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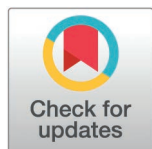
RESEARCH ARTICLE

# What competencies physical activity professionals should possess to better integrate climate change related issues into their practice: A Delphi study

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## Abstract

Climate change threatens human health and performance, creating new challenges for physical activity professionals. To prepare them, it is essential to define the competencies required to better integrate climate change–related considerations into their professional practice. This study used the Delphi method to identify such competencies. A panel of 143 experts was invited to participate in a three-round Delphi study. Round one used an open-ended questionnaire to gather their perspectives, which were analyzed qualitatively to identify recurring themes and sub-themes. In rounds two and three, experts rated their agreement with each competency using 11-point Likert scales. Items with a median score  $\geq 8$  were retained for Round 3, and those with improved consensus ( $\geq 70\%$  of scores  $\geq 8$ ) and high stability (median variation  $< 15\%$  between rounds 2 and 3) were retained as consensus competencies. Thirty-four experts from 10 countries reached a final consensus on 18 competencies: 7 knowledge, 8 skills, and 3 attitudes. Within knowledge, strongest agreement concerned recognizing how climate-related health risks disproportionately affect vulnerable populations and identifying risks associated with physical activity during extreme conditions. For skills, consensus was highest for assessing risks linked to outdoor activity and the ability to adapt exercise prescription and make rapid decisions to ensure client safety. For attitudes, the strongest agreement emphasized willingness to adapt professional practice in response to climate extremes. The 18 identified competencies offer a guide for incorporating climate change related issues into physical activity professionals training program.

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**Data availability statement:** Quantitative data generated during this study may be requested from the Research Ethics Committee ([cierreh@uqam.ca](mailto:cierreh@uqam.ca)) on reasonable request after appropriate review. However, the free-text data collected in survey 1 can not be shared because it contains potentially identifying information. This restriction has been imposed by the Research Ethics Committee.

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**Competing interests:** The authors have declared that no competing interests exist.

## 1. Introduction

Climate change, characterized by long-term shifts in temperature, precipitation, and extreme weather, poses major risks to human health [1]. Rising global temperatures, sea level rise, and heatwaves contribute to over 150,000 deaths annually, with projections of an additional 250,000 deaths per year between 2030 and 2050 [2]. Climate change affects health through direct impacts such as heat-related illnesses, respiratory and cardiovascular diseases, and vector-borne infections [1,3] as well as indirect impacts including mental health disorders, sleep and eating disturbances, displacement-related violence, and long-term migration burdens that disproportionately affect vulnerable groups [4–8]. Given these wide-ranging health consequences, attention has increasingly turned to how climate change shapes everyday behaviors that influence long-term well-being. Physical activity, in particular, is both directly and indirectly affected by changing environmental conditions, with climate-related factors altering opportunities, safety, and motivation for participation. While rising temperatures may extend opportunities for outdoor recreation [9,10], these are outweighed by health risks such as heat stress and cardiovascular strain [11,12]. More frequent heatwaves impair performance and increase heat-related illnesses, especially in outdoor or poorly ventilated indoor settings [11,13]. Air pollution further discourages activity by reducing lung function and increasing cardiovascular risks [13–15]. Extreme weather and natural disasters can damage sport infrastructures, limiting participation [10,16,17], and severe winter conditions promote sedentary behaviors [18]. These growing climate change threats underscore the need for health professionals to implement adaptive strategies that protect well-being, enhance resilience, and reduce exposure to climate change health risks [19,20].

Despite the urgency, many health professionals, including physicians, nurses, physiotherapists, and physical activity professionals, remain insufficiently trained to integrate climate-related knowledge into their practice [20–23]. For physical activity professionals in particular, whose expertise lies in sports performance, rehabilitation, and health promotion [24,25], climate change introduces new challenges. Rising heat, poor air quality, and unstable environmental conditions directly affect their clients' ability to engage in safe physical activities [13,20,26]. Physical activity professionals are uniquely positioned to integrate mitigation and adaptation strategies into their practice, working across diverse age groups and populations to promote climate-conscious physical activity. By equipping them with the knowledge, skills, and attitudes to respond to climate change, the profession can ensure that physical activity-based interventions not only support individual health but also contribute to collective resilience and environmental sustainability. Yet, current physical activity curricula rarely include climate-related content [26]. For instance, only 13% of German outdoor sports coaches reported receiving formal training on heat-health risks during their certification [20]. Schneider et al. [10,13,27,28] highlighted the growing threats climate change poses to athlete safety and performance, proposing preventive frameworks including education, but without specifying required competencies. Even recent existing professional frameworks, such as the Essential Competencies of Practice for Kinesiologists in Ontario [29], do not mention climate change. This

leaves physical activity professionals underprepared to safeguard health in clinical, community, and outdoor contexts increasingly shaped by climate-driven hazards.

To address this gap, several medical disciplines have started integrating climate-related issues into both initial and continuing education program. However, similar initiatives are still lacking for physical activity professionals. Defining the competencies required to recognize, prevent, and mitigate climate-related health risks is a crucial step. Such an effort first requires identifying the specific content that could inform education programs, namely, the knowledge, skills, and attitudes that physical activity professionals should acquire to better integrate climate considerations into their practice. In recent years, many authors [20,27,30,16] have highlighted the bidirectional links between climate issues and physical activity, underscoring the importance of preparing professionals to address them. The Delphi method offers a particularly valuable approach for gathering expert consensus on this topic. Therefore, the objective of this study is to identify the educational competencies (knowledge, skills, and attitudes) that physical activity professionals should develop to effectively integrate climate change into their professional practice.

## 2. Methods

### Ethics statement

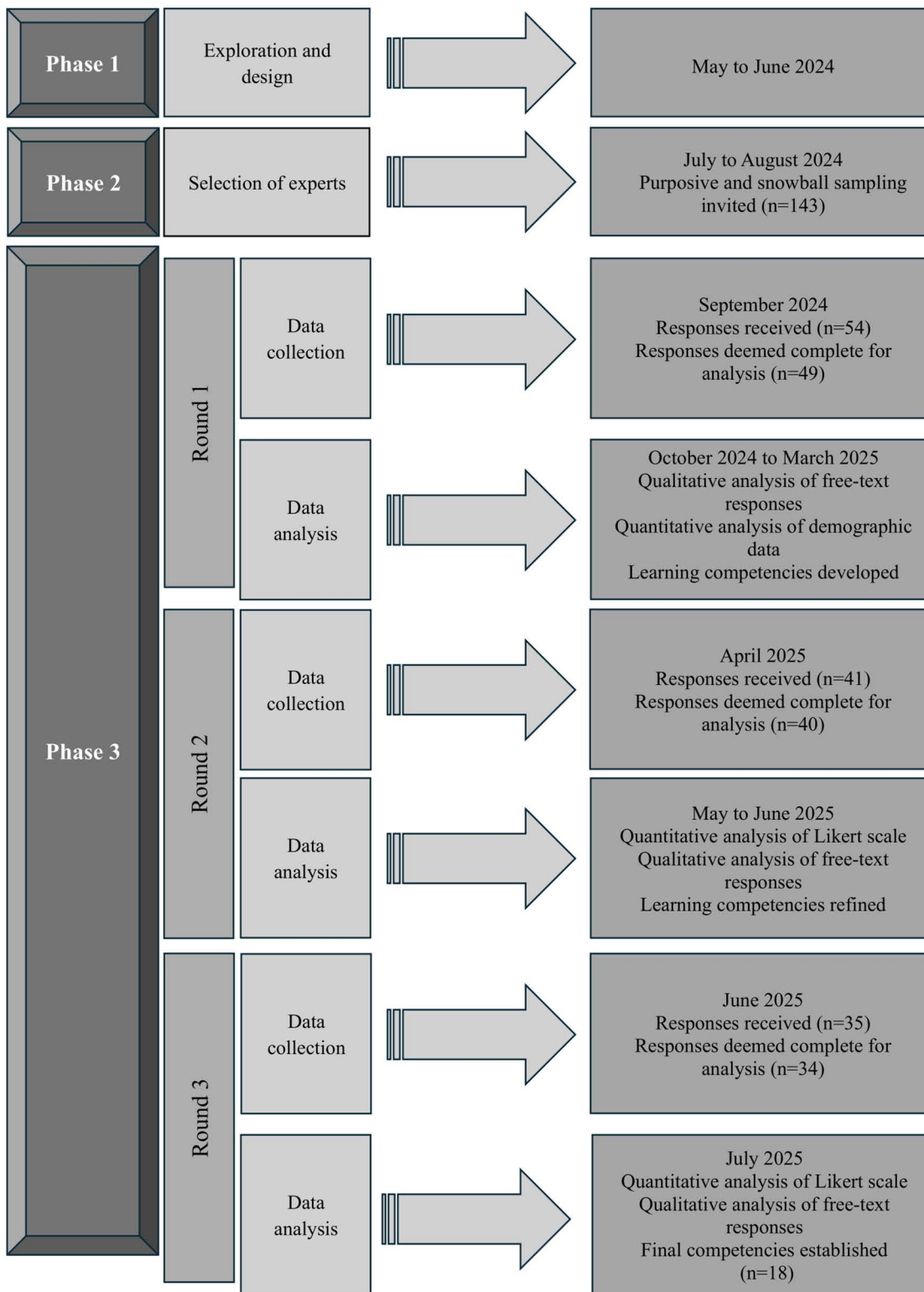
This project received ethics approval from the Université du Québec à Montréal (Project #2024–6762). All participants were adults and provided informed consent prior to their participation in the study. Before data collection began, participants electronically confirmed their written consent. Participants received detailed information about the study objectives, procedures, potential risks and benefits, confidentiality measures, voluntary participation, and their right to withdraw at any time.

### 2.1 Conceptual framework

This study employed a Delphi method to identify relevant competencies. The competencies, in this context, are defined as the integration of knowledge, skills, and attitudes enabling individuals to respond successfully to complex demands in specific situations [31]. Knowledge refers to the essential information the kinesiologist needs to know. Skills involve the practical application of this knowledge, i.e., what the kinesiologist must know how to do in order to carry out their work and use their knowledge correctly. Skills are acquired progressively through practice or other types of experience. Attitudes represent the behaviors that the kinesiologist must adopt to respond effectively to the demands of their profession. This framework aligns with public health competency models that emphasize the interplay of knowledge, skills, and attitudes as essential components of effective professional practice [32–35].

### 2.1 Study design

Considering the limited empirical guidance on climate-related competencies for physical activity professionals, expert consensus methods offer a rigorous avenue to integrate insights and define key educational priorities. Accordingly, we employed the classic Delphi method to engage professionals from physical activity and health fields. This method supports a systematic process for identifying, refining, and prioritizing competencies crucial for incorporating climate considerations into professional practices. The Delphi technique was chosen for its ability to enhance the validity of findings by fostering consensus that transcends individual opinions and builds on collective expertise [36]. By combining qualitative and quantitative elements, it enables the discovery of novel insights and the clarification of complex data [37]. The study was structured into three distinct phases, as illustrated in Fig 1. This manuscript was written according to the recommendations for the interdisciplinary standardized reporting of Delphi studies in social and health sciences (DELPHISTAR). The DELPHISTAR checklist is provided in supplementary material (S1 Table). This study was not preregistered.



**Fig 1. Flow diagram of Delphi study process.**

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## Phase 1 – Exploration and design

The steering group was established, consisting of three experts (PB, TG, and TAD) with expertise in environmental and exercise physiology, health behavior, environment, outdoor activity, sport and physical activity. To initiate the study, TAD and PB conducted a preliminary review of the available literature to assess whether specific material existed regarding the competencies that physical activity professionals should possess to address climate-related issue in their practice. This review confirmed the absence of such specific material, thereby validating the need for a structured expert consultation approach, such as the Delphi method. Next, a targeted review of published Delphi studies in related fields, such as health sciences and nursing [36,38] was carried out. This step aimed to identify methodological best practices and relevant examples to inform the design of the present study. The research team designed and developed an open-ended questionnaire aimed at collecting a wide range of expert perspectives on the competencies physical activity professionals should possess in relation to climate change and its implications. This questionnaire constituted the first round of the Delphi process. (S2 Text).

## Phase 2 – Selection of experts

Expert recruitment followed a hybrid strategy combining purposive and snowball sampling. To establish the expert panel, we first identified experts through a review of the literature in the field of physical activity and climate change [5,13,14,16,30,39] and through professional connections developed at relevant academic conferences. This initial list included international researchers and academics with recognized expertise in health and physical activity sciences. Then, these experts were invited to refer additional qualified individuals from their professional networks. This dual approach allowed the formation of a diverse and highly qualified group of contributors while leveraging existing academic networks [40]. Participants were eligible if they (1) had reliable internet access, (2) were fluent in French or English, and (3) were at least 18 years old. These criteria ensured the necessary technological and communicative capacity to engage meaningfully in the study. A final list of 143 international experts was created.

## Phase 3 – Three rounds of the Delphi methods

### 1. Round 1

**Procedure and data collection.** The use of the open-ended questions was intentional to (i) avoid influencing the experts and (ii) gather as much diverse content as possible to inform the development of Round 2. The team drafted five open-ended questions exploring (1) knowledge, (2) skills, (3) attitudes, (4) any additional factors, and (5) any other relevant considerations related to climate change and physical activity. The full questionnaire is provided in S1 Text. To ensure clarity and relevance, the questions were then pilot tested with five researchers and professors in physical activity field from different institutions. Before completing the survey, participants were asked sociodemographic questions as well as questions about their position and expertise.

Surveys were administered online, hosted by Qualtrics XM (Qualtrics International Inc., USA). Email was used to send survey links to participants for each round. The French and English versions of the Round 1 survey were distributed via email to 143 experts during the last week of August 2024, using a list compiled by the research team. Participants were asked to complete and submit their responses within five weeks, by the end of September 2024.

**Data analysis.** A thematic analysis was employed to identify the educational competencies regarding climate change. This qualitative analytic method is widely recognized and frequently utilized, particularly in addressing areas that are under-researched [41]. Thematic analysis in this study was conducted following the six-phase approach outlined by Braun and Clarke [42], which includes: (1) familiarization with the data, (2) generation of initial codes, (3) identification of themes, (4) review of themes, (5) definition and naming of themes, and (6) production of the final report. Each of these phases was systematically applied throughout the analytical process. In order to standardize and avoid bias in the encoding process,

encoding protocols were implemented by two raters (KH and EC). These protocols established guidelines to standardize the evaluation process. They defined when and if a statement should be associated with a certain, unconnected category. Qualitative feedback was thematically analyzed by two authors (KH and EC), and reviewed with the steering group to determine what, if any, modifications were required before the competencies were presented in next round.

## 2. Round 2

**Procedure and data collection.** The second-round questionnaire was designed based on the proposed competencies developed in round 1. After several revisions and correction of proposed competencies by the research team (KH, PB, and TAD), the final version of the questionnaire was finalized with 52 competencies ([S2 Text](#)). In round 2, the experts were asked to score each proposed competency on an 11-point Likert scale (ranging from 0=extremely unimportant to 10=extremely important), and complete and submit their responses within two weeks, by the end of April 2025. In round 2, participants were also allowed to comment on each competency and provide feedback or suggestions for any refinements. Participants received two reminder emails containing the same questionnaire (no changes were made) to minimize attrition.

**Data analysis.** Qualitative feedback was carefully reviewed and discussed by the steering committee to assess the need for revisions. Quantitative data were analyzed in Microsoft Excel 2016 (Version 16.0, Microsoft Corporation, Redmond, WA, USA) to calculate the median score of participants' ratings. Both the median and mean values of participants' ratings were calculated to provide a comprehensive view of the central tendency of responses. The median was preferred over the mean as a measure of central tendency, as it is less influenced by outliers and skewed distributions, common characteristics in Delphi responses, thereby offering a more robust criterion for establishing consensus [43–45]. A consensus threshold was defined as a median score  $\geq 8$ , consistent with established recommendations in Delphi studies [44].

## 3. Round 3

**Procedure and data collection.** In the third round, the research team (KH, TG, PB, and TAD) reviewed and revised the competencies that resulted from analysis of the second round and the final version of the questionnaire was finalized with 41 competencies. The same 11-point Likert scale was used for scoring, ranging from 0 (extremely unimportant) to 10 (extremely important). Participants were also invited to provide additional feedback or suggest refinements.

**Data analysis.** In the third round, qualitative feedback was reviewed and discussed by the team. Quantitative data were analyzed in Microsoft Excel to calculate the **median score** of participants' ratings. The consensus criteria were defined as follows for the third round: (1) stability, i.e., a median score variation of no more than 15% between rounds 2 and 3 [44] and (2) improved consensus, i.e., at least 70% of participants assigning a score of  $\geq 8$  [44].

## 3. Results

### 3.1 Demographic characteristics of panel members

Throughout the three Delphi rounds, the features of participants showed considerable stability. The predominant age group of experts was 40–49 years old. Most experts were based in France and Canada. In terms of academic position, professors consistently represented the largest share. Regarding professional experience, nearly half of the participants reported more than 10 years of experience, ensuring that the panel was composed of highly experienced experts [Table 1](#).

### 3.2 Round 1

A total of 54 responses were received, comprising 21 responses in English and 33 in French. Of these, 49 responses (20 in English and 29 in French) were deemed complete and suitable for analysis. Five responses were excluded due to incomplete demographic information, lack of an email address for contact in the second round of the Delphi, and failure to answer some questions. Analysis of first-round Delphi responses yielded 18 themes and 40 sub-themes presented in [Fig 2](#).

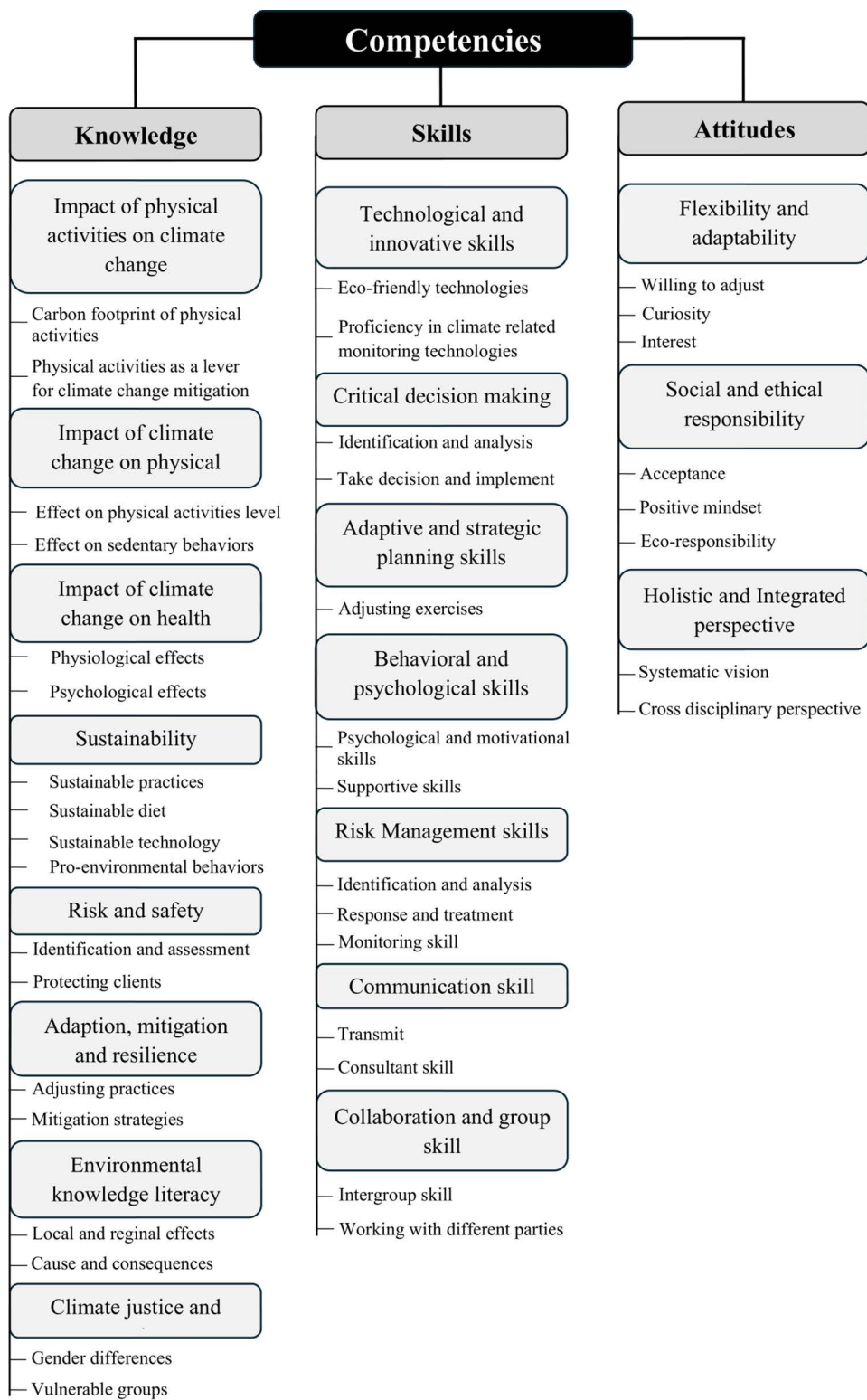
**Table 1. Demographic characteristics of panel members.**

	Round 1 (n=49)	Round 2 (n=39)	Round 3 (n=34)
<b>Sex</b>			
Male n (%)	33 (67%)	26 (67%)	23 (68%)
Females n (%)	16 (33%)	13 (33%)	11 (32%)
<b>Age groups, n (%)</b>			
20-29 years	6 (12%)	3 (8%)	3 (9%)
30-39 years	14 (29%)	12 (31%)	10 (29%)
40-49 years	19 (39%)	15 (38%)	14 (41%)
50-59 years	9 (18%)	8 (20%)	6 (18%)
≥ 60 years	1 (2%)	1 (3%)	1 (3%)
<b>Country of residence, n (%)</b>			
Canada	12 (25%)	10 (26%)	10 (29%)
France	22 (45%)	16 (41.5%)	14 (41%)
Germany	4 (8%)	2 (5%)	2 (6%)
UK	1 (2%)	1 (2.5%)	1 (3%)
Switzerland	4 (8%)	4 (10%)	3 (9%)
USA	2 (4%)	2 (5%)	1 (3%)
Singapore	2 (4%)	2 (5%)	2 (6%)
Ireland	1 (2%)	1 (2.5%)	1 (3%)
Australia	1 (2%)	1 (2.5%)	0 (0%)
<b>Current position, n (%)</b>			
Professor	23 (47%)	18 (46%)	14 (41%)
Assistant Professor	13 (27%)	11 (28%)	10 (29%)
Lecturer	1 (2%)	1 (3%)	1 (3%)
Research fellow	6 (12%)	4 (10%)	4 (12%)
PhD student	5 (10%)	4 (10%)	4 (12%)
Kinesiologist	1 (2%)	1 (3%)	1 (3%)
<b>Years of experience, n (%)</b>			
< 5 years	11 (22%)	8 (21%)	8 (23.5%)
5-9 years	11 (22%)	8 (21%)	8 (23.5%)
10-14 years	7 (15%)	6 (15%)	5 (15%)
15-19 years	6 (12%)	5 (12%)	4 (12%)
≥ 20	14 (29%)	12 (31%)	9 (26%)

<https://doi.org/10.1371/journal.pclm.0000812.t001>

### 3.3 Round 2

In the second round, 41 competencies achieved a median score  $\geq 8$  and were retained, while 11 competencies were excluded. Additionally, two competencies were reassigned to different thematic categories based on participant feedback (“Be able to explain to their clients how they can be prepared to cope with climate extreme events [e.g., heat waves, floods, and extreme weather events]” and “Educate clients on safe strategies related to physical activities in extreme heat conditions to prevent heat-related illnesses or other diseases”). These two competencies were reassigned from “risk management skill” to “communication skill”. However, none of the existing themes or sub-themes were entirely removed. A detailed summary of central tendency measures, and consensus levels, and competency modifications from round 2 is available in [S2 Table](#).



**Fig 2. Analysis of the first round of the Delphi that yielded 18 themes (boxes) and 40 sub-themes.**

<https://doi.org/10.1371/journal.pclm.0000812.g002>

### 3.4 Round 3

In the third round, application of the two predefined consensus criteria (i.e., stability and improved consensus) resulted in the exclusion of 23 competencies (7 knowledge, 9 skills, and 7 attitudes). They are presented in red in [S2 Table](#). These items were all excluded because they did not reach the improved consensus criteria (i.e., at least 70% with a score  $\geq 8$ ). No items were excluded based on the stability criteria. Ultimately, consensus was reached on 18 competencies, including 7 knowledge, 8 skills, and 3 attitudes, as presented in [Table 2](#).

## 4. Discussion

To our knowledge, this study is the first to identify the educational competencies that physical activity professionals should develop to effectively integrate climate change into their professional practice. Through a three-round Delphi process, the expert panel reached consensus on 18 key competencies (7 knowledge competencies, 8 skills competencies and 3 attitudinal competencies) that can guide the development of specific initial or continuing training programs. Overall, the competencies identified cluster into three overarching themes, for which we propose practical guidance on how they can be integrated into training curriculum and professional development programs.

First, the highest agreement was on competencies related to identifying and managing health risks from climate and extreme weather events (items #3, 5, 13, 14 for knowledge; items #26, 27, 31, 33 for skills in [S2 Table](#)). This shows

**Table 2. The 18 competencies that physical activity professionals should possess to better address climate change related issues into their practices.**

<b>Regarding knowledge (n=7), physical activity professionals should be able to...</b>
- Describe how climate change influences participation, injury risks, and barriers to physical activities
- Explain and recognize the health risks associated with climate change
- Identify the win-win pro-environmental behaviors for health and climate change (e.g., meat consumption reduction, active transport)
- Identify health risks associated with exercise and physical activities during extreme temperatures, during pollution alerts, or after extreme weather events for their clients
- Knowledge of how to minimize climate-related health risks and ensure safe physical activity conditions for their clients
- Understand how to modify and adapt their clinical practices based on the health risks (e.g., heat exhaustion, heatstroke, cardiac events) caused by climate change
- Understand how climate-related health risks disproportionately affect vulnerable populations (older adults, children, women, indigenous people, individuals with disabilities, or low incomes)
<b>Regarding skills (n=8), physical activity professionals should be able to...</b>
- Identify and analyze the risks related to outdoor physical activities (e.g., heat stress, dehydration, heat stroke) to ensure the safety of their clients
- Make rapid decisions to ensure client safety during extreme climate events
- Modify and adjust exercise elements (intensity, duration, frequency, exercise type) in response to climate-related health risks, such as dehydration, heat exhaustion, and hyperthermia
- Monitor and identify the physiological symptoms related to climate extreme events or poor environmental conditions (air, water), which may affect athletic performance
- Present alternative rehabilitation strategies for vulnerable individuals who may be affected during extreme climate events
- Monitor the vital signals during climate extreme events or poor environmental conditions among their clients (e.g., body temperature, hydration levels, exertion)
- Be able to educate clients on safe strategies related to physical activities in extreme heat conditions to prevent heat-related illnesses or other diseases
- Provide personalized advice on how poor environmental conditions (e.g., air, water, temperature, and climate extreme events) can impact clients' health and physical activity plans
<b>Regarding attitudes (n=3), physical activity professionals should be able to...</b>
- Demonstrate flexibility in modifying training plans and sessions based on climate-related factors
- Willing to adapt their professional practices based on climate extreme events such as heat waves, air pollution, or extreme weather
- Promote physical activities that align with climate goals

<https://doi.org/10.1371/journal.pclm.0000812.t002>

that the priority for physical activity professionals in a changing climate is ensuring patient and client safety in changing environments. In particular, the ability to identify (knowledge) and analyze (skills) risks related to outdoor physical activity (e.g., heat stress, dehydration, heat stroke, pollution-related respiratory issues) achieved the highest consensus (median scores of 9, 94–97% agreement). These results align with recent literature showing that professionals consistently identify heat-related risks as a major challenge for outdoor sports requiring systematic recognition and monitoring [13,20,27,30,46]. Health professionals also anticipate greater vulnerability to heat stress under climate change, calling for stronger training in risk assessment and rapid response [2]. Current guidelines emphasize structural strategies (e.g., cooling infrastructure), organizational protocols (e.g., early warning systems), and individual-level strategies (e.g., acclimatization/acclimation, hydration, protective clothing) [27,16,47].

To address this, education programs should incorporate: (i) tools like the Climate Fresk workshop (<https://climatefresk.org/world/>) to help professionals grasp systemic connections between climate, health, and physical activity, while empowering them to take action, (ii) presentation of the current guidelines for safe physical activity in hot weather and during air pollution events; (iii) practical simulations and case-based learning (e.g., climate chamber sessions, use of monitoring devices for temperature and pollution); (iv) introduction to the development of emergency protocols and decision-making scenarios (e.g., what to do if a client shows signs of heat exhaustion); and (v) training on how to communicate clear, evidence-based recommendations to clients during pollution or heat alerts.

Second, experts also emphasized the need to adapt professional practices in response to climate-related health risks and educate clients (items #12, 15 for knowledge; items #28, 36, 37 for skills; items #41, 42, 48 for attitudes in [S2 Table](#)). In particular, the ability to modify and adjust exercise elements in response to climate-related health risks achieved the highest consensus (median scores of 10, 94–97% agreement). Such adaptability is critical to ensure safe participation in physical activity despite rapidly changing conditions, and mirrors the shift in healthcare professions toward flexible, context-sensitive practices. Importantly, the attitudinal competencies that reached consensus were strongly oriented toward flexibility and a willingness to adapt professional practice in response to climate extremes. Another key finding was the emphasis on understanding how climate-related health risks disproportionately affect vulnerable populations, such as older adults, children, persons living with disabilities, and low-income groups (items #22 for knowledge; items #32 for skills in [S2 Table](#)). This aligns with broader discussions on the insufficient integration of marginalized populations in physical activity curricula and the limited attention to social justice frameworks in professional guidelines [48]. Vulnerable populations already face significant barriers to physical activity (e.g., chronic disease, obesity, mobility or cognitive limitations), which are likely to be exacerbated by climate-related risks such as extreme heat, air pollution, and reduced access to safe spaces [49,50]. As such, physical activity professionals must develop a nuanced understanding of how these intersecting factors uniquely affect vulnerable groups. Without this awareness, practitioners risk delivering interventions that are ineffective or exclusionary, potentially leading to disengagement and adverse health outcomes [49,50].

To better prepare future physical activity professionals, curricula should include: (i) specific information about who are the most at risk of hazard-related health problems and why, (ii) design of adapted intervention strategies for high-risk populations, such as safe indoor alternatives during heat and pollution events, and (iii) organizing interdisciplinary workshops (e.g., with public health, urban planning, and environmental science students) to design holistic interventions.

In comparing our findings with prior Delphi-based research, our study occupies a distinct position. While Alsop et al. [36], achieved a narrower consensus (11 competencies) with a broad health professional target group, without addressing climate-related risks, our study produced a richer competency framework specifically developed to address the unique problems of climate change, particularly designed for physical activity professionals. Similarly, Schneider et al. [13,27,28] identified climate-related risks in sport and proposed prevention models but did not specify the professional competencies required to address them. Our work extends this literature by moving beyond risk categorization and prevention frameworks to articulate the professional competencies that physical activity professionals must possess. In doing so, we bridge

the gap between identifying risks or preventive measures and equipping physical activity professionals with the competencies to respond effectively.

## 5. Strength and limitations

An important strength of the study lies in its inclusion of a diverse cohort of international participants with relevant expertise, enhancing the generalizability of the findings across global contexts. Additionally, the use of the Delphi method constitutes a methodological advantage, as it facilitates expert consensus through the generation of group-level rather than individual-level insights. However, this approach may also introduce potential bias, as the validity and robustness of the outcomes are highly contingent upon the careful and representative selection of panelists. Furthermore, although we have diverse participants from five continents, we did not have any experts from the African countries. Consequently, the findings should be interpreted as reflecting perspectives primarily from the regions represented, and caution is warranted when extrapolating to under-represented contexts. Future Delphi studies should prioritize strategies to enhance participation from these regions (e.g., multilingual administration, targeted recruitment through regional professional societies and institutions).

## 6. Conclusion

This study established expert consensus on 18 competencies, comprising 7 knowledge, 8 skills, and 3 attitudes that physical activity professionals should possess to better address the challenges of climate change in their practice. These competencies underscore the need for a comprehensive understanding of climate-related health risks, the ability to adapt exercise protocols, ensure client safety under extreme environmental conditions, and the capacity to promote pro-environmental behaviors and sustainable practices. They also highlight the importance of supporting vulnerable populations. Attitudinal dimensions emphasize flexibility and the need to promote physical activities that align with climate goals. These competencies provide a foundation for embedding sustainability and climate resilience within physical activity education program.

## Supporting information

### **S1 Table. Delphi studies in social and health sciences checklist.**

(DOCX)

### **S2 Table. Summary of central tendency measures, consensus levels, and modifications from round 2.**

(DOCX)

### **S1 Text. First questionnaire of the Delphi process.**

(DOCX)

### **S2 Text. Second questionnaire of the Delphi process.**

(DOCX)

## Author contributions

**Conceptualization:** Kazem Hozhabri, Tegwen Gadais, Paquito Bernard, Thomas A Deshayes.

**Data curation:** Kazem Hozhabri, Thomas A Deshayes.

**Formal analysis:** Kazem Hozhabri, Tegwen Gadais, Paquito Bernard, Élianne Carrier, Thomas A Deshayes.

**Funding acquisition:** Tegwen Gadais, Paquito Bernard, Thomas A Deshayes.

**Methodology:** Kazem Hozhabri, Tegwen Gadais, Paquito Bernard, Thomas A Deshayes.

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