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Preparedness of nurses for climate change: questionnaire development and preliminary validation

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ABSTRACT

Background: Nurses are well-positioned to lead climate action efforts. There are several tools currently available for measuring nurses' awareness, attitudes and practices regarding climate change. While each of these existing tools provides valuable insights into nurses' awareness, attitudes, and practices regarding climate change, none of them address preparedness in taking actions in the near future, which is important to inform strategies for motivating climate change actions targeting nurses.

Objectives: To describe the development and validation an instrument, provides a means to measure nurses internationally regarding their self-perceived engagement (achievement and preparedness), as well as their awareness and attitudes towards climate change.

Methods: A self-administered structured questionnaire for a cross-sectional multinational survey was developed. The 2018 International Council of Nursing (ICN)'s Position Statement on Nurses, Climate Change and Health was used to guide the achievement and preparedness of climate change actions. An expert panel of six nursing scholars rated the content validity. Scale-level and item-level Content Validity Index (S-CVI and I-CVI) were calculated. Based on the first 509 responses from the survey, internal consistency was assessed by Cronbach's alpha, convergent validity by correlation analyses, and structural validity was assessed by exploratory factor analysis.

Findings: The I-CVI of the final version was above 0.83 for all items except one. The S-CVI was 0.96. The internal consistency assessed by Cronbach's alpha was 0.943. All constructs were significantly positively associated with each other. Eight factors were identified by exploratory factor analysis, which structurally largely agree with the different parts of the questionnaire.

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Conclusion: The instrument is valid and reliable for assessing nurses' preparedness for climate change.

What is already known

- Unpreparedness to discuss or act on climate change has been reported among nurses despite their awareness and concern, yet assessment of the extent of preparedness is lacking.
- Most studies on health professionals' perceptions of climate change health implications have been conducted in English-speaking countries.

What this paper adds

- An instrument was specifically developed to collect preparedness for climate change actions, alongside with achievement, awareness & attitudes. ICN's 2018 Statement guided tool development and content validity rated by six experts Africa, Asia, North America, South America, and Oceania.
- Responses were collected from nurses in different roles, such as clinical, educational, research, and administrative, to evaluate the psychometric properties. With strong psychometric properties, the instrument is valid and reliable for use.
- Questionnaire results will inform strategies for nurses to lead climate action.

1. Introduction

Nurses are well-suited to expand their role and lead global climate action due to their large numbers, high public trust, and proximity to vulnerable groups (Butterfield et al., 2021). The diverse roles of nurses, ranging from immediate medical care to research, advocacy, management and policy making, highlight their invaluable contribution to addressing the health challenges posed by climate change (Mani et al., 2024). The International Council of Nursing (ICN), American Academy of Nursing, and other initiatives, recommend various actions for nurses, including leadership, training, activism, and advocacy (Butterfield et al., 2021; International Council of Nurses, 2018; Leffers and Butterfield, 2018). Among them, the Position Statement on Nurses, Climate Change and Health issued by the ICN in 2008, and revised in 2018, supports the notion that nurses of different positions, including clinicians, educators, researchers, policy influencers, and executives, can make powerful contributions to mitigating climate change and supporting climate-vulnerable communities (International Council of Nurses, 2018). The ICN position statement provides comprehensive recommendations for climate action at both organizational and individual levels. Mitigation actions are efforts to reduce or prevent the causes of climate change. Examples include reducing healthcare waste, ensuring proper waste management, and promoting green lifestyles to lower greenhouse gas emissions. Adaptation actions involve making specific changes to reduce vulnerability to climate changes, such as engaging in health committees for the safety of health workers and regulating the work environment. Resilience actions, closely related to adaptation, focus on enhancing the ability to withstand climate-related impacts, such as collaborating with communities to build resilience against climate change.

Nurses have shown varying levels of achievements, including more behavioral actions at home than at work, and some involvement in climate change awareness campaigns (Sambath et al., 2022; Schenk et al., 2019). Despite policy statements calling for action, there has been little achievement in integrating climate change content into nursing training (Barna et al., 2012). Only a small percentage (18 %−45 %) of nursing faculty include climate change content in their teaching, and many nursing schools lack sustainability-related classes (Amerson et al., 2022; Eide and Odom-Maryon, 2019; Godbole and Lamb, 2018; Powers and Kennedy, 2011). Regarding the level of preparedness, only one study on public health nurses reported that over 70 % of public health nurses claimed lack of ability and over 90 % were unprepared to address health impacts from climate change (Polivka et al., 2012). In terms of awareness, nurses and nursing faculties have moderate awareness of climate change impacts, but many struggle to identify specific health impacts (Anåker et al., 2015; Buriro et al., 2018; Polivka et al., 2012; Sambath et al., 2022; Schenk et al., 2021; Streich, 2014; Xiao et al., 2016). Some nurses were not even aware of the concept of climate change prior to survey (Nieto-Cerezo, 2016; Nsengiyumva et al., 2020; Xiao et al., 2016). Attitudes towards climate change are generally concerned and motivated, with nurses expressing interest in learning more about the topic (Chung et al., 2024; Kalogirou et al., 2020; Sambath et al., 2022; Schenk et al., 2021; Xiao et al., 2016).

There are several tools currently available for measuring nurses' awareness, attitudes and practices regarding climate change. The Climate, Health, and Nursing Tool assesses awareness, concern, motivation, and behaviors related to climate change among nurses (Schenk et al., 2021). With five language versions, the instrument has been applied to nurses and nursing students globally (Jeong et al., 2022). The Sustainability Attitudes in Nursing Survey-2 evaluates nurses' attitudes towards climate change and sustainability (Richardson et al., 2015). Originally developed to measure nursing students' attitudes, it has also been applied to faculty and practicing nurses worldwide (Amerson et al., 2022; Chung et al., 2024; Cruz et al., 2018; Richardson et al., 2015, 2016). The New Ecological Paradigm scale measures environmental concerns and perspectives on related policies, participation patterns, or environmental-friendly behaviors (Dunlap et al., 2000). Although not developed for nurses, it has measured nursing faculty's awareness and attitudes toward sustainability (Amerson et al., 2022). It is widely used in the United States and other nations, though

limited among nurses (Anderson, 2012). The Global Warming Questionnaire assesses university nursing students' knowledge about global warming and has only been used in Turkey (Ergin et al., 2021). The Nurses' Environmental Awareness Tool evaluates nurses' awareness of environmental issues and their related behaviors (Schenk et al., 2015). It focuses on the importance of awareness in driving behavioral change, and includes Nurse Awareness Scale (fact awareness, and relatedness to human health), Nurse Professional Ecological Behaviors Scale (behavioural frequency, and behavioural difficulty), and Personal Ecological Behaviors Scale (behavioural frequency, and behavioural difficulty). Lastly, the Sustainability Consciousness Questionnaire measures sustainability consciousness among individuals (Gericke et al., 2019). It has been used among nursing students in Saudi Arabia and Egypt, though originally developed for non-nursing university students in Sweden (Gericke et al., 2019; Moustafa Saleh and Elsabahy, 2022).

While each of these tools provides valuable insights, none of them directly address preparedness in taking actions in the near future, which is important to inform strategies for motivating climate change actions targeting nurses. Moreover, the nursing populations from Asia and other regions are not adequately represented. These areas often have relatively higher climate vulnerability or lack of resources and readiness to address the impact of climate change (Asmall et al., 2021; Ford et al., 2015; Mani and Goniewicz, 2023; Nagy et al., 2019). Therefore, a new instrument specifically for assessing nurses' preparedness for climate change is needed. The proposed instrument adopts the list of actions based on the 2018 ICN recommendations to assess self-perceived engagement in the past (achievement) and in the near future (preparedness). Moreover, the proposed instrument would also fill the gap regarding the lack of instruments on the nurse educators' preparedness. Furthermore, this instrument incorporates awareness of nurse-led climate change initiatives, sectors contributing to climate change, impacts to different parties and nursing practices, and attitudes toward responsible parties, areas less explored in the literature, to offer novel insights into awareness and attitudes.

This study aimed to describe the development and validation for this instrument, which provides a means to measure nurses internationally regarding their self-perceived engagement (achievement and preparedness) with climate change actions recommended by the ICN, as well as their awareness and attitudes towards climate change.

2. Methods

2.1. Survey instrument development

A structured self-reported questionnaire was developed from the ICN 2018 Statement and literature about nurses and other health professionals regarding climate change and health (Ergin et al., 2021; International Council of Nurses, 2018; Kotcher et al., 2021; Leffers and Butterfield, 2018; Ryan et al., 2020; Sambath et al., 2022). Fig. 1 summarizes the development and validation process. First, literature review on the ICN 2018 Statement and nurses' and other heath professionals' regards on climate change and health was conducted and supported the generation of instrument items in English (United Kingdom). Then, the draft instrument in English (United Kingdom) was reviewed by the panel of experts and revisions were made accordingly. This iterative process continued until no further feedback was received and the content validity index of the final version was reported. The final version of the instrument in English (United Kingdom) was converted into English (United States) with local adaptation, as well as translated into Spanish and Traditional Chinese through proper forward and backward translation. The Traditional Chinse version was then converted into Simplified Chinese with local adaptation. These language versions were consolidated into the multilingual version available in the online platform, which collected data for the instrument validation. The development and validation process of the instrument are detailed in subsequent sections.

The questionnaire was designed to address the objectives of the survey, namely (i) to assess nurses' achievement of recommendations of the ICN 2018 Statement on climate change in the past five years, (ii) to assess nurses' preparedness to achieve these recommendations in the next five years, (iii) to assess nurses' awareness of existing international nurse-specific climate change and health initiatives, (iv) to examine nurses' attitude towards protecting climate vulnerable groups, and (v) to explore differences in achievement, preparedness, awareness and attitudes toward climate change among nurses across regions.

Hence, the questionnaire was developed with six parts as follows:

I. Awareness of international nurse-led climate change and health initiatives

There are three questions assessing respondents' awareness of international nurse-led climate change and health initiatives. Respondents indicate the extent to which they have heard about these initiatives (Never, heard of but not familiar, heard of and familiar with).

II. Achievement of the recommendations of the ICN 2018 Position Statement and preparedness to achieve these recommendations

There are six questions assessing respondents' achievements of the ICN 2018 Position Statement recommendations for individual nurses over the past five years. Nurses registered for less than five years are asked to evaluate their experiences since their registration. Respondents rate on a scale from 0 to 10, where a higher score indicates higher achievement, with 0 indicating none, 1 minimal, and 10 completely. Prompts on specific areas of achievement follow any response from 1 to 10. Detailed components of each action, according to the ICN recommendations, are included in the questionnaire. If respondents indicate any level of engagement, they are prompted to specify the particular action(s) they are involved in. This ensures the objectivity in the interpretation of each action.

The next six questions assess respondents' preparedness to achieve these recommendations in the next five years. Respondents rate their preparedness on a scale from −5 to 5, where a higher score indicates greater preparedness, with 0 indicating neutral, −5

definitely unlikely, and 5 definitely likely. If respondents opt for any level of engagement in the next five years, the respondents are prompted to indicate the determining factor(s) they considered, namely willingness, opportunities, both, or others. This enables interpretation of the quantitative results.

III. Practice and preparedness in nursing education related to climate change

This part is only answered by respondents who identified themselves as nurse educators. The first question assesses the inclusion of climate change and its health-related components in the nursing curriculum in the past five years. Nurses who have worked as educators for less than five years are asked to evaluate their experience since they started working as educators. Respondents rate on a scale from 0 to 10, where a higher score indicates higher achievement, with 0 indicating none, 1 minimal, and 10 completely. Prompts on specific areas of achievement follow any response from 1 to 10.

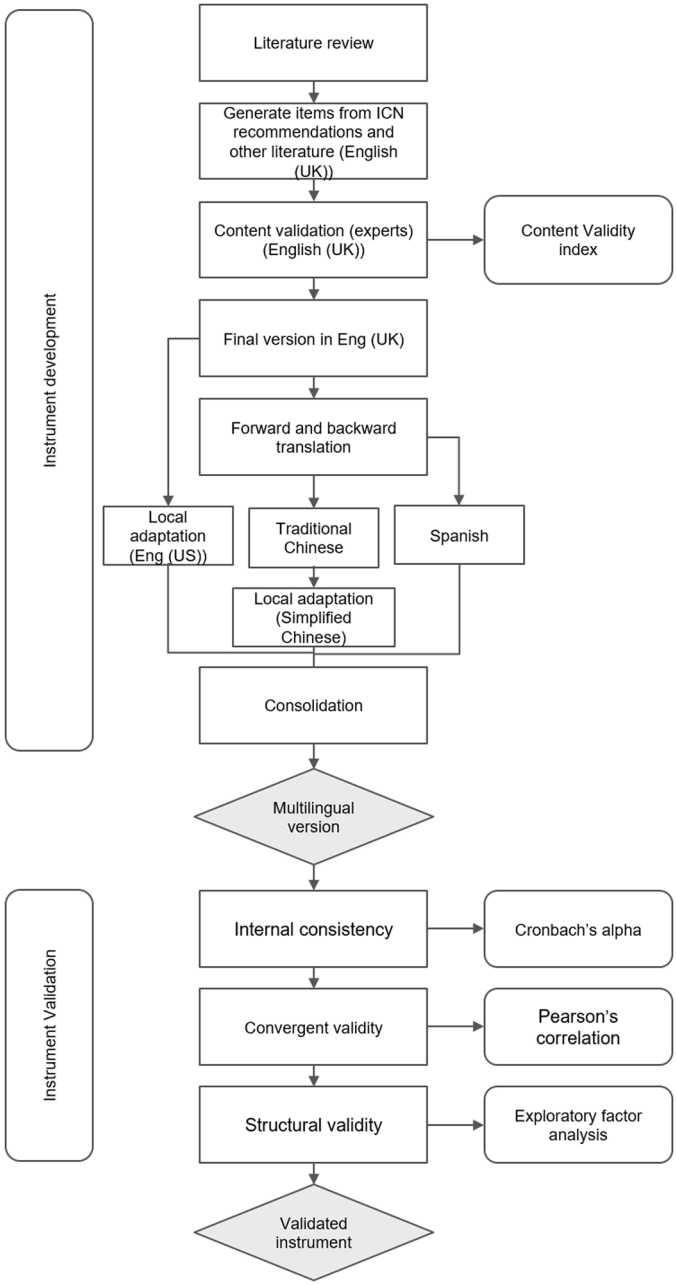

Fig. 1. Flowchart of development and validation process of the instrument.

An additional question assesses nurse educators' preparedness to include climate change and its health-related components in the nursing curriculum in the next five years. Respondents rate their preparedness on a scale from −5 to 5, where a higher score indicates greater preparedness, with 0 indicating neutral, −5 definitely unlikely, and 5 definitely likely. Determining factors influencing the response are also collected.

IV. Attitude regarding vulnerable group

There are five questions assessing respondents' prioritization of vulnerable groups affected by climate change, their prioritization of what nurses' actions to help these vulnerable groups, perceived impacts of climate change on the different parties, perceived contributors to climate change, and perceived parties responsible for combating climate change. In the first two questions, respondents rank the options for questions according to priority. In the remaining three questions (with 19 items), respondents rated on a scale from 0 to 10, where a higher score indicates greater extent, with 0 indicating none, 1 minimal, and 10 completely.

V. Climate change impact on nursing practices

There is one question assessing how climate change influences nursing practice. Respondents rate on a scale from 0 to 10, where a higher score indicates greater extent, with 0 indicating none, 1 minimal, and 10 completely. Prompts on specific areas of achievement will be asked for any response from 1 to 10.

VI. Demographics

Questions cover demographic information such as age, gender, place of current practice, number of years of practice, level of education and place of training, and public health training. The final question collects information on the source of referral to this survey.

VII. Quality check

To ensure data quality, an attention check question, "If you are paying attention, please select 'agree'," is inserted in the midst of the questionnaire. Failure to select the required option renders the sample invalid. During the data collection, self-selection bias will be minimized by the collaborators actively reaching out to potential respondents, who may not be so enthusiastic to participate, and the attention-check question helps to ensure validity of responses.

2.2. Content validity

A panel of six experts (nursing scholars from Chile, Hong Kong Special Administrative Region [Hong Kong], mainland China, New Zealand, the United States, and South Africa) were invited to rate the relevance of the instrument. The experts rated the relevancy of each item on a 4-point scale (1 = very irrelevant; 4 = very relevant) (Polit and Beck, 2006). The experts also provided open-ended comments for suggested changes. Corresponding revised items were sent to the panel for reassessment. This iterative process continued until no further feedback was needed. For example, the initial version of the achievement and preparedness items followed the five recommended actions for individual nurses in the ICN 2018 Statement. After expert review, an additional item targeting respondents' own healthy lifestyle was added to align with the call for empowerment. Another major change was splitting specific actions from the stem questions into separate Boolean questions for clarity. Minor changes included elaborating terms and adding options for the questions. The item-level Content Validity Index (I-CVI) was calculated as the proportion of 3 or above ratings by the panel members. An I-CVI of 0.78 or above was considered excellent. The scale-level CVI (S-CVI) was the average of I-CVI, and 0.9 or above was excellent (Polit et al., 2007).

2.3. Translation and cultural adaptation

The questionnaire was first developed in English (United Kingdom). We followed the standard cross-cultural adaption procedure, which covered both the linguistic and cultural equivalence of the translated versions (Beaton et al., 2000). After the expert panel finalized the English (United Kingdom) version, translation to the traditional Chinese version was independently performed by the co-first author and a research assistant. A combined version was then amalgamated by the first and co-first authors, who are proficient in both traditional Chinese and English, and cultural adaptation was ensured as both of them are local researchers. Back translation was performed by a professional translation company. The back-translated version was then compared with the original for further revision by first and co-first authors. A single modified bilingual version was then used for field-testing in Hong Kong, a city where nurses are bilingual, and revisions were made accordingly. An English (United States) version and a simplified Chinese version were developed based on the final bilingual version. As linguistically, these versions are very similar to the English (United Kingdom) and

traditional Chinese, respectively, local adaptation instead of the full forward and back translation was performed. Researchers in the United States (co-author Cole) and the mainland China (co-author Hu) ensured the linguistic and cultural equivalence. The Spanish version was independently translated from the English (United Kingdom) version by co-author (Palmeiro Silva) and another faculty member in Chile. Co-author (Palmeiro Silva) ensured the cultural equivalence in the combined version. Then, the back translation was performed by a professional translation company. All language versions were field-tested in the corresponding region to ensure linguistic and cultural equivalence. For example, in the English (United States) version, the term 'licensed' was added alongside 'registered'; and terms for education levels were aligned across different regions. Subject to additional collaborators, more language versions may be developed. For example, a Malay version is under development. English (United Kingdom) version and Traditional Chinese versions are provided as supplementary materials.

Participants can switch between different languages in the online survey platform (https://hku.au1.qualtrics.com/jfe/form/SV_3rv1aHgDJWE621M). Paper forms of corresponding languages are available at some sites if online data collection is difficult.

2.4. Instrument evaluation

The survey involves nursing schools from universities, including but not limited to the Universitas 21 Health Sciences Group – Nursing and Midwifery network, to coordinate data collection in respective regions. The inclusion criteria for the survey include individuals licensed as registered nurses for at least one year, and currently practicing as a nurse (e.g. clinician/ direct care, educator, researcher, policy influencer, or executive/ administrator/ manager). Samples from the target population were recruited by convenience sampling for pilot testing. The bilingual version was piloted with 15 bilingual-speaking respondents in Hong Kong in April 2023, the respondents went through cognitive debriefing after completing the questionnaire. Then, questionnaires were piloted with 10 respondents in each collaborating region to ensure the questionnaire was comprehensible and culturally applicable to the local respondents. Any subsequent amendments required were reported to the project lead and discussed accordingly. Data collection was launched immediately after the pilot phase. The survey was launched in June 2023. Survey completion takes between 15 and 30 minutes .

2.4.1. Participants and sample size

Preliminary results of the first 509 valid responses received by February 2024 were used to estimate psychometric properties. As a sample of 84 was needed to detect correlation coefficient of 0.3 with 80 % power and 5 % level of significance, the current sample was sufficient. To avoid overpowering, the interpretation of the results of correlation would focus on the magnitude of the correlation in addition to statistical significance. For exploratory factor analysis, our sample size was large enough to cater for minimal sample size under different scenarios (MacCallum et al., 1999). Descriptive statistics were used to describe the sample characteristics.

2.4.2. Reliability and validity

Internal consistency was assessed by Cronbach's alpha, with values above 0.7 as acceptable, 0.8 as good and 0.9 as excellent (Nunnally and Bernstein, 1994). Convergent validity could be revealed by the relationships among the mean scores of awareness (Part I), achievement (Part II/III), preparedness (Part II/III), attitudes (Part IV), and impacted practice (Part V), which were explored with Pearson's correlation. For parts with more than one question, mean scores across the questions in the same part were used for the analyses.

Structural validity was examined by exploratory factor analysis to identify latent constructs represented by the questionnaire items. Factors refer to underlying constructs or dimensions that group together related items from the questionnaire. As this instrument was newly developed, we took this data-driven and flexible approach to identify the unobserved constructs instead of adopting the confirmatory factor analysis approach. To conduct the exploratory factor analysis, suitability of data for factor analysis was assessed by Kaiser-Meyer-Olkin measure, with 0.8 or above as excellent, and Bartlett's Test of Sphericity, with a significant result as enough correlation between variables. Maximum likelihood was chosen to be the extraction method and number of factors was determined by eigenvalues greater than 1 and the scree plot. To enhance interpretation, Varimax rotation was performed. Factor loadings of 0.4 or above were considered significant indicators of the corresponding factors.

A 5 % level of significance was adopted and SPSS (version 28) was used for analyses. Missing data were excluded in respective analyses.

2.5. Ethics and dissemination

Ethics approval was obtained from The University of Hong Kong/ Hospital Authority Hong Kong West Cluster Institutional Review Board (UW23–245). If collaborators were required to obtain additional ethics approval from their own ethics committee, additional approval was sought accordingly. Survey results will be disseminated in aggregated level, participant anonymity will be maintained. The results will be disseminated through international conferences, reports and journal articles. Data are being stored on a secure, password-protected computer at The University of Hong Kong and available upon reasonable request.

2.6. Public involvement statement

Respondents, who are nurses, are involved in providing data to the survey.

3. Results

3.1. Overview

The characteristics of the first 509 valid responses are presented in Table 1. About 55.2 % of the respondents were from Asia, followed by Oceania, America and others. About 50.3 % were aged 18–39 and 79.2 % were female. Over 60 % worked <20 years as registered nurses. Most respondents obtained an education level of bachelor degree (42.2 %), followed by master degree /postgraduate certificate/postgraduate diploma (25.0 %). About 57.4 % worked as clinicians or provide direct care, and 52.1 % worked in hospital/ nursing home/hospice.

3.2. Content validity

The I-CVI of the final version are all above 0.83 except the item of fundraising to support living conditions of at-risk populations as one of the options to protect the vulnerable groups against climate change hazards (0.67). The S-CVI was 0.96.

3.3. Internal consistency

The internal consistency (assessed by Cronbach's alpha) was 0.943, with 0.849, 0.891, 0.711, and 0.943 for Part I to Part IV, respectively. Part V consists of one numeric question only and Cronbach's alpha could not be estimated separately.

3.4. Convergent validity

The mean scores of awareness, achievement, preparedness, attitudes, and impacted practice were significantly positively

Table 1
Sample characteristics of the first 509 valid responses.

Characteristics	Number (%)
Region	
Asia	281 (55.2 %)
Oceania	113 (22.2 %)
America	77 (15.1 %)
Others or missing	38 (7.5 %)
Age group	
18–39	256 (50.3 %)
40–64	194 (38.1 %)
65 or above	16 (3.1 %)
Prefer not to say or missing	43 (8.4 %)
Sex	
Female	403 (79.2 %)
Male	65 (12.8 %)
Prefer not to say or missing	41 (8.1 %)
Number of years as registered nurses	
1–4	87 (17.1 %)
5–10	111 (21.8 %)
11–20	123 (24.2 %)
21–30	92 (18.1 %)
Over 30	96 (18.9 %)
Education level	
Certificate/diploma/higher diploma/associate degree	65 (12.8 %)
Bachelor	215 (42.2 %)
Master/postgraduate certificate/postgraduate diploma	127 (25.0 %)
Doctor	67 (13.2 %)
Missing	35 (6.9 %)
Major professional role	
Clinician/direct care only	292 (57.4 %)
Educator only	80 (15.7 %)
Executive/administrator/manager/others only	46 (9.0 %)
Researcher only	24 (4.7 %)
Multiple roles	67 (13.2 %)
Work setting	
Hospital/nursing home/hospice only	265 (52.1 %)
Clinic/outpatient/primary care/community only	56 (11.0 %)
Educational only	84 (16.5 %)
Others	16 (3.1 %)
Multiple	53 (10.4 %)
Missing	35 (6.9 %)

associated with each other, explored with Pearson's correlation. The strongest correlation was observed between the mean achievement score and the mean preparedness score (0.528, $p < 0.001$), followed by mean attitudes score and the mean impacted practice score (0.509, $p < 0.001$) and mean achievement score and the impacted practice score (0.507, $p < 0.001$) (Table 2a). Among nurse educators ($n = 125$), significantly positive associations were reported for achievement and preparedness in nursing education scores with awareness, achievement, preparedness, attitudes, and impacted practice scores, having the strongest correlation between the achievement scores in nursing education and in the actions recommended by the 2018 ICN Position Statement (0.579, $p < 0.001$) and the preparedness scores in nursing education and in general (0.594, $p < 0.001$) (Table 2b). Except few pairs of correlations, all the correlations were above 0.3 in magnitude.

3.5. Structural validity

The Kaiser-Meyer-Olkin measure was 0.905 and the Bartlett's Test of Sphericity had a p-value of <0.001, supporting suitability for exploratory factor analysis. The analysis (excluding the two questions that were specific to nurse educators) generated eight factors, all with eigenvalues greater than one. The structure mostly followed the designated parts in the questionnaire (Table 3). Factor 1 was labeled as "Responsibility for helping to combat climate change", which included all items from the same question. Factor 2 was labeled as "Affected parties from climate change", which included all items from the same question. However, the item about impacted practice was also loaded onto this factor and the item about the world being affected was loaded onto Factor 6 simultaneously. Factor 3 was labeled as "Preparedness for climate change in the next five years", which included all items related to preparedness. However, two items related to preparedness in terms of green lifestyle were also loaded onto Factor 8. Factor 4 was about "Achievements in climate change actions", which included all items related to achievement, except those related to green lifestyle. Again, the item about impacted practice was loaded onto this factor. Both Factor 5 and Factor 6 were about "Sectors that contributed to climate change", which included all items related to that question. The industrial, commercial and transportation sectors belonged to Factor 6, which could be interpreted as "directly" contributing sectors, while the others which are "less directly" contributing belonged to Factor 5. Factor 7 was labeled as "Awareness of international nurse-led climate change and health initiatives", which included all three items related to awareness of international nurse-led climate change and health initiatives. Factor 8 was labeled as "Green lifestyle practice and empowerment", which included both achievement and preparedness in terms of self-practice of a green lifestyle either practiced by themselves or by empowering others to do so.

4. Discussion

This paper described the development and validation of a comprehensive, instrument aimed at assessing achievement, preparedness, awareness, and attitudes toward climate change among the nurses internationally. This instrument is being used in an ongoing survey led by The University of Hong Kong and collaborating with the Nursing and Midwifery Discipline group members of the U21 Health Sciences Group. Data gathered by this instrument will provide stakeholders, both nationally and internationally, with the information needed to develop targeted policies that empower nurses to take effective climate action. For example, nurse educators can help enhance nursing curricula and post-registration training programs that address areas with low awareness or where misconceptions were reported. Healthcare facility administrators may target areas that nurses had lower preparedness, particularly influenced by the lack of opportunities, to foster an environment that supports such practices. Government officials can also support healthcare facilities by allocating more resources to support those initiatives. International climate change initiatives may target areas that are less achieved or less prepared to scale up advocacy and related campaigns.

Among existing instruments applied to nurses, the instrument of Climate, Health, and Nursing Tool, developed using the I-Change model, was the first comprehensive tool to assess five key domains related to climate change among nurses: awareness (nurses' understanding of the health impacts of climate change), motivation (their drive to engage in climate-related actions), concern (levels of concern about climate change's effects on health), home behavior (sustainability practices in personal life), and work behaviors (actions taken in professional settings to address climate change) (Schenk et al., 2021). Available in five languages, namely English, Spanish, Portuguese, Italian, and Finnish, it was applied mainly in the North America and Europe (Jeong et al., 2022). While acknowledging Climate, Health, and Nursing Tool as a comprehensive and reliable tool, we developed a new tool to address constructs not fully explored in Climate, Health, and Nursing Tool and similar surveys. Specifically, our instrument assesses nurses' preparedness

Table 2a
Pearson's correlation coefficients among the different constructs.

	No. of item	n	Mean(SD)	Awareness	Achievement	Preparedness	Attitude	Impacted practice
Awareness	3	509	1.32 (0.50)	1				
Achievement	6	509	2.87 (2.09)	0.347**	1			
Preparedness	6	509	1.51 (1.83)	0.316**	0.528**	1		
Attitude	19	479	6.62 (1.85)	0.126**	0.309**	0.402**	1	
Impacted practice	1	475	4.34 (2.96)	0.245**	0.507**	0.395**	0.509**	1

n: sample size.
SD: standard deviation.
** $p < 0.001$.

Table 2b
Pearson's correlation coefficients among the different constructs (nurses with nursing educator role).

	No. of item	n	Mean(SD)	Awareness	Achievement	Preparedness	Attitude	Impacted practice
Achievement in nursing education	1	125	4.01 (3.29)	0.454**	0.579**	0.468**	0.224*	0.406**
Preparedness in nursing education	1	125	2.45 (2.20)	0.321**	0.395**	0.594**	0.333**	0.425**

n: sample size.
SD: standard deviation.
* $p < 0.05$.
** $p < 0.001$.

for climate change, a unique construct not previously explored. Unlike Climate, Health, and Nursing Tool, which examined motivation as a driving force, our tool focuses on expected engagement in specific actions guided by the 2018 ICN recommendations. This allows for comparison of achievement and preparedness, using the same set of actions for both. Some behaviors (home or work) assessed by Climate, Health, and Nursing Tool may overlap with the achievement construct of our instrument. If both tools generate consistent findings, this corroborates the survey's validity. Both Climate, Health, and Nursing Tool and our instrument explore awareness, but ours specifically targets international nurse-led initiatives related to climate change, and knowledge of vulnerable populations is quantified by rating each group's vulnerability by the nurses. While Climate, Health, and Nursing Tool assesses concern about the impact on self, family and health, our tool allows different rating for different parties. Furthermore, our instrument was developed with inputs from experts worldwide, including Chile, Hong Kong, mainland China, New Zealand, the United States, and South Africa. This diverse input ensures adaptability to various nursing communities (Butterfield et al., 2021).

Overall, the newly developed instrument showed high reliability and validity, comparable to the existing tools. Our instrument demonstrated high internal consistency with a Cronbach's alpha of 0.943. The I-CVIs were above 0.83 for all items except one and, and the S-CVI was 0.96. Comparatively, the Cronbach's α varied among the existing tools, with 0.67 to 0.91 for the subscales of the Climate, Health, and Nursing Tool instrument, 0.86 for the instrument of Sustainability Attitudes in Nursing Survey-2, and 0.83 for the New Ecological Paradigm scale (Amerson et al., 2022; Chung et al., 2024; Jeong et al., 2022; Winquist et al., 2023). Convergent validity of our instrument was shown by significant positive associations among the awareness, achievement, preparedness, attitudes, and impacted practice scores. All correlation coefficients were above 0.3, except three pairs. The correlations between achievement and preparedness, attitudes and impacted practice, and achievement and impacted practice, were the strongest, with correlation coefficients above 0.5. Similar properties were also observed in existing instruments, with the instrument of Climate, Health, and Nursing Tool showing factor correlations ranging from 0.25 to 0.72 among factors (Winquist et al., 2023). While structural validity of our instrument has been validated by exploratory factor analysis only, the instrument was also initially explored by exploratory factor analysis, and subsequently demonstrated by a confirmatory factor analysis (Winquist et al., 2023). As with the instruments of Climate, Health, and Nursing Tool and Sustainability Attitudes in Nursing Survey-2, which have multiple language versions, adequate forward and back translation was performed in our translation process, moreover, cultural adaptation was ensured by involving local researchers in different collaborating sites. Field-testing of the questionnaire was performed in each site before the start of the study proper. For example, some of the continued training system for nurses are different than the others, hence, adjustment in aligning the wordings of the education level was made.

In the absence of validated scales for comparison, convergent validity was assessed through the correlation among the various constructs studied. Findings from correlation analysis indicated that the constructs were generally well-aligned, especially with regard to nurses' perceived practices impacted by climate change, which were positively correlated with their achievements and attitudes towards climate change actions. This finding is consistent with the Knowledge, Attitude, and Practice model, which posits that individuals' knowledge is highly correlated with their attitudes and practices (Badran, 1995). In our instrument, nurses' knowledge could be inferred from their experience of the impacted practice, while their practice and attitudes were reflected in their achievements in climate change actions and attitudes towards climate change, respectively.

The eight factors identified by the exploratory factor analysis largely correspond to the different parts of the questionnaire. The interpretation of these factors also aligns with the intended design of the questionnaire, with a few exceptions. First, the item about the world being affected by climate change was loaded onto the factor concerning direct contributing sectors to climate change. This overlap might reflect the common perceptions of respondents, who view the world as being affected by climate change and identify the industrial, commercial, and transportation sectors as major contributing sectors. Second, the item about perceived impacted practices loaded onto two factors. According to the Knowledge, Attitude, and Practice model, practice may be inseparable from other constructs related to attitudes and knowledge. Third, the items about preparedness in terms of green lifestyle were loaded onto two factors. Although it is not preferable statistically, it reflected nurses' view that this action differed from the other actions.

One of the key strengths of the development of the instrument regarding climate change actions for nurses is that the tool is grounded in the 2018 ICN's Position Statement on Nurses, Climate Change and Health (International Council of Nurses, 2018). This ensures the contents align with international recommendations in the area of climate change action. Moreover, nursing scholars from Africa, Asia, North America, South America, and Oceania formed the expert panel. Finally, responses collected from nurses in differing roles, such as clinical, educational, research, and administration, and geographic regions were used in the evaluation of psychometric properties. This diverse representation will ensure the instrument's applicability in various regions and across nursing respondents with various backgrounds.

Nevertheless, this study is not without its limitations. Although the instrument has good-to-excellent psychometric properties, it is

Table 3
Factor loadings of questions in the instrument.

No[#]	Questions/Items	Factors							
		F1	F2	F3	F4	F5	F6	F7	F8
	To what extent are the following institutions, groups and individuals responsible for helping to combat climate change?								
18a	…general public	0.747							
18b	…healthcare sector	0.825							
18c	…nursing profession	0.757							
18d	…local government	0.804							
18e	…international organizations	0.757							
18f	…advocacy group	0.724							
18*g*	…yourself	0.753							
	To what extent climate change is affecting…								
16a	…yourself		0.897						
16b	…your family		0.881						
16c	…nurses		0.621						
16d	…your community		0.651						
16e	…the world		0.381				0.544		
19	*As a nurse, to what extent does climate change influenced/impacted your nursing practice or the care provided in the past five years?*		0.402		0.381				
	How likely are you, as a nurse, to… in the next five years?								
10	… engage in policy advocacy that promotes the reduction of healthcare waste and ensure correct waste management …			0.743					
11	… engage in environmental health committees (institutional/ local/global level) that focus on the health workers and the healthcare environment…			0.786					
14	…engage with non-nursing and/or non-health sectors to support strategies that lower greenhouse gas emissions…			0.709					
15	…work with communities to build resilience to the impacts of climate change to address underlying vulnerabilities…			0.739					
	As a nurse, to what extent have you …… in the past five years?								
4	…engaged in policy advocacy that promotes the reduction of healthcare waste and ensure correct waste management …				0.640				
5	… engaged in environmental health committees (institutional/ local/global level) that focus on the safety and protection of health workers and the management and regulation of the healthcare environment…				0.761				
8	…engaged with non-nursing and/or non-health sectors to support strategies that lower greenhouse gas emissions …				0.675				
9	…worked with communities to build resilience to the impacts of climate change to address underlying vulnerabilities…				0.708				
	To what extent are the following sectors contributing to climate change?								
17d	…education sector					0.634			
17e	…agricultural sector					0.444			
17f	…healthcare sector (nursing)					0.855			
17*g*	…healthcare sector (excluding nursing)					0.808			
	To what extent are the following sectors contributing to climate change?								
17a	…industrial sector						0.713		
17b	…commercial sector						0.690		
17c	…transportation sector						0.718		
	Have you ever heard of …prior to this survey?								
1	…the position statement of International Council of Nurses (ICN) "Nurses, Climate Change and Health"…							0.714	
2	…the Nurse Climate Challenge…							0.848	
3	…the Alliance of Nurses for Healthy Environments…							0.753	
	As a nurse, to what extent have you …… in the past five years?								
6	…made greener lifestyle choices and changed your practice to decrease your contribution to greenhouse gas emissions…								0.715
7	… empowered others (i.e. work clients, family, friends, community) to make greener lifestyle choices and change their practices to decrease their contribution to greenhouse gas emissions…								0.636
	How likely are you, as a nurse, to… in the next five years?								
12	…make greener lifestyle choices and change your practices to decrease your contribution to greenhouse gas emissions...			0.425					0.522
13	… empower others (i.e. work clients, family, friends, community) to make greener lifestyle choices and change their practices to decrease their contribution to greenhouse gas emissions…			0.550					0.489

FI: Responsibility for helping to combat climate change.
F2: Affected parties from climate change.
F3: Preparedness for climate change in the next five years.
F4: Achievements in climate change actions.
F5: Sectors that contributed to climate change directly.

F6: Sectors that contributed to climate change indirectly.
F7: Awareness of international nurse-led climate change and health initiatives.
F8: Green lifestyle practice and empowerment.
[#] As the survey is on-going, items have been renumbered in this paper to conceal the position of the attention check question in the questionnaire. As only 125 responses were collected for the nurse educator-specific questions, such questions were excluded from the exploratory factor analysis.

limited by its cross-sectional self-reported design, which cannot establish causality. Future research may consider a longitudinal design to observe any changes over time. Moreover, psychometric properties for language-specific versions were not available due to sample size restrictions, and the respondents could switch between languages on the online platform. Separate scores for each specific climate change action achieved or prepared for were not available. Items that do not collect quantitative data were excluded from evaluation of psychometric properties, though they helped interpret findings. Only willingness and availability of opportunities were explored as factors in preparedness, future studies may explore more factors and barriers. Test-retest reliability was not assessed, as exposure to the questionnaire could change the awareness, attitude and preparedness.

While this study provided preliminary validation of the instrument's structure and validity, future research could further test the psychometric properties. In particular, future studies may restrict language switching and collect larger samples to evaluate language-specific psychometric properties. Confirmatory factor analysis may be conducted to validate the factor structure. Comprehensive item analysis may be performed to further refine the items for future rounds of survey.

5. Conclusion

In conclusion, this instrument is valid and reliable for examining achievement, preparedness, awareness and attitudes toward climate change among nurses globally. The data collected from this instrument have the potential to provide valuable insights into how nurses globally prepare for and respond to the health challenges posed by climate change. More importantly, such findings will inform stakeholders, including nurse educators, healthcare facility administrators, government officials, and international climate change initiatives, in developing targeted policies and programs to empower nurses in effective climate action.

Disclaimer

Study enrolment and data collection are ongoing. The planned end date for this study is early 2025.

Data availability

Due to the small sample size of our expert panel, our data are not suitable for sharing as participants could be recognized.

Patient consent for publication

Not applicable.

Declaration of generative AI and AI-assisted technologies in the writing process

During the preparation of this work the authors used ChatGPT in order to enhance the readability of the manuscript. After using this tool/service, the authors reviewed and edited the content as needed and take full responsibility for the content of the published article.

CRediT authorship contribution statement

Pui Hing Chau: Writing – review & editing, Writing – original draft, Validation, Methodology, Formal analysis, Conceptualization. **Tiffany L.T. Yu:** Writing – review & editing, Writing – original draft, Validation, Methodology, Formal analysis, Conceptualization. **Yan Hu:** Writing – review & editing, Validation, Methodology. **Yasna K. Palmeiro Silva:** Writing – review & editing, Validation, Methodology. **Eileen Gilder:** Writing – review & editing, Validation, Methodology. **Michelle Cole:** Writing – review & editing, Validation, Methodology. **Roinah Ngunyulu:** Writing – review & editing, Validation, Methodology. **Chia-Chin Lin:** Writing – review & editing, Validation, Methodology, Conceptualization.

Declaration of competing interest

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

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Supplementary materials

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