinical
41 trial practice. While clinical teachers bear legal responsibility for medical disputes due
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3 99 to incorrect guidance, when medical students conduct clinical treatment activities
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5 100 without the permission of the clinical teacher, individuals bear the corresponding legal
6
7 101 responsibility.

8
9 102 There is now a growing awareness that students are influenced not only by what is
10
11 103 taught in the formal curriculum, but also by unspoken, powerful messages conveyed
12
13 104 through interactions with superiors and educators during students' clinical practice
14
15 105 [6-8]. For example, although students are taught to wash their hands before interacting
16
17 106 with patients, it is not until they witness doctors engaging in this behaviour within a
18
19 107 clinical setting that this requirement is truly understood.

20
21 108 One of the medical teachers from Harbin Medical University said that the main
22
23 109 purpose of clinical practice is to form proper 'clinical thinking'. This lays a solid
24
25 110 foundation for the student's future work. My teachers not only provided us with
26
27 111 knowledge but exemplars of proper work ethic and style. Thus, I am attempting to
28
29 112 pass on these characteristics to students.

30
31 113 Medical school curricula need to be strengthened to comprehensively advocate safety
32
33 114 training. Work within this 'hidden curriculum' can deal with students who may engage
34
35 115 in or be taught practices that oppose content from the formal curriculum, professional
36
37 116 values, and even safe patient care. During pressure situations, such as those
38
39 117 experienced during emergencies, doctors can be challenged with making proper
40
41 118 decisions in a timely fashion, which could be an enormous threat to patient safety [9].

42
43 119 Therefore, the nation's medical schools, teaching hospitals, and health systems
44
45 120 recognize that achieving greater patient safety requires more than a brief course in an
46
47 121 already crowded medical school curriculum. There is a need for a fundamental culture
48
49 122 change across all phases of medical education. [10].

50
51 123 Some scholars have addressed issues related to improved patient safety. For instance,
52
53 124 we previously observed that open communication, non-punitive responses to errors,
54
55 125 and professionalism are key areas of concern regarding medical students' perceptions
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57 126 of the patient safety culture [11]. Leung investigated perspectives of the patient safety
58
59 127 culture among medical students in Hong Kong and Singapore and compared students'
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128 educational needs. However, the study only surveyed two cohorts of second-year

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3 129 medical students, and it did not consider students in different years of medical school.
4
5 130 [12].

6
7 131 Patient safety education in areas with low medical standards and high medical risks,
8
9 132 as is the case in developing countries like China, is in its infancy [13]. While a few
10
11 133 reports have explored safety education content and teaching methods in China [14],
12
13 134 patient safety education has not been fully implemented within curricula and clinical
14
15 135 practice. Ensuring the safety of patients is the primary task of medical staff. Medical
16
17 136 students should have the capacity to ensure the safety of patients in the process of
18
19 137 pursuing a medical career in the future. Patient safety education for medical students
20
21 138 is to curb or reduce medical errors from the source and to promote patient safety. [13].
22
23 139 The first important question, then, is to determine what knowledge medical students
24
25 140 are specifically lacking. Additionally, information is needed regarding cognitive
26
27 141 components of students' perceptions of patient safety culture. Finally, we need to
28
29 142 assess students' explicit educational needs and what should be focused upon within a
30
31 143 patient safety curriculum. Understanding these various components are the first steps
32
33 144 in providing patient safety education.

34
35 145 Low levels of hospital management, limited personal technology, and other issues are
36
37 146 prevalent in developing countries; therefore, patient safety problems tend to be more
38
39 147 serious than what is observed in developed countries [15]. Addressing safety
40
41 148 education for medical students in developing countries is particularly urgent. The
42
43 149 WHO Director General, Margaret Chan, highlighted patient safety as a key task going
44
45 150 forward [16]. This led to the publication of a Chinese version of the 'WHO Patient
46
47 151 Safety Course Guide' in July 2012 in support of a resolution from the Ministry of
48
49 152 Health (National Health and Family Planning Commission of the People's Republic
50
51 153 of China).

52
53 154 Heilongjiang province, as the healthcare centre of Northeast China, has the largest
54
55 155 area and availability of health resources, and it has more than 30 million people [17],
56
57 156 while Harbin Medical University has the best educational reputation with the most
58
59 157 stringent entrance requirements. Qiqihar Medical University, Mudanjiang Medical
60
158 University, and the Medical College of Jiamusi University are also prominent (along

1
2
3 159 with their three-level hospitals) in Heilongjiang province. The four medical schools
4
5 160 provide medical and health service personnel training for the province. The medical
6
7 161 students as the future medical workers trained by the medical schools in the region
8
9 162 need to bear some pressure and mission. However, there are few studies on patient
10
11 163 safety culture of medical students. Understanding the baseline patient safety culture,
12
13 164 and identifying important and urgent educational needs, is critical for the effective
14
15 165 design and successful implementation of education programs at Heilongjiang's
16
17 166 medical institutions. Consequently, we evaluated patient safety culture from students'
18
19 167 perspectives. This was done to explore factors critical to transforming patient safety
20
21 168 perspectives and address students' educational needs.

21 169 **2. Methods**

22 170 **2.1 Sampling and Data collection**

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24
25 171 In 2014, a cross-sectional survey was conducted with four medical schools in
26
27 172 Heilongjiang province. Cooperation was obtained from managers in the student
28
29 173 offices. Some schools offered courses in doctor-patient relations and evidence-based
30
31 174 medicine, but there was no dedicated and systematic patient safety course. None of
32
33 175 the students had received any prior formal teaching on patient safety, enabling a
34
35 176 baseline assessment of safety culture among these students. We used systematic
36
37 177 random sampling to select 800 clinical medical students from a roster of all medical
38
39 178 undergraduates at each school. We provided these students with detailed explanations
40
41 179 of the objective of this investigation; some students expressed interest in participating
42
43 180 in the survey, while others declined to participate. Students who were willing to
44
45 181 participate in the investigation were given two days to complete the questionnaire
46
47 182 anonymously; they were asked to then return it to a box provided in a counsellor's
48
49 183 office. Respondents' names and other identifiers were not collected. Using this
50
51 184 procedure, we obtained 2498 valid questionnaires (total response rate: 78.1%). Of the
52
53 185 students who participated, 726 (response rate: 90.8%) came from Harbin Medical
54
55 186 University, 631 (78.9%) from Qiqihar Medical University, 459 (57.4%) from
56
57 187 Mudanjiang Medical University, and 682 (85.3%) from the Medical College of
58
59 188 Jiamusi University.

189 2.2 Questionnaire

190 We used the Attitudes toward Patient Safety Questionnaire III (APSQ-III) [12,18-21],
191 which was specifically designed for students and covers nine key factors related to
192 patient safety culture. The APSQ-III assesses several factors regarding patient safety
193 culture, rather than examining differences in patient safety education. Therefore, this
194 measure can more accurately reflect realistic educational needs [12].

195 The questionnaire consists of 26 items covering nine key patient safety factors:

- 196 (a) patient safety training received (items 1–3);
- 197 (b) error reporting confidence (items 4–6);
- 198 (c) working hours as an error cause (items 7–9);
- 199 (d) error inevitability (items 10–12);
- 200 (e) professional incompetence as an error cause (items 13–16);
- 201 (f) disclosure responsibility (items 17–19);
- 202 (g) team functioning (items 20 and 21);
- 203 (h) patient involvement in reducing error (items 22 and 23);
- 204 and (i) importance of patient safety in the curriculum (items 24–26).

205 2.3 Data analyses

206 Responses were recorded on a five-point Likert scale, with 5 = strongly agree and 1 =
207 strongly disagree. Responses were grouped into agree (i.e. 4 or 5) and disagree (i.e. 1
208 or 2), and overall percentages were obtained [12]. An analysis of variance was used to
209 compare the rate of positive responses between students in different years of medical school.
210 We also excluded unanswered questions from the analyses. Level of significance was
211 set at $p < 0.05$.

212 2.4 Ethics approval

213 The study protocol was reviewed and approved by the Research Ethics Committee of
214 Harbin Medical University. Before the survey, approval was also obtained from each
215 school. All participants voluntarily and anonymously participated and provided their
216 written informed consent.

217 3. Results

218 Of the Year 1–5 students who responded to the demographic questions, 1,055 (42.4%)

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2
3 219 were male, and 1,435 (57.4%) were female. Response rates varied between cohorts
4
5 220 (from first to fifth-years): 399 (16%); 483 (19.3%); 587 (23.5%); 746 (29.9%); 283
6
7 221 (11.3%) (Table 1).

8
9 222 Table 2 summarizes safety culture perceptions, by survey domain, for the combined
10
11 223 group and the four subgroups. The overall highest scores were for, 'patient safety
12
13 224 training received', 'patient involvement in reducing errors', 'I have a good
14
15 225 understanding of patient safety issues as a result of my undergraduate medical
16
17 226 training', and 'patients have an important role in preventing medical errors'. The
18
19 227 lowest average domain scores were for, 'professional incompetence as an error cause',
20
21 228 'disclosure responsibility', 'medical errors are a sign of incompetence', and 'it is not
22
229 necessary to report errors, which do not result in adverse outcomes for the patient'.

23
24 230 Specific to each medical institution, the highest level of positive safety perceptions
25
26 231 was from Mudanjiang Medical College, with the highest score for the 'patient safety
27
28 232 training received' domain. Jiamusi Medical College was second with their highest
29
30 233 domain score for 'working hours as an error cause'. Qiqihar Medical University
31
32 234 reported their highest score for 'patient involvement in reducing errors'. The lowest
33
34 235 score among these three institutions was for 'professional incompetence as an error
35
36 236 cause'. The lowest positive patient safety perceptions came from Harbin Medical
37
38 237 University, with their highest domain score for 'patient safety training received', and
39
40 238 their lowest score for 'error reporting confidence'. There was a statistically significant
41
42 239 difference between schools on responses to all nine key patient safety factors.

43
44 240 Table 3 summarizes safety culture perceptions based on survey domains for the
45
46 241 combined group and for the five subgroups. The table displays results sorted by safety
47
48 242 domain score. Perceptions of patient safety culture varied based on cohort. All five
49
50 243 cohorts had a positive perception of 'patient safety training received' and 'patient
51
52 244 involvement in reducing errors'. Moreover, first and second-year students' perceptions
53
54 245 of 'working hours as an error cause' were high. Third-year students had a better
55
56 246 awareness of 'team functioning'. In addition to the aforementioned domains, fourth
57
58 247 and fifth-year students also had a deep understanding of 'error inevitability'. The
59
60 248 lowest scores were in the 'professional incompetence as an error cause' and

1
2
3 249 'importance of patient safety in the curriculum' domains for all cohorts. Table 4 shows
4
5 250 that there was a significant difference ($p < 0.05$) between cohorts on responses to the
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7 251 factors 'patient safety training received', 'error reporting confidence', 'working hours
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9 252 as an error cause', 'error inevitability', 'team functioning', 'patient involvement in
10
11 253 reducing errors', and 'importance of patient safety in the curriculum'.

12 254 **4. Discussion**

13
14 255 As patient safety is a top health care priority, all medical undergraduates should have
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16 256 the necessary capacity to ensure minimal patient harm as they embark on their future
17
18 257 career. Education and training are key to achieving this goal [4]. As medical students
19
20 258 are an integral part of our future health care systems, their experiences during school
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22 259 (and their perceptions of patient safety culture) have an important influence on their
23
24 260 attitudes toward patient safety and their behaviours within this domain [22]. Screening
25
26 261 perceptions in key areas regarding patient safety is an opportunity to improve clinical
27
28 262 acumen and future medical education. The present findings provide explicit medical
29
30 263 student perspectives relevant to critical clinical services. Such information can be
31
32 264 utilized by medical directors and clinical service supervisors for real-time assessment
33
34 265 while promoting a safety culture. The APSQ-III has a stable factor structure and
35
36 266 criterion validity; it can also distinguish between diverse student subgroups [12]. We
37
38 267 conducted the present study to demonstrate how the APSQ-III can identify differences
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40 268 between different cohorts across several medical universities in Northeast China.

41 269 Overall, our study highlights that medical student opinions/evaluations regarding
42
43 270 patient safety cultures are positive [23]. Interestingly, although none of our
44
45 271 participants had received any formal teaching on the subject, students from all four
46
47 272 universities were more likely to report having been trained well in the subject (84.9%).
48
49 273 This finding is similar to that of a previous study by Leung in Hong Kong [12], who
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51 274 revealed that the result could be due to students' misunderstanding or an inability to
52
53 275 distinguish teaching from what had been learned from the public media. We believe
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55 276 that this may be due to a common psychological phenomenon of escaping
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57 277 responsibility among students in China, which refers to the notion that students in this
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59 278 culture are struggling to cope with and protect themselves in an intensely hierarchical

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3 279 environment. This means that not only are they afraid to tell the truth, but they also
4
5 280 fear the effects of doing so on teachers' evaluations of them. Many students do not
6
7 281 want to acknowledge errors or defects, and they may be unwilling to report problems
8
9 282 to avoid poor evaluations or to fit in with their teams [4]. Therefore, more attention
10
11 283 must be paid to the phenomenon of reluctance to “speak up” in Chinese culture and
12
13 284 more vigilance is required to prevent this fear of exposing deficiencies.

14
15 285 Compared with results from Leung, their three highest scores were for ‘working hours
16
17 286 as an error cause’, ‘error inevitability’, and ‘importance of patient safety in the
18
19 287 curriculum’. ‘Patient involvement in reducing error’ and ‘team functioning’ received
20
21 288 the lowest overall scores in that previous study [12]. In the present study, ‘patient
22
23 289 involvement in reducing errors’ and ‘patient safety training received’ were the most
24
25 290 positively endorsed domains, while ‘professional incompetence as an error cause’ and
26
27 291 ‘disclosure responsibility’ were strong barriers to positive student patient safety
28
29 292 perceptions. In contrast with students in Hong Kong, mainland students responded
30
31 293 positively to items relating to ‘patient involvement in reducing errors’. A probable
32
33 294 reason for this is that patients in Hong Kong must follow the arrangements made by
34
35 295 public medical institutions regarding waiting lists, hospitalisation, and surgery, in
36
37 296 accordance with the process established for their illness. They cannot choose their
38
39 297 doctors for themselves; however, they are generally trusting of doctors and hospitals.
40
41 298 In mainland China, however, the patient's understanding of their diagnosis and
42
43 299 treatment has been continuously improving, and the traditional medical model has
44
45 300 gradually been replaced by active patient participation [24]. The doctor and patient
46
47 301 undertake the process of medical decision-making together, and the patient has the
48
49 302 right to choose their doctor independently. In addition, medical staff often encourage
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51 303 patients and their families to participate in procedures relating to diagnosis and
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53 304 treatment [25]. This may include encouraging patients or family members to
54
55 305 participate in examining the label on an infusion bottle for the name of the drug,
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57 306 reading drug information, and so on. Furthermore, previous work has shown that
58
59 307 patient participation can reduce the occurrence of medical errors [26]; therefore,

1
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3 308 Chinese medical students have positive attitudes on the item.
4
5 309 Our study found that responses to the ‘professional incompetence as an error cause’
6
7 310 domain were negative, especially for the following items: ‘medical errors are a sign of
8
9 311 incompetence’ (32.5%), ‘medical students generally consider errors as inevitable’
10
11 312 (74.9%), and ‘even the most experienced and competent doctors make errors’ (84.3%);
12
13 313 however, the students lack a proper understanding regarding the reasons for errors.
14
15 314 Our results are similar to those of Moskowitz et al., who found that students in the US
16
17 315 were uncertain what defined an error and what led to medical errors [19].
18
19 316 Medical students generally agreed that medical errors are caused by humans and a
20
21 317 sign of incompetence (32.5%). This shows that the present sample of medical students
22
23 318 lacked awareness regarding systematic errors. Long working hours and medical staff
24
25 319 incompetence were noted by several students as important reasons for errors. This
26
27 320 may indicate that the students were placing an emphasis on human factors resulting in
28
29 321 errors. This is in line with findings from a previous study involving Hong Kong
30
31 322 students, where most students reported that ‘if they work hard, they can eliminate
32
33 323 errors’ was an effective strategy for preventing future errors [27]. These findings
34
35 324 could suggest a need for emphasizing the potential role of other factors (e.g. system
36
37 325 errors and procedural complexity) during the occurrence of medical errors.
38
39 326 Several students reported positive evaluations of their error reporting confidence, but
40
41 327 a punitive evaluation surrounding their responsibility in reporting (i.e. what and how
42
43 328 to report when witnessing a problem with patient care). Medical students’ high
44
45 329 confidence in reporting medical errors (74.9%) is similar to the results of a Turkish
46
47 330 study conducted by Karaoglu et al [28-29]. They found that 60.7% (n = 147) of
48
49 331 students stated that they would report an error to the hospital committee if they,
50
51 332 themselves, made a medical error. Furthermore, 68.6% (n = 166) of the students stated
52
53 333 that they would report a medical error they witnessed.
54
55 334 In Flin et al.’s study, most students stated they would speak up about an error.
56
57 335 However, this result was a bit confusing, since students also endorsed the item, ‘it is
58
59 336 not necessary to report errors that do not result in adverse outcomes for the patient’
60
337 (60.8%)[30]. More than 50% of students from the Medical College at Jiamusi

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3 338 University agreed with this statement, as well. All members of the medical team,
4
5 339 including medical students, should be able to recognize unsafe conditions, report
6
7 340 errors, and improve error disclosure if not sufficiently conducted. This persistent
8
9 341 cultural change should contribute to the eradication of errors and reduce patient safety
10
11 342 concerns [31-33].

12 343 Several students agreed with the following statements: ‘my training is preparing me to
13
14 344 understand the causes of medical errors’ (84.8%) and ‘I have a good understanding of
15
16 345 patient safety issues because of my undergraduate medical training’ (85.2%). This
17
18 346 illustrates that medical students have grand expectations regarding patient safety
19
20 347 education, which is in line with the findings of Madigosky and colleagues [34]. This
21
22 348 US-based study revealed that awareness of patient safety and medical errors can be
23
24 349 increased and sustained using an experiential curriculum, which students rated as a
25
26 350 valuable experience [34-35].

27 351 Insights can also be gained from the similarities observed between the four medical
28
29 352 schools. The descending order of positive perceptions regarding patient safety cultures
30
31 353 from the four universities were as follows: Mudanjiang Medical University, the
32
33 354 Medical College of Jiamusi University, Qiqihar Medical University, and Harbin
34
35 355 Medical University. There was no evidence of different reporting practices between
36
37 356 the four medical schools. Yet, differences in local patient safety cultures, as well as
38
39 357 differences in students’ social and cultural backgrounds, may be significant
40
41 358 contributing factors [31]. However, the present study design did not enable an
42
43 359 exploration of these factors; we could only determine focal aspects of future teaching.
44
45 360 For example, Mudanjiang Medical University, the Medical College of Jiamusi
46
47 361 University, and Qiqihar Medical University would likely target education toward the
48
49 362 classification, and underlying mechanisms of medical errors. In contrast, Harbin
50
51 363 Medical University might target confidence in error reporting as an area for
52
53 364 improvement.

54 365 Our results are counter to those from other countries. For example, Flin et al.’s study
55
56 366 in the UK found that most first-year students reported ‘medium low’ or ‘average’
57
58 367 levels of knowledge regarding errors and patient safety issues [36-40]. Our results

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2
3 368 revealed that positive perceptions of patient safety culture tended to decrease from
4 369 younger to older cohorts. As seen in Table 3, more senior students appeared to have
5 370 less positive perceptions of ‘error reporting confidence’ and ‘the importance of patient
6 371 safety in the curriculum’. Possible reasons include their experience of working in
7 372 strong clinical hierarchies, which is known to have a negative influence on error
8 373 reporting and disclosure of medical errors [41]. It is likely that this decrease in
9 374 medical error disclosure emerges as result of the increasing awareness and more
10 375 realistic self-assessment that students develop during the process of medical education
11 376 [42]. It could also be the result of inadequate training and preparation of young
12 377 doctors. Additionally, more senior students appeared to have less positive perceptions
13 378 of ‘the importance of patient safety in the curriculum’. A likely reason for this is that
14 379 from the first grade to the fifth grade in university, with the increasing number of
15 380 courses and pressure of examinations, students do not want to add new courses to the
16 381 curriculum. However, the underlying reason for this remains to be established.

17 382 One of the limitations of this study is a possible non-response bias. Students who
18 383 agreed to respond to the survey may have been more likely than their non-responding
19 384 peers to be interested in patient safety. This greater level of interest may have led to
20 385 inflation of attitude ratings. Another limitation is that the study made use of a
21 386 non-standardised survey instrument, and that the APSQ-III is a self-assessment
22 387 questionnaire which addresses students' self-assessment of patient safety culture
23 388 rather than the actual teachings provided. Therefore, the present results may not be
24 389 indicative of students' actual skills and knowledge. Moreover extrapolation of the
25 390 findings to other medical colleges should be done with caution. Nevertheless, this is
26 391 the first use of the APSQ-III to compare patient safety cultures in different schools
27 392 and cohorts within mainland China. While the present sample was taken from only
28 393 one region in China, we covered almost all the medical colleges within a rather large
29 394 province. Furthermore, we recruited a cohort of medical students across five years of
30 395 their programs; therefore, the present study represents an important first step toward
31 396 patient safety education research in China. We believe that our findings can help
32 397 educators develop curricula for patient safety education.

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2
3 398 In conclusion, our study researched perceptions of patient safety culture among
4 399 medical students in China. Our results further suggest that medical students'
5 400 perceptions regarding patient safety cultures can provide a tool for guiding medical
6 401 education. Institutions should have an increased emphasis on issues related to the
7 402 reasons behind medical errors and error reporting. Shifts in patient safety cultures
8 403 should be based on situations affecting different schools and cohorts, especially
9 404 among third-year medical students. Longitudinal studies using a validated instrument
10 405 should also be conducted to better evaluate patient safety education programs and
11 406 their relative impact on local healthcare development. Further studies should explore
12 407 the culture of reporting errors and how students in nursing and healthcare profession
13 408 programs address these errors.

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37 537 Haonan Jia and Yan Lu collected the data; He Liu, Ying Li, and Yuming Wu analysed
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42
43 540 manuscript for publication.

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47 543 request.

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549 Table 1 Participants' demographic characteristic

Characteristic	Number. (%) of respondents			
	A	B	C	D
Gender				
Male	322 (44.4)	261 (41.7)	167 (36.4)	305 (45)
Female	404 (55.6)	366 (58.3)	292 (63.6)	377 (55)
Year in medical school				
First year	111 (15.3)	186 (29.5)	36 (7.8)	66 (9.7)
Second year	132 (18.2)	146 (23.1)	115 (25.1)	90 (13.2)
Third year	154 (21.2)	117 (18.5)	110 (24)	206 (30.2)
Fourth year	245 (33.7)	100 (15.9)	131 (28.5)	270 (39.6)
Fifth year	84 (11.6)	82 (13)	67 (14.6)	50 (7.3)
Overall	726 (29.1)	631 (25.3)	459 (18.4)	682 (27.3)

550 A = Harbin Medical University; B = Qiqihar Medical University; C = Mudanjiang

551 Medical University; D = Medical College of Jiamusi University.

552 Table 2 Student responses to the items in the APSQ-III.

Domain	Positive responses (%) [‡]				
	Overall	Between schools			
		A	B	C	D
Patient safety training received	84.9	57.3	90	99.4	98.5
1. My training is preparing me to understand the causes of medical errors.	84.8	56.6	89.7	99	99
2. I have a good understanding of patient safety issues as a result of my undergraduate medical training.	85.2	58.4	90.2	99.8	97
3. My training is preparing me to prevent medical errors.	84.7	56.8	90.1	99.3	99.4
Error reporting confidence	74.9	53.1	75.8	85.6	88.1
4. I would feel comfortable reporting any errors I had made, no matter how serious the outcome had been for the patient.	71.6	52.9	68.5	80.5	85.7
5. I would feel comfortable reporting any errors other people had made, no matter how serious the outcome had been for the patient.	76.7	53.4	79.8	88.1	89.5
6. I am confident I can talk openly to my supervisor about an error I had made, even if it resulted in potential or actual harm to my patient.	76.5	53.1	79	88.1	89.2
Working hours as an error cause	83.4	56.2	88.2	98	98.7

7. Shorter shifts for doctors will reduce medical errors.	81.7	53.9	85.9	97.1	97.3
8. By not taking regular breaks during shifts, doctors are at an increased risk of making errors.	84.7	57.8	89.8	98.9	99.5
9. The number of hours doctors work increases the likelihood of making medical errors.	83.8	56.8	89	97.9	99.4
Error inevitability	74.9	55.2	80.9	87.1	82.2
10. Even the most experienced and competent doctors make errors.	84.3	56.7	89.4	99.8	98.7
11. A true professional does not make mistakes or errors. [†]	68.9	53	79.3	86.1	64.8
12. Human error is inevitable.	71.6	56	73.9	75.4	83.2
Professional incompetence as an error cause	58.4	53.25	59.6	61	60
13. Most medical errors result from careless nurses	68.1	56.8	79	79.3	62.1
14. If people paid more attention at work, medical errors would be avoided [†]	67.2	53.2	62.5	72.8	80.1
15. Most medical errors result from careless doctors [†]	65.8	55.1	74.2	77.1	61.4
16. Medical errors are a sign of incompetence [†]	32.5	47.9	22.7	14.7	36.5
Disclosure responsibility	69.4	55.1	72.6	78.4	74.8
17. It is not necessary to report errors which do not result in adverse outcomes for the patient [†]	60.8	57.6	70.7	69.8	48.8
18. Doctors have a responsibility to disclose errors to patients only if the errors result in patient harm.	80.8	55	85.2	93.8	94.5
19. All medical errors should be reported.	66.7	52.6	61.9	71.6	81

Team functioning	76.9	55.7	77.5	87.6	91.8
20. Better multidisciplinary teamwork will reduce medical errors.	69.2	54.9	64.5	75.4	84.5
21. Teaching students teamwork skills will reduce medical errors.	84.7	56.6	90.5	99.8	99.1
Patient involvement in reducing errors	84.7	56.7	90.2	99.4	98.7
22. Patients have an important role in preventing medical errors.	85.1	56.1	90.5	99.5	98.6
23. Encouraging patients to be more involved in their care can help to reduce the risk of medical errors occurring.	84.5	57.3	90	99.3	98.8
Importance of patient safety in the curriculum	71.6	56.4	78.5	82.4	74.4
24. Teaching students about patient safety should be an important priority in medical students' training.	84.1	55.9	89.5	99.1	98.6
25. Patient safety issues cannot be taught; they can only be learned through clinical experience, which is gained when one is qualified. †	46.6	55.8	55.4	50	25.3
26. Learning about patient safety issues before I qualify will enable me to become a more effective doctor.	85	57.5	90.7	99.3	99.4

553 A = Harbin Medical University; B = Qiqihar Medical University; C = Mudanjiang Medical University; D = Medical College of Jiamusi
 554 University; †Positive responses are those with 'agree' or 'strongly agree'. The denominator for each question may vary because not every
 555 student responded to every question in the survey; † Negatively worded item, where the percent positive response is based on those who

556 responded, 'strongly disagree' or 'disagree.'

557

558 Table 3 Student responses to the nine factors in the APSQ-III.

Schools	Year in medical school	Positive responses (%) [‡]								
		Patient safety training received	Error reporting confidence	Working hours as an error cause	Error inevitability	Professional incompetence as an error cause	Disclosure responsibility	Team functioning	Patient involvement in reducing errors	Importance of patient safety in the curriculum
A	first	78.6	73.4	79.7	71.9	56.6	66.4	73.9	80.8	50.7
	second	74.3	62.9	74.4	71.4	56	66.6	64	71.9	49.8
	third	57.1	52.9	56.2	52.8	51.9	51.4	57.5	55.1	41.5
	fourth	43.1	40	40.5	45.4	51.1	48.7	42.7	42.8	37.6
	fifth	45.2	46.4	42.6	41.1	51.8	46.6	51.2	42.7	33.7
B	first	99.4	84.7	95.8	86	61.5	78.2	84.1	98.9	62.6
	second	97.2	86.8	95	91.1	66.3	78.5	87	99.1	59.8
	third	98	72.7	95.9	83.8	59.2	63.3	81.3	100	63.5
	fourth	98.9	86.5	97.3	84.4	60.9	77.5	78.8	97.3	63.5

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	fifth	61.4	51.9	61.2	61.6	51.5	57.4	56.1	58.7	47.2
C	first	99.1	90.3	96.1	91.9	62	84.1	86.4	98.2	63.5
	second	99.6	90.3	98.3	84.2	63.6	81.2	81.1	99.5	63.2
	third	100	83.4	97.9	87.1	60.7	78.2	91	100	59.3
	fourth	97	77.9	96.9	86.9	60	75.2	87.2	95.7	66.5
	fifth	99.7	79.9	99.4	85.2	58.5	70.9	92.6	100	58.2
D	first	99.1	87.1	99.2	86	63.3	72.7	90.2	97.1	56.7
	second	98.5	88.7	99.2	83.2	61.3	77.5	91	98.2	54.6
	third	97.1	87.2	97.2	82.9	59.9	74.8	89.3	99.2	57.8
	fourth	100	96.1	100	74.2	52.3	67	97.7	100	52.4
	fifth	100	78	100	79.3	41	74.9	100	100	65.1

559 A = Harbin Medical University; B = Qiqihar Medical University; C = Mudanjiang Medical University; D = Medical College of Jiamusi

560 University; †Positive responses are those who responded, 'agree' or 'strongly agree.' The denominator for each question may vary because not
561 every student responded to every question in the survey.

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563 Table 4 Factors in the APSQ-III that demonstrated significant differences between the five cohorts of four schools.

Year in	Positive responses (%) [†]
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medical school	Patient safety training received*	Error reporting confidence*	Working hours as an error cause*	Error inevitability*	Professional incompetence as an error cause	Disclosure responsibility	Team functioning*	Patient involvement in reducing errors*	Importance of patient safety in the curriculum*
first	93.5	82.5	91.7	82.7	60.4	74.4	82.5	93.5	58.1
second	91.9	81.6	90.9	82.6	61.9	75.8	79.9	91.5	56.9
third	87.4	74.6	86.4	76	57.8	67	79.7	87.9	54.9
fourth	80.7	73.2	79.5	68.2	54.4	63.9	75.3	80	51.5
fifth	72.4	61.8	71.7	64.7	51.6	60.4	71	71	49.1

564 *P<0.05; †Positive responses are those who responded, ‘agree’ or ‘strongly agree.’ The denominator for each question may vary because not
565 every student responded to every question in the survey.

STROBE Statement—Checklist of items that should be included in reports of *cross-sectional studies*

	Item No	Recommendation	Reported on page #
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	1
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3-6
Objectives	3	State specific objectives, including any prespecified hypotheses	6
Methods			
Study design	4	Present key elements of study design early in the paper	6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants	6
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6
Data sources/measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	6-7
Bias	9	Describe any efforts to address potential sources of bias	6
Study size	10	Explain how the study size was arrived at	6
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6-7
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	7
		(b) Describe any methods used to examine subgroups and interactions	6
		(c) Explain how missing data were addressed	6
		(d) If applicable, describe analytical methods taking account of sampling strategy	6
		(e) Describe any sensitivity analyses	
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	7-8, 19
		(b) Give reasons for non-participation at each stage	
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	7
		(b) Indicate number of participants with missing data for each variable of interest	6, 19
Outcome data	15*	Report numbers of outcome events or summary measures	6-9
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted	

		estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	
		(b) Report category boundaries when continuous variables were categorized	
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	
Discussion			
Key results	18	Summarise key results with reference to study objectives	9-12, 19-25
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	13
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	13
Generalisability	21	Discuss the generalisability (external validity) of the study results	13
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	17-18

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Perceptions of patient safety culture among medical students: A cross-sectional investigation in Heilongjiang Province, China

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Secondary Subject Heading:	Health policy, Medical education and training
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2
3 **1 Perceptions of patient safety culture among medical students: A cross-sectional**
4 **2 investigation in Heilongjiang Province, China**

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45 40 **Abstract**

6
7 41 **Objectives:** The medical school education plays an important role in promoting
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9 42 patient safety. In this study, we assess medical students' perceptions of patient safety
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11 43 culture, identify their educational needs, and provide evidence on the most important
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13 44 content relating to patient safety for the medical school curriculum.

14 45 **Method:** This cross-sectional study was conducted in four medical universities in
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16 46 Heilongjiang province. First through fifth year medical students completed an
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18 47 anonymous questionnaire—the Attitudes toward Patient Safety Questionnaire III
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20 48 (APSQ-III). We analysed the differences in responses across the four universities and
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22 49 cohorts.

23 50 **Results:** Overall perceptions of patient safety culture across the four medical
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25 51 universities were positive. The highest positive response rate was for 'I have a good
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27 52 understanding of patient safety issues as a result of my undergraduate medical training'
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29 53 (range: 58.4%–99.8%), whereas the lowest positive response rate was for 'medical
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31 54 errors are a sign of incompetence' (14.7%–47.9%). Respondents in the earlier years of
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33 55 school tended to have more positive responses for items concerning working hours
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35 56 and teamwork; however, fourth and fifth year students had more positive responses
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37 57 for error inevitability. Items with the lowest positive response rates across the cohorts
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39 58 included items related to 'professional incompetence as a cause of error' and
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41 59 'disclosure responsibility'.

42 60 **Conclusions:** While students had generally positive views of the patient safety culture,
43
44 61 none of them had been exposed to any formal curriculum content on patient safety.
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46 62 Policymakers should focus more on how educational needs vary across schools and
47
48 63 cohorts in order to establish appropriate curricula.

49 64 **Keywords:** medical education, patient safety, medicine students

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53 66 **Strengths and limitations of this study**

54 67 ► This is the first study to use the APSQ-III to compare patient safety culture
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56 68 across different medical schools and grades in Heilongjiang province, China.

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- 69 ▶ We covered almost all the medical colleges in Heilongjiang province.
 - 70 ▶ The study is limited by the potential non-response bias. Students who responded
71 to the survey might have been more interested than their peers in patient safety,
72 which might have inflated the attitude ratings.
 - 73 ▶ The results might not be generalisable to all medical colleges in China, although
74 our sample size was large.

75 **1. Introduction**

76 Providing patients with a safe and comfortable medical environment is an important
77 task for medical and healthcare organizations worldwide. Indeed, in 1999, the
78 Institute of Medicine (IOM) released a report called ‘To Err Is Human: Building a
79 Safer Health System’ to highlight the importance of patient safety.¹ Studies conducted
80 in several countries have shown that a lack of attention to patient safety can lead to
81 medical errors, which in turn can harm patients and increase their hospitalization
82 time.^{2 3} Hence, the maintenance and promotion of patient safety is of utmost
83 importance.

84 The advancement of patient safety requires a fundamental change in the healthcare
85 culture. Reducing harm through an improved safety culture is a global priority.⁴
86 Policymakers, payers, and groups such as the Agency for Healthcare Research and
87 Quality (AHRQ), National Patient Safety Agency, and World Health Organization
88 have developed numerous safety initiatives at the national and institutional levels.⁵
89 However, most of these initiatives targeted doctors, managers, and other healthcare
90 professionals—rather less attention has been paid to medical students, who are the
91 next generation of medical workers.⁶ It is essential for medical students to have a
92 good understanding of the patient safety culture. Because this understanding will
93 doubtlessly influence their treatment of patient safety issues throughout their working
94 lives

95 In 1980, Hilfiker proposed that medical graduates lack the ability to handle medical
96 errors.⁷ Even by 1998, Pilpel and his colleagues found that there was not yet any
97 formal document for medical students that described how to handle medical errors.⁸
98 While the launch of the ‘Building a Safer Health Care System’ in 1999 triggered a

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3 99 global discussion of patient safety issues,¹ a later study by Leape et al. concluded that
4 the status of patient safety education is not optimal.⁹ The Australian Health Safety and
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100 the status of patient safety education is not optimal.⁹ The Australian Health Safety and
101 Quality Committee published the National Patient Safety Education Framework
102 (NPSF) in 2005.¹⁰ Then, in 2008, the WHO launched the first expert committee on
103 patient safety issues in undergraduate medical curricula.¹¹ Subsequently, the
104 Patient Safety Alliance conducted pilot studies in 11 schools worldwide, and
105 proposed that advocacy for patient safety activities is one of the most important
106 WHO initiatives in the 21st century globally.

107 The primary prerequisite for the implementation of education on patient safety culture
108 is to understand medical students' current awareness of a safety culture. To this end,
109 Carruthers et al. used the Attitudes toward Patient Safety Questionnaire (APSQ) to
110 study medical students' perceptions of the patient safety culture.¹² Similarly, Liao et
111 al. surveyed 367 medical students at three medical colleges in the United States about
112 the patient safety culture,⁵ while Bowman et al. explored knowledge of patient safety
113 culture among 170 medical students at the University of California at San Francisco.¹³
114 Leung et al. surveyed second year students at medical schools in Hong Kong and
115 Singapore about their perceptions of the patient safety culture and compared their
116 different educational needs.¹⁴ However, patient safety education in areas with low
117 medical standards and high medical risks—for example, in developing countries
118 like China—is still in its infancy.¹⁵ One thing we do understand, from a report
119 exploring safety education content and teaching methods in China,¹⁶ is that patient
120 safety education has not been fully implemented within the curricula and clinical
121 practice therein.

122 Heilongjiang province, as the healthcare centre of Northeast China, has the largest
123 area and availability of health resources, and it has more than 30 million people.¹⁷
124 Heilongjiang province has four prominent medical schools that provide medical and
125 health service personnel training for the entire province: Harbin Medical University,
126 Qiqihar Medical University, Mudanjiang Medical University, and the Medical College
127 of Jiamusi University. Of these, Harbin Medical University has the best educational
128 reputation and most stringent entrance requirements, although the others (along with

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3 129 their affiliated tertiary hospitals) have good reputations as well. However, there are no
4
5 130 studies examining perceptions of a patient safety culture among medical students in
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7 131 Heilongjiang province, and few in China as a whole. Understanding current
8
9 132 perceptions of the patient safety culture and identifying medical students' most urgent
10
11 133 educational needs in that area, is critical for the effective design and successful
12
13 134 implementation of education programs at Heilongjiang's medical institutions.
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15 135 Consequently, we evaluated the students' perceptions of the patient safety culture at
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17 136 these four medical schools, with the goal of identifying domains critical to
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19 137 transforming patient safety perspectives and addressing students' educational needs.

20 138 **2. Methods**

21 139 **2.1 Sampling and Data collection**

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23 140 In 2014, we conducted a cross-sectional survey of four medical schools in
24
25 141 Heilongjiang province. The cooperation of the schools was obtained by contacting the
26
27 142 managers of the student affairs offices. While some of these schools offered courses in
28
29 143 doctor-patient relations and evidence-based medicine, none of them had a dedicated
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31 144 or systematic patient safety course. Furthermore, none of the students had received
32
33 145 any prior formal teaching on patient safety. As such, we could obtain a baseline
34
35 146 assessment of these students' views on the patient safety culture. We used systematic
36
37 147 random sampling to select 800 clinical medical students from a roster of all medical
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39 148 undergraduates at each school. We provided these students with detailed explanations
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41 149 of the objective of this investigation; some students expressed interest in participating
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43 150 in the survey, while others declined to participate. Students who were willing to
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45 151 participate were given two days to complete the questionnaire anonymously, after
46
47 152 which they returned it to a box provided in a counsellor's office. We did not collect
48
49 153 respondents' names or any other identifiers. Using this procedure, we obtained 2498
50
51 154 valid questionnaires (total response rate: 78.1%). Of the students who participated,
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53 155 726 (response rate: 90.8%) came from Harbin Medical University, 631 (78.9%) from
54
55 156 Qiqihar Medical University, 459 (57.4%) from Mudanjiang Medical University, and
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57 157 682 (85.3%) from the Medical College of Jiamusi University.

58 158 **2.2 Questionnaire**

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3 159 We used the APSQ-III,^{12 14 18-20} which was specifically designed for students and
4
5 160 covers nine key domains related to the patient safety culture. The APSQ-III assesses
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7 161 several domains regarding patient safety culture, rather than examining differences in
8
9 162 patient safety education. As such, it can more accurately reflect realistic educational
10
11 163 needs.¹⁴ The APSQ-III has a stable domain structure and criterion validity; it can also
12
13 164 distinguish between diverse student subgroups.¹⁴

14 165 The questionnaire comprises 26 items covering nine key patient safety domains:

- 15 166 (a) patient safety training received (items 1–3);
16
17 167 (b) error reporting confidence (items 4–6);
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19 168 (c) working hours as an error cause (items 7–9);
20
21 169 (d) error inevitability (items 10–12);
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23 170 (e) professional incompetence as an error cause (items 13–16);
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25 171 (f) disclosure responsibility (items 17–19);
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27 172 (g) team functioning (items 20 and 21);
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29 173 (h) patient involvement in reducing error (items 22 and 23); and
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31 174 (i) importance of patient safety in the curriculum (items 24–26).

32 175 **2.3 Data analyses**

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34 176 Responses were recorded on a five-point Likert scale, with 5 = strongly agree and 1 =
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36 177 strongly disagree. Responses were grouped into agree (i.e. 4 or 5) and disagree (i.e. 1
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38 178 or 2), and overall percentages were obtained.¹⁴ An analysis of variance was used to
39
40 179 compare the positive responses rate among students in different years of medical
41
42 180 school. We also excluded unanswered questions from the analyses. The significance
43
44 181 was set at $p < 0.05$.

45 182 **2.4 Patient and public involvement**

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47 183 Patients and public are not involved in the process of this study. As described in more
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49 184 detail in the methods section, we investigated the cognition of medical students on
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51 185 patient safety culture. And the participants will be informed of the study results via
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53 186 lectures in their schools.

54 187 **2.5 Ethics approval**

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3 188 The study protocol was reviewed and approved by the Research Ethics Committee of
4 189 Harbin Medical University. Before conducting the survey, we obtained approval from
5 190 each school. All participants voluntarily and anonymously participated and provided
6 191 their written informed consent.
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8

9 192 **3. Results**

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11 193 Of the students who responded to the demographic questions, 1,055 (42.4%) were
12 194 male, and 1,435 (57.4%) were female. The response rates varied among the school
13 195 year cohorts: first year, 399 (16%); second year, 483 (19.3%); third year, 587 (23.5%);
14 196 fourth year, 746 (29.9%); and fifth year, 283 (11.3%) (Table 1).

15
16
17 197 Table 2 summarizes the patient safety culture perceptions, by survey domain, for the
18 198 total sample and the four subgroups by medical school. The overall highest positive
19 199 response rates were for the following domains: ‘patient safety training received’,
20 200 ‘patient involvement in reducing errors’, ‘I have a good understanding of patient
21 201 safety issues as a result of my undergraduate medical training’, and ‘patients have an
22 202 important role in preventing medical errors’. The lowest positive response rates were
23 203 for the domains ‘professional incompetence as an error cause’, ‘disclosure
24 204 responsibility’, ‘medical errors are a sign of incompetence’, and ‘it is not necessary to
25 205 report errors, which do not result in adverse outcomes for the patient’.

26 206 When looking at specific medical schools, the highest positive response rates were
27 207 found in Mudanjiang Medical College, for the domain ‘patient safety training
28 208 received’. Jiamusi Medical College had the second highest rates overall, and its
29 209 highest positive response rate was for the domain ‘working hours as an error cause’.
30 210 In Qiqihar Medical University, the highest positive response rate was for ‘patient
31 211 involvement in reducing errors’. In all four institutions, the lowest positive response
32 212 rate was for ‘professional incompetence as an error cause’. The overall lowest positive
33 213 response rates came from Harbin Medical University; the highest positive response
34 214 rate was for the domain ‘patient safety training received’, and the lowest for ‘error
35 215 reporting confidence’. We observed statistically significant differences among the
36 216 schools in their responses to all nine key patient safety domains.

37 217 Table 3 summarizes the patient safety culture perceptions for the total sample and five
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3 218 school year cohorts, according to the APSQ-III domains. Perceptions of patient safety
4 219 culture varied noticeably according to school year. All five cohorts had a positive
5 220 perception of ‘patient safety training received’ and ‘patient involvement in reducing
6 221 errors’. However, first and second year students had more positive perceptions of
7 222 ‘working hours as an error cause’, while third year students had a more positive view
8 223 of ‘team functioning’. Besides the aforementioned domains, fourth and fifth year
9 224 students had high positive response rates for ‘error inevitability’. The lowest positive
10 225 response rates were for ‘professional incompetence as an error cause’ and ‘importance
11 226 of patient safety in the curriculum’ for all cohorts. As shown in Table 4, there was a
12 227 significant difference ($p < 0.05$) among cohorts in their positive response rates for
13 228 ‘patient safety training received’, ‘error reporting confidence’, ‘working hours as an
14 229 error cause’, ‘error inevitability’, ‘team functioning’, ‘patient involvement in reducing
15 230 errors’, and ‘importance of patient safety in the curriculum’.

231 **4. Discussion**

232 Patient safety is a top health care priority, and all medical undergraduates must have
233 the necessary capacity to minimize patient harm as they embark on their future career.
234 Education and training are key to achieving this goal.⁵ Medical students’ experiences
235 at medical school, as well as their perceptions of the patient safety culture, have an
236 important influence on their attitudes toward patient safety and their behaviours
237 within this domain.²¹ Therefore, screening their perceptions of the key areas of patient
238 safety, as in the present study, offers an opportunity to improve their clinical acumen
239 and future medical education. It can also be utilized by medical directors and clinical
240 service supervisors for real-time assessment in promoting a safety culture. We also
241 conducted the present study to demonstrate how the APSQ-III can be used to identify
242 differences among school year cohorts across several medical universities in
243 Northeast China.
244 The findings of this study highlight that medical students tend to have generally
245 positive perceptions of the patient safety culture.²² Interestingly, although none of our
246 participants had received any formal teaching on the subject, students from all four
247 universities tended to report that they had been trained in this subject well (84.9%).

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3 248 This finding is similar to that of a previous study by Leung et al. in Hong Kong,¹⁴
4 249 who proposed that the result could be due to students' misunderstanding or an
5 250 inability to distinguish teaching from they have learned from public media. We also
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7 251 believe that this is because of a rather common psychological phenomenon among
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9 252 students in China—that is, escaping responsibility. This phenomenon refers to the idea
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11 253 that Chinese students are struggling to cope with and protect themselves in an
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13 254 intensely hierarchical environment, which manifests as a fear of telling the truth
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15 255 because of its potential impact on teachers' evaluations of them. Accordingly, many
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17 256 students do not want to acknowledge errors or defects, and may be unwilling to report
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19 257 problems to avoid poor evaluations or to fit in within their teams.⁵ Therefore, more
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21 258 attention should be paid to this reluctance to 'speak up' in Chinese culture, and greater
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23 259 vigilance is required to prevent a fear of exposing deficiencies.

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25 260 Leung et al. found the highest positive response rates for 'working hours as an error
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27 261 cause', 'error inevitability', and 'importance of patient safety in the curriculum',
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29 262 whereas 'patient involvement in reducing error' and 'team functioning' had the lowest
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31 263 overall positive response rates.¹⁴ By contrast, in the present study, 'patient
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33 264 involvement in reducing errors' and 'patient safety training received' had the highest
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35 265 positive response rates, while 'professional incompetence as an error cause' and
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37 266 'disclosure responsibility' had the lowest. In contrast with students in Hong Kong,
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39 267 students in mainland China responded positively to items relating to 'patient
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41 268 involvement in reducing errors'. A probable reason for this finding is that patients in
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43 269 Hong Kong must adhere to the illness-specific arrangements made by public medical
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45 270 institutions regarding waiting lists, hospitalisation, and surgery. Additionally, they
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47 271 cannot choose their own doctors (however, they are generally trusting of doctors and
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49 272 hospitals). In mainland China, however, patients' understanding of their diagnosis and
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51 273 treatment has been continuously improving, and the traditional medical model is
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53 274 gradually being replaced with more active patient participation.²³ The doctor and
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55 275 patient undertake the process of medical decision-making together, and the patient has
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57 276 the right to choose their doctor independently. In addition, medical staff in mainland
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59 277 China often encourage patients and their families to participate in diagnosis- and

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3 278 treatment-related procedures.²⁴ This might include encouraging patients or family
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5 279 members to participate in examining the label on an infusion bottle to obtain the name
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7 280 of the drug, reading drug information, and so on. Previous research has shown that
8
9 281 patient participation can reduce the occurrence of medical errors.²⁵ All these points
10
11 282 might explain why Chinese medical students show positive attitudes for this domain.
12
13 283 We found that responses to the ‘professional incompetence as an error cause’ domain
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15 284 were more negative compared to responses in the other domains, especially for the
16
17 285 following items: ‘medical errors are a sign of incompetence’ (32.5%), ‘medical
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19 286 students generally consider errors as inevitable’ (74.9%), and ‘even the most
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21 287 experienced and competent doctors make errors’ (84.3%). These findings suggest that
22
23 288 students lack a proper understanding of the causes for certain errors. Our results are
24
25 289 similar to those of Moskowitz et al., who found that students in the US were uncertain
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27 290 as to what constituted an error and what caused errors.¹⁸
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29 291 Medical students generally agreed that medical errors are caused by humans and a
30
31 292 sign of incompetence (32.5%), showing that they lacked awareness of systematic
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33 293 errors. Furthermore, a number of students agreed that long working hours and medical
34
35 294 staff incompetence were important causes of errors. This finding indicates that the
36
37 295 students emphasized human factors in judging the causes of errors, which aligns with
38
39 296 findings from a previous study on students from Hong Kong: in that study, most
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41 297 students reported that ‘if they work hard, they can eliminate errors’ was an effective
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43 298 strategy for preventing future errors.²⁶ These findings suggest a need for emphasizing
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45 299 the potential role of other factors (e.g. systemic errors and procedural complexity)
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47 300 during the occurrence of medical errors.
48
49 301 Several students reported positive perceptions of their error reporting confidence, but
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51 302 had less positive perceptions of their responsibility for reporting (i.e. what and how to
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53 303 report a problem with patient care when they witness it). Their highly positive views
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55 304 on reporting medical errors (74.9%) are similar to the results of a Turkish study
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57 305 conducted by Karaoglu et al.,^{27 28} who found that 60.7% (n = 147) of students stated
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59 306 that they would report an error to the hospital committee if they had made it
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307 themselves. Furthermore, 68.6% (n = 166) of the students in that study stated that they

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3 308 would report a medical error if they witnessed one.
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5 309 In Flin et al.'s study, most students reported that they would speak up about an error.
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7 310 However, this result was somewhat confusing, since students also had high positive
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9 311 response rates for the item, 'it is not necessary to report errors that do not result in
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11 312 adverse outcomes for the patient' (60.8%).²⁹ More than 50% of the students attending
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13 313 the Medical College at Jiamusi University agreed with this statement. All members of
14
15 314 the medical team, including medical students, should be able to recognize unsafe
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17 315 conditions, report errors, and strive to improve error disclosure in settings where it is
18
19 316 lacking. This persistent cultural change should contribute to the eradication of errors
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21 317 and reduce patient safety concerns.³⁰⁻³²
22
23 318 Numerous students agreed with the following statements: 'my training is preparing
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25 319 me to understand the causes of medical errors' (84.8%) and 'I have a good
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27 320 understanding of patient safety issues because of my undergraduate medical training'
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29 321 (85.2%). This finding illustrates that medical students tend to have grand expectations
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31 322 regarding patient safety education, which is in line with the findings of Madigosky et
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33 323 al.³³ This US-based study also revealed that awareness of patient safety and medical
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35 324 errors can be increased and sustained via an experiential curriculum, which students
36
37 325 rated as a valuable experience.^{13 33}
38
39 326 Insights can be gleaned from the differences observed among the four medical schools.
40
41 327 The four universities ranked as follows in their positive response rates, in descending
42
43 328 order: Mudanjiang Medical University, the Medical College of Jiamusi University,
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45 329 Qiqihar Medical University, and Harbin Medical University. Notably, we found no
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47 330 evidence of different reporting practices between the four medical schools. Possibly,
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49 331 the differences in local patient safety cultures, as well as students' social and cultural
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51 332 backgrounds, are significant contributing factors to these different positive response
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53 333 rates.³⁰ However, the present study design did not enable an exploration of these
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55 334 factors; we could only determine the focal aspects of future teaching. For example,
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57 335 Mudanjiang Medical University, the Medical College of Jiamusi University, and
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59 336 Qiqihar Medical University might target education toward the classification and
337 underlying mechanisms of medical errors. In contrast, Harbin Medical University

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3 338 might target students' confidence in error reporting as an area for improvement.
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5 339 Our results run counter to those from other countries. For example, Flin et al.'s study
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7 340 in the UK found that most first year students reported 'medium low' or 'average'
8
9 341 levels of knowledge regarding errors and patient safety issues.³⁴⁻³⁸ Our results
10
11 342 revealed that positive perceptions of a patient safety culture tended to decrease as
12
13 343 students progressed through medical school. As seen in Table 3, more senior students
14
15 344 appeared to have less positive perceptions of 'error reporting confidence' and 'the
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17 345 importance of patient safety in the curriculum'. Possible reasons for these findings
18
19 346 include senior students' experience of working in strong clinical hierarchies, which is
20
21 347 known to have a negative influence on error reporting and disclosure of medical
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23 348 errors.³⁹ Furthermore, this decrease in medical error disclosure might emerge as result
24
25 349 of the increasing awareness and more realistic self-assessment that students develop
26
27 350 during the process of medical education.⁴⁰ It could also be the result of inadequate
28
29 351 training and preparation of young doctors. More senior students also appeared to have
30
31 352 less positive perceptions of 'the importance of patient safety in the curriculum'. A
32
33 353 likely reason for this finding is that because students face an increasing number of
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35 354 courses and pressure of examinations as they progress from their first to their fifth
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37 355 year, they do not want to add new courses to their curriculum. Still, the precise reason
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39 356 for this remains to be determined.

40 357 A limitation of this study is the possible non-response bias. Students who agreed to
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42 358 respond to the survey might have been more interested in patient safety than their
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44 359 non-responding peers. This greater level of interest might have led to the inflation of
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46 360 attitude ratings. Another limitation is that we made use of a non-standardised survey
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48 361 instrument. In addition, the APSQ-III is a self-assessment questionnaire that addresses
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50 362 students' own perceptions of a patient safety culture rather than their actual teachings
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52 363 in this area. Therefore, the present results might not be indicative of students' actual
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54 364 skills and knowledge. Moreover, extrapolation of our findings to other medical
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56 365 colleges should be done with caution. Nevertheless, this is the first use of the
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58 366 APSQ-III to compare patient safety cultures across different schools and school year
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60 367 cohorts within mainland China. While the present sample was taken from only one

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3 368 region in China, we covered almost all the medical colleges within this rather large
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5 369 province. Furthermore, we recruited a cohort of medical students across all five years
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7 370 of their programs; therefore, this study represents an important advancement in
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9 371 research on patient safety education in China. We believe that our findings can help
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11 372 educators develop suitable curricula for a patient safety education.

12 373 In conclusion, our study explored perceptions of the patient safety culture among
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14 374 medical students in China. These findings suggest that medical students' perceptions
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16 375 of the patient safety culture can provide a tool for guiding medical education.
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18 376 Institutions should focus more on issues related to the causes of medical errors and
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20 377 error reporting. Shifts in patient safety culture should also be based on situations
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22 378 affecting different schools and cohorts, especially among third year medical students.
23
24 379 Longitudinal studies using a validated instrument should also be conducted to better
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26 380 evaluate patient safety education programs and their relative impact on local
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28 381 healthcare development. Further studies should also explore the culture of reporting
29
30 382 errors and how students in nursing and healthcare education programs address these
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32 383 errors.

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31 503 **Author contributions statement:**

32 504 Mingli Jiao, Qunhong Wu, Ying Li and He Liu. designed the study; Jinghua Liu, Limin
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34 505 Liu, Yanming Zhao, Kexin Jiang, Huiying Fang, Peihang Sun, Peng Li, Yameng Wang,
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36 506 Haonan Jia and Yan Lu collected the data; He Liu, Ying Li, and Yuming Wu analysed
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38 507 the data; He Liu, Ying Li, Mingli Jiao, Siqi Zhao drafted the manuscript; and Mingli
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40 508 Jiao contributed to the manuscript's revision. All authors approved the final
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42 509 manuscript for publication.

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46 511 **Data sharing statement:** Data are available from the corresponding author upon
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48 512 request.

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520 Table 1 Respondents' demographic characteristics

Characteristic	n (%)			
	A	B	C	D
Gender				
Male	322 (44.4)	261 (41.7)	167 (36.4)	305 (45)
Female	404 (55.6)	366 (58.3)	292 (63.6)	377 (55)
Year in medical school				
First	111 (15.3)	186 (29.5)	36 (7.8)	66 (9.7)
Second	132 (18.2)	146 (23.1)	115 (25.1)	90 (13.2)
Third	154 (21.2)	117 (18.5)	110 (24)	206 (30.2)
Fourth	245 (33.7)	100 (15.9)	131 (28.5)	270 (39.6)
Fifth	84 (11.6)	82 (13)	67 (14.6)	50 (7.3)
Overall	726 (29.1)	631 (25.3)	459 (18.4)	682 (27.3)

521 A = Harbin Medical University; B = Qiqihar Medical University; C = Mudanjiang

522 Medical University; D = Medical College of Jiamusi University

523 Table 2 Responses to APSQ-III items

Domain	Positive responses (%) [‡]				
	Overall	Between schools			
		A	B	C	D
Patient safety training received	84.9	57.3	90	99.4	98.5
1. My training is preparing me to understand the causes of medical errors.	84.8	56.6	89.7	99	99
2. I have a good understanding of patient safety issues as a result of my undergraduate medical training.	85.2	58.4	90.2	99.8	97
3. My training is preparing me to prevent medical errors.	84.7	56.8	90.1	99.3	99.4
Error reporting confidence	74.9	53.1	75.8	85.6	88.1
4. I would feel comfortable reporting any errors I had made, no matter how serious the outcome had been for the patient.	71.6	52.9	68.5	80.5	85.7
5. I would feel comfortable reporting any errors other people had made, no matter how serious the outcome had been for the patient.	76.7	53.4	79.8	88.1	89.5
6. I am confident I can talk openly to my supervisor about an error I had made, even if it resulted in potential or actual harm to my patient.	76.5	53.1	79	88.1	89.2
Working hours as an error cause	83.4	56.2	88.2	98	98.7

7. Shorter shifts for doctors will reduce medical errors.	81.7	53.9	85.9	97.1	97.3
8. By not taking regular breaks during shifts, doctors are at an increased risk of making errors.	84.7	57.8	89.8	98.9	99.5
9. The number of hours doctors work increases the likelihood of making medical errors.	83.8	56.8	89	97.9	99.4
Error inevitability	74.9	55.2	80.9	87.1	82.2
10. Even the most experienced and competent doctors make errors.	84.3	56.7	89.4	99.8	98.7
11. A true professional does not make mistakes or errors. [†]	68.9	53	79.3	86.1	64.8
12. Human error is inevitable.	71.6	56	73.9	75.4	83.2
Professional incompetence as an error cause	58.4	53.25	59.6	61	60
13. Most medical errors result from careless nurses	68.1	56.8	79	79.3	62.1
14. If people paid more attention at work, medical errors would be avoided [†]	67.2	53.2	62.5	72.8	80.1
15. Most medical errors result from careless doctors [†]	65.8	55.1	74.2	77.1	61.4
16. Medical errors are a sign of incompetence [†]	32.5	47.9	22.7	14.7	36.5
Disclosure responsibility	69.4	55.1	72.6	78.4	74.8
17. It is not necessary to report errors which do not result in adverse outcomes for the patient [†]	60.8	57.6	70.7	69.8	48.8
18. Doctors have a responsibility to disclose errors to patients only if the errors result in patient harm.	80.8	55	85.2	93.8	94.5
19. All medical errors should be reported.	66.7	52.6	61.9	71.6	81

Team functioning	76.9	55.7	77.5	87.6	91.8
20. Better multidisciplinary teamwork will reduce medical errors.	69.2	54.9	64.5	75.4	84.5
21. Teaching students teamwork skills will reduce medical errors.	84.7	56.6	90.5	99.8	99.1
Patient involvement in reducing errors	84.7	56.7	90.2	99.4	98.7
22. Patients have an important role in preventing medical errors.	85.1	56.1	90.5	99.5	98.6
23. Encouraging patients to be more involved in their care can help to reduce the risk of medical errors occurring.	84.5	57.3	90	99.3	98.8
Importance of patient safety in the curriculum	71.6	56.4	78.5	82.4	74.4
24. Teaching students about patient safety should be an important priority in medical students' training.	84.1	55.9	89.5	99.1	98.6
25. Patient safety issues cannot be taught; they can only be learned through clinical experience, which is gained when one is qualified. †	46.6	55.8	55.4	50	25.3
26. Learning about patient safety issues before I qualify will enable me to become a more effective doctor.	85	57.5	90.7	99.3	99.4

524 A = Harbin Medical University; B = Qiqihar Medical University; C = Mudanjiang Medical University; D = Medical College of Jiamusi

525 University; †Positive responses include responses of 'agree' or 'strongly agree'. The denominator for each question might vary because some

526 students did not respond to every question in the survey; † Negatively worded item, where the positive response rate is based on responses of

527 'strongly disagree' or 'disagree'.

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529 Table 3 Responses to the nine domains of the APSQ-III

		Positive responses (%) [‡]								
Schools	Year in medical school	Patient safety training received	Error reporting confidence	Working hours as an error cause	Error inevitability	Professional incompetence as an error cause	Disclosure responsibility	Team functioning	Patient involvement in reducing errors	Importance of patient safety in the curriculum
A	First	78.6	73.4	79.7	71.9	56.6	66.4	73.9	80.8	50.7
	Second	74.3	62.9	74.4	71.4	56	66.6	64	71.9	49.8
	Third	57.1	52.9	56.2	52.8	51.9	51.4	57.5	55.1	41.5
	Fourth	43.1	40	40.5	45.4	51.1	48.7	42.7	42.8	37.6
	Fifth	45.2	46.4	42.6	41.1	51.8	46.6	51.2	42.7	33.7
B	First	99.4	84.7	95.8	86	61.5	78.2	84.1	98.9	62.6
	Second	97.2	86.8	95	91.1	66.3	78.5	87	99.1	59.8
	Third	98	72.7	95.9	83.8	59.2	63.3	81.3	100	63.5
	Fourth	98.9	86.5	97.3	84.4	60.9	77.5	78.8	97.3	63.5

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	Fifth	61.4	51.9	61.2	61.6	51.5	57.4	56.1	58.7	47.2
C	First	99.1	90.3	96.1	91.9	62	84.1	86.4	98.2	63.5
	Second	99.6	90.3	98.3	84.2	63.6	81.2	81.1	99.5	63.2
	Third	100	83.4	97.9	87.1	60.7	78.2	91	100	59.3
	Fourth	97	77.9	96.9	86.9	60	75.2	87.2	95.7	66.5
	Fifth	99.7	79.9	99.4	85.2	58.5	70.9	92.6	100	58.2
D	First	99.1	87.1	99.2	86	63.3	72.7	90.2	97.1	56.7
	Second	98.5	88.7	99.2	83.2	61.3	77.5	91	98.2	54.6
	Third	97.1	87.2	97.2	82.9	59.9	74.8	89.3	99.2	57.8
	Fourth	100	96.1	100	74.2	52.3	67	97.7	100	52.4
	Fifth	100	78	100	79.3	41	74.9	100	100	65.1

530 A = Harbin Medical University; B = Qiqihar Medical University; C = Mudanjiang Medical University; D = Medical College of Jiamusi

531 University; †Positive responses include responses of ‘agree’ or ‘strongly agree’. The denominator for each question might vary because some
532 students did not respond to every question in the survey.

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537 Table 4 APSQ-III domains that demonstrated significant differences between the five cohorts across all four schools

Year in medical school	Positive responses (%) [†]								
	Patient safety training received*	Error reporting confidence*	Working hours as an error cause*	Error inevitability*	Professional incompetence as an error cause	Disclosure responsibility	Team functioning*	Patient involvement in reducing errors*	Importance of patient safety in the curriculum*
First	93.5	82.5	91.7	82.7	60.4	74.4	82.5	93.5	58.1
Second	91.9	81.6	90.9	82.6	61.9	75.8	79.9	91.5	56.9
Third	87.4	74.6	86.4	76	57.8	67	79.7	87.9	54.9
Fourth	80.7	73.2	79.5	68.2	54.4	63.9	75.3	80	51.5
Fifth	72.4	61.8	71.7	64.7	51.6	60.4	71	71	49.1

538 *P < 0.05; [†]Positive responses include responses of 'agree' or 'strongly agree'. The denominator for each question might vary because some
539 students did not respond to every question in the survey.

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STROBE Statement—Checklist of items that should be included in reports of *cross-sectional studies*

	Item No	Recommendation	Reported on page #
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	1
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3-5
Objectives	3	State specific objectives, including any prespecified hypotheses	5
Methods			
Study design	4	Present key elements of study design early in the paper	5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants	5
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5
Data sources/measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	5-6
Bias	9	Describe any efforts to address potential sources of bias	5
Study size	10	Explain how the study size was arrived at	5
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	5-6
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	6
		(b) Describe any methods used to examine subgroups and interactions	5
		(c) Explain how missing data were addressed	5
		(d) If applicable, describe analytical methods taking account of sampling strategy	5
		(e) Describe any sensitivity analyses	
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	6-7, 18
		(b) Give reasons for non-participation at each stage	
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	6
		(b) Indicate number of participants with missing data for each variable of interest	5, 18
Outcome data	15*	Report numbers of outcome events or summary measures	5-8
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted	

		estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	
		(b) Report category boundaries when continuous variables were categorized	
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	
Discussion			
Key results	18	Summarise key results with reference to study objectives	8-11, 18-24
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	12
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	12
Generalisability	21	Discuss the generalisability (external validity) of the study results	12
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	17

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at www.strobe-statement.org.