

The Canadian Assessment of Physical Literacy: Development of a Model of Children's Capacity for a Healthy, Active Lifestyle Through a Delphi Process

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Background: The Canadian Assessment of Physical Literacy (CAPL) was conceptualized as a tool to monitor children's physical literacy. The original model (fitness, activity behavior, knowledge, motor skill) required revision and relative weights for calculating/interpreting scores were required. **Methods:** Nineteen childhood physical activity/fitness experts completed a 3-round Delphi process. Round 1 was open-ended questions. Subsequent rounds rated statements using a 5-point Likert scale. Recommendations were sought regarding protocol inclusion, relative importance within composite scores and score interpretation. **Results:** Delphi participant consensus was achieved for 64% (47/73) of statement topics, including a revised conceptual model, specific assessment protocols, the importance of longitudinal tracking, and the relative importance of individual protocols and composite scores. Divergent opinions remained regarding the inclusion of sleep time, assessment/scoring of the obstacle course assessment of motor skill, and the need for an overall physical literacy classification. **Conclusions:** The revised CAPL model (overlapping domains of physical competence, motivation, and knowledge, encompassed by daily behavior) is appropriate for monitoring the physical literacy of children aged 8 to 12 years. Objectively measured domains (daily behavior, physical competence) have higher relative importance. The interpretation of CAPL results should be reevaluated as more data become available.

Keywords: physical activity assessment, evaluation, health determinants, health promotion, community-based research

Physical literacy is broadly understood as the individual's capacity for a healthy, active lifestyle. However, published definitions of the term "physical literacy" are highly variable. The lack of consensus regarding the constituent subdomains hampers the development of a standardized assessment to monitor this important "healthy living" construct. Whitehead has defined physical literacy as "the motivation, confidence, physical competence, knowledge, and understanding to maintain physical activity throughout life."¹ The definition proposed by Tremblay and Lloyd identified physical competence (motor skill and fitness), knowledge and physical activity behavior as being the components of physical literacy.² Others have defined physical literacy as being comprised of various combinations of similar skills, abilities and behaviors.³⁻⁶ That less than 10% of Canadian children achieve the minimum daily physical

activity recommended for optimal health suggests that deficits of physical literacy are common.⁷ Enhancing the capacity of children to achieve and maintain a physically active lifestyle would be expected to benefit their physical and mental health, both immediately during childhood and long term.⁸

Physical literacy is defined here as the attributes, characteristics, skills and behaviors that are related to the capacity for, and commitment to, a healthy, active lifestyle. We propose that a physically literate individual is one who has the motivation, confidence, knowledge, skills, and fitness necessary to enjoy and be committed to the physical activity and sedentary behaviors associated with optimal physical and mental health. Thus, the desired outcome of a "healthy, active lifestyle" is contingent upon both the underlying attributes and characteristics that contribute to

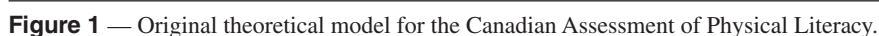
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The Canadian Assessment of Physical Literacy (CAPL) was developed as a comprehensive, valid and reliable measure of physical literacy for children in Grades 4 to 6.^{2,9,10} Children in these grades were initially selected because they could independently complete the knowledge questionnaire and pedometer records but had not yet reached adolescence, when physical activity declines more dramatically.⁷ Details of the CAPL development are being published separately¹¹ but are briefly reviewed here as historical context to the Delphi panel process and discussions. Initially, the scope and content of the CAPL was informed by expert consultations, including university faculty, physical education consultants from local school boards, a representative of the Ontario Ministry of Culture, Tourism, and Sport and representatives of Canadian organizations focused on encouraging childhood physical literacy (eg, Active Healthy Kids Canada, ParticipACTION, Physical and Health Education Canada (PHE Canada), Ontario Physical and Health Education Association). These experts originally conceptualized the CAPL as having 4 domains (Figure 1): physical activity behavior, physical fitness, motor skill, and knowledge/awareness/understanding.^{2,10} The Scientific Advisory Panel for the CAPL project, chaired by Dr. M. Tremblay, identified specific protocols that could assess different facets within each of these initial domains (eg, aerobic fitness, flexibility, body composition, and muscular strength and endurance as components of physical fitness). Protocols were standardized tests when available (eg, pedometer step counts to evaluate daily physical activity) and newly developed protocols when age appropriate validated assessments were nonexistent.^{9,12,13} Protocols were selected to enable group assessments (eg, use of pedometers for large surveys, optimizing the potential of CAPL use for population surveillance).^{13,14}

Methods

Delphi Participants

International experts were identified via academic databases using the search terms *physical literacy*, *childhood physical activity*, *physical fitness measurement*, *motor skill development*, *childhood motivation*, and *physical activity knowledge assessment*. Referrals and recommendations expanded the list of potential experts to



ensure representation for each CAPL domain (both those originally proposed (Figure 1) and the domains within the model subsequently considered by the Delphi panel (Figure 4), enhancing consideration of each physical literacy component during the Delphi process. All identified experts were invited to participate in the 3-round Delphi process. Participants were assigned a unique identification number to maintain response confidentiality.

Delphi Process. The goal of a Delphi process is consensus after 3 structured rounds of discussion. For this project, consensus was defined as agreement among 75% of the panel.^{18,19} Each round

was conducted electronically, using a secure website and reminder e-mails, between December 2012 and March 2013 (Figure 2). Experts who did not respond were withdrawn from subsequent rounds.

Round 1. Round 1 included 29 open-ended questions. The questions reflected the CAPL assessment protocols as established to that point, with the questions grouped into sections reflecting overall physical literacy and the proposed domains of the revised CAPL model (see [Online Supplementary Material](#)). The goal was to gather expert opinion regarding the inclusion of each proposed CAPL item

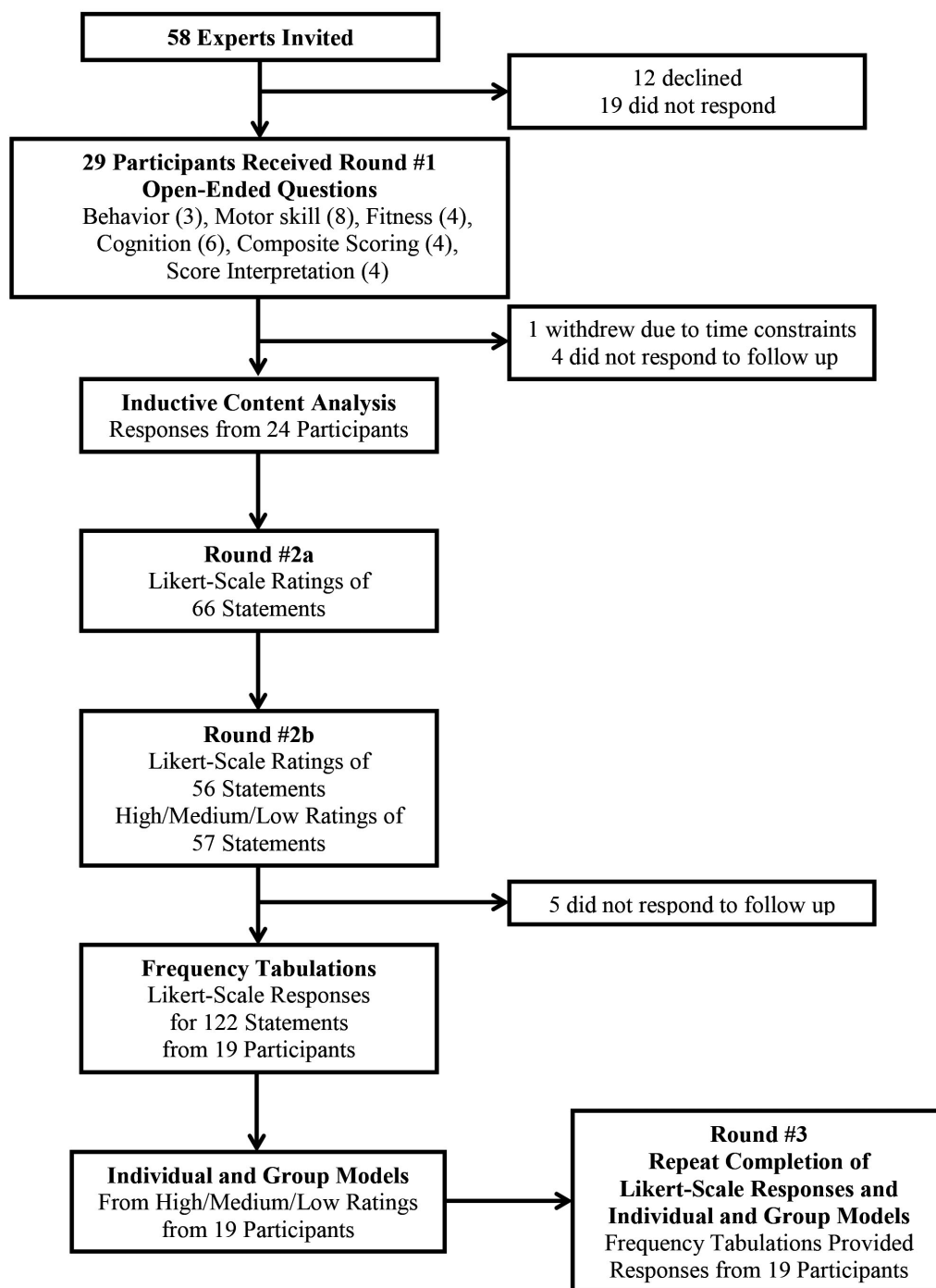


Figure 2 — Description of Delphi process and expert participation.

and the calculation and development of individual test, domain, and overall scores. Additional information was sought regarding the relative importance of composite scores and score interpretation. Three researchers independently analyzed Round 1 responses using inductive content analysis.²⁰ This allowed important concepts to be conveyed by the Delphi participants without a preconceived framework. Each researcher independently identified common themes and areas of divergent opinion, using this information to develop proposed statements for Round 2. The 3 researchers plus the second author then met to discuss the proposed statements, address differences of interpretation, and agree on the final list of statements that would comprise the Round 2 questionnaire. Where expert opinions were diverse, multiple statements were created to convey all divergent opinions.

Round 2. Delphi participants rated each statement and a revised CAPL theoretical model using a 5-point Likert scale (strongly disagree, disagree, neutral, agree, and strongly agree).⁹ Open-ended questions were not provided. The goal was to indicate the degree of consensus on each topic and to evaluate whether Round 1 responses had been effectively conveyed. Due to software limitations, Round 2 was completed in 2 parts: a webpage questionnaire (Round 2a) followed by a text document circulated by e-mail (Round 2b). All responses were returned electronically, with coded ID numbers assigned by the lead author. Round 2a statements addressed item inclusion/exclusion, assessment methods and protocol scoring. Round 2b sought feedback on the relative importance of individual protocols within composite scores, using a 3-point scale (high, medium, low). For Round 2b, consensus was defined as 75% of the panel assigning the same relative importance.^{18,19} Two Delphi participants completed Round 2a but were unable to complete Round 2b. These experts did participate in the final round as their responses were integral to the composition of Round 2a.

Round 3. Round 2a statements were recirculated. Each participant received their previous response as well as the group distribution of responses for each statement. Delphi participants could confirm or alter their original rating based on the information provided. Diagrammatic models, reflecting Round 2b recommendations for item importance and composite scoring, were also circulated for evaluation. The lead author created a model, similar to Figure 3, to reflect the Round 1 and 2 responses of each expert. The first and second authors then created a group model (Figure 3) to reflect commonalities among the individual models. Protocols higher up on the diagram were relatively more important compared with items lower down. Protocols within the same box were equally important. Delphi participants were asked to indicate their level of agreement with each model using the 5-point Likert scale. The 2 experts who did not complete Round 2b were presented only with the group model.

Results

Participants

We invited 58 experts throughout the 3-round Delphi process. Nineteen of the 29(65%) experts who originally agreed to participate completed all 3 Rounds. Those who dropped out either did not respond or withdrew due to time constraints. Descriptive characteristics of the final panel are provided in Table 1.

The final Delphi panel had 25 ± 15 years of research experience within their field (range: 5 to 65 years) and a combined total of 4,181 peer-reviewed publications (range: 15 to 1,500 publications

per expert). All Delphi participants held an academic appointment (professor emeritus = 4, professor = 10, associate professor = 3, assistant professor = 2), many with cross-disciplinary areas of expertise.

Round 1. The majority of comments were supportive of assessing childhood physical literacy and the protocols originally included in the CAPL. Delphi panel participants agreed that a model fit analysis should be used to revise the CAPL model and determine the assignment of protocols to domains.⁹ The revised CAPL model (Figure 4), which more closely aligned with the physical literacy definition proposed by Whitehead, was used in subsequent rounds of the Delphi process.¹

Substantial heterogeneity occurred regarding inclusion of flexibility and body composition assessments, scoring the time for obstacle course completion, and the knowledge assessment content. Philosophical concerns regarding the calculation of composite scores were raised by 10 of 24 participants (42%) who felt that aggregating results into domain scores would reduce the value of the individual tests or that combined scores would have limited meaning. Areas of agreement and division among Round 1 responses are detailed in the [Online Supplementary Material](#). Qualitative analyses generated 140 statements that comprised the Round 2a and 2b questionnaires (see [Online Supplementary Material](#)).

Round 2. Round 2a consisted of 66 statements (see [Online Supplementary Material](#)): 28 representing agreement among Delphi participants, 24 representing diverse opinions, and 14 reflecting new ideas not originally proposed in Round 1. A majority (19 of 28, 68%) of the statements reflecting expert agreement reached consensus, 4 (14%) nearly reached consensus, and 5 (18%) were not supported. Of the 24 statements based on areas of division, 9 (38%) reached consensus, 4 (17%) nearly reached consensus, and 11 (46%) remained diverse. Of the 14 statements created from novel concepts proposed in Round 1, 4 (29%) reached consensus, 4 (29%) were near consensus, and 6 (42%) remained diverse.

Round 2b consisted of 74 statements (see [Online Supplementary Material](#)) representing the relative importance of each protocol within the proposed domains (Figure 4) and an overall physical literacy score. Consensus ($\geq 75\%$ of respondents) was achieved for 61 of 140 statements (44%); of these 53 statements achieved consensus support and the Delphi participants collectively disagreed with 8 statements. Seventeen (89%) Delphi participants agreed that the revised physical literacy model (Figure 4) was an appropriate visualization for the assessment of physical literacy. Consensus support was provided for pedometer step counts, a self-report measure of sedentary time, and self-reported weekly time spent in moderate-vigorous physical activity within the daily behavior domain. Consensus indicated that the physical competence domain was comprised of measures of body mass index (BMI), waist circumference, muscular strength and endurance (plank isometric hold and grip strength), flexibility (sit and reach), and aerobic fitness (PACER shuttle run). Consensus was also achieved for cueing children during obstacle course performance and including the interrelated components of completion time and skill performance within the obstacle course evaluation. The skill component of the obstacle course score evaluates fundamental movement skills, while the timing component introduces the need for higher order movement skills such as dynamic balance, spatial awareness, gross motor coordination and interceptive timing. Most Delphi participants (68%) agreed that children of all ages should complete the same obstacle course. Using the same course for children 8 to 12 years of age would allow longitudinal tracking of motor skill

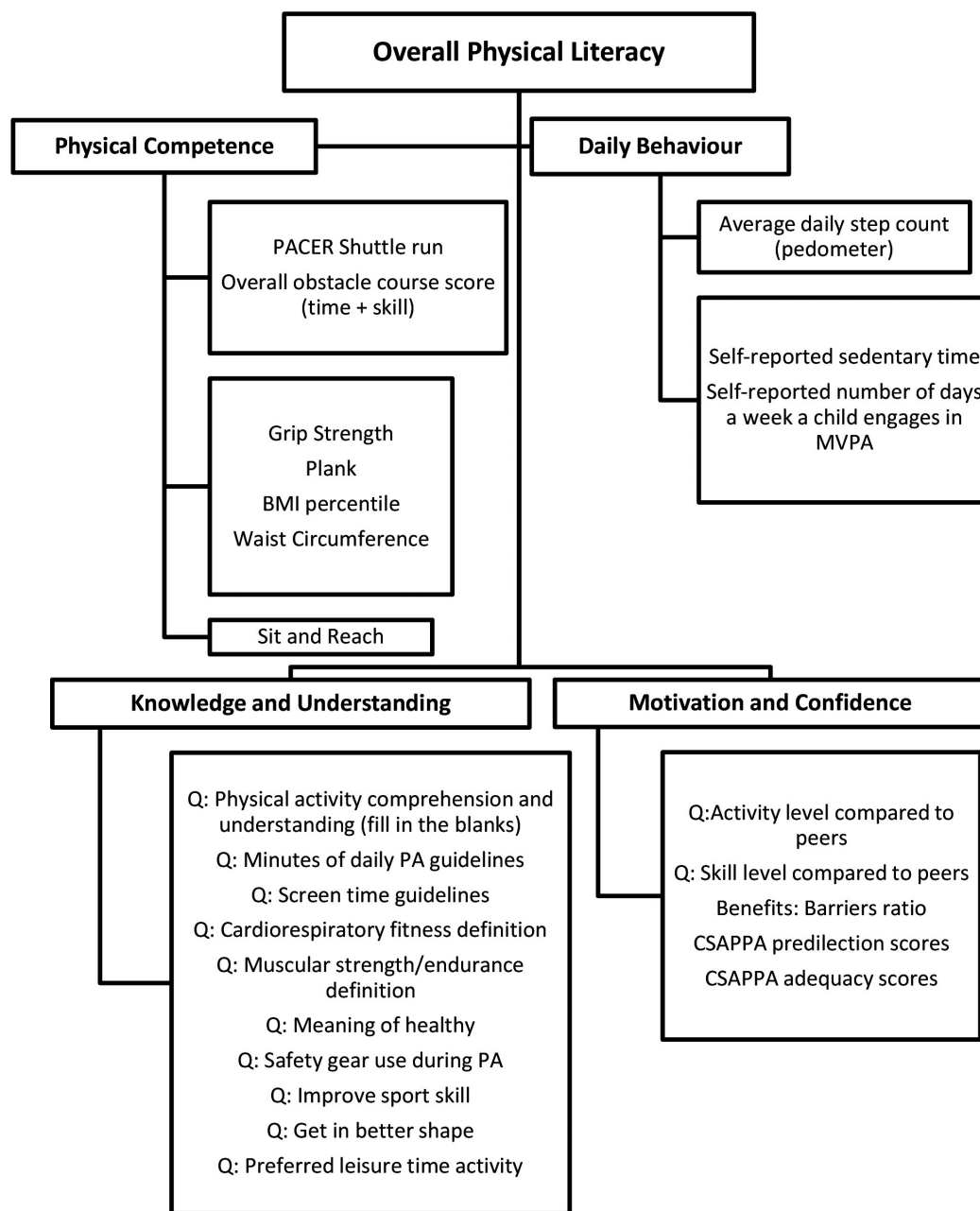


Figure 3 — Model created to reflect weighting of protocols by Delphi participants in Round 3, each Delphi panel expert received 2 figures: (a) the figure shown above, which represented the combined recommendations from all Delphi panel participants, and (b) a similar figure depicting each participant's own ratings of the relative importance of each protocol within each domain score and the relative importance of each domain within an overall Canadian Assessment of Physical Literacy score. In both figures, items placed higher up on the diagram have higher relative importance and items within the same box have the same relative importance.

performance. However, the Delphi panel also felt that it was very important that score interpretation should differ by age (eg, a score of 15 at age 8 would be interpreted differently than a score of 15 at age 12) to reflect growth and maturational influences on motor skill development. Within the motivation and knowledge domains, Delphi participants agreed that item analysis should be conducted to inform the relative importance of individual protocols within the CAPL questionnaire.

The Delphi participants agreed that individual protocol scores, domain scores and overall scores should be provided as both numeric scores and performance categories. The numeric scores

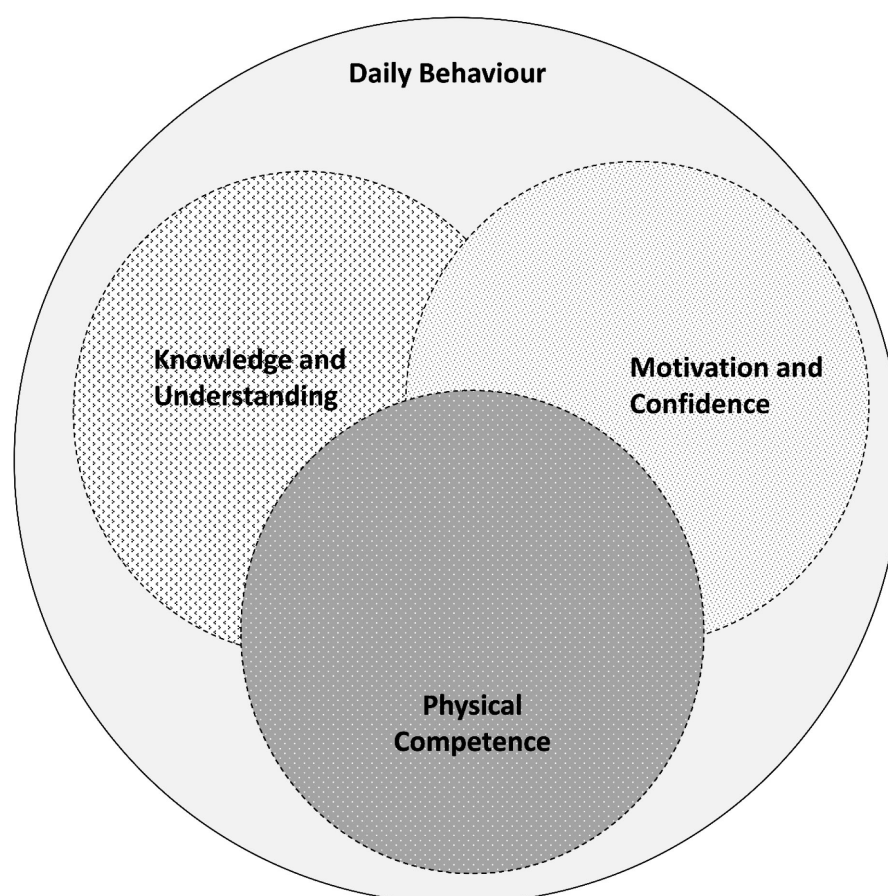
would enable CAPL participants to track improvements over time. Categories of performance would enhance the understanding and interpretation of the numerical value while accounting for differences in age and sex. It was also agreed that where possible, scores should be criterion referenced to reflect the physical literacy level associated with good health. If CAPL participants missed a score (eg, were physically unable to complete a protocol), it was agreed that an overall domain score could still be calculated using a statistical algorithm.

Opinions were diverse regarding the inclusion of a sleep assessment, with those opposed suggesting that while sleep was important

Table 1 Descriptive Characteristics of Experts Completing the Delphi Process

Characteristic	Descriptors	N
Sex	Male	15
	Female	4
Location	North America	15
	Europe	2
	Australia	2
Area of expertise ^a	Child physical activity	19
	Child fitness	9
	Physical activity/fitness measurement	9
	Motor skill development	7
	Cognition	6
	Disability and medical physical activity	4
Career length	Sum	472 years
	Average	25 years
	Range	5–65 years
Number of publications	Sum	4,181
	Average	220
	Range	15–1,500

^a Total number exceeds 19, as Delphi participants could report their expertise in multiple categories.

**Figure 4** — Revised model for the Canadian Assessment of Physical Literacy.

for health its relevance to physical literacy was less clear. Opinions were also diverse regarding the number of practice trials children should complete as part of the obstacle course assessment. Most Delphi participants were neutral about including sitting height in the CAPL protocol, a decision that would allow scores to be interpreted relative to maturational status.²¹

Round 3. Round 3 responses are detailed in the [Online Supplementary Material](#). The 66 statements that comprised Round 2a were repeated verbatim. Round 2b responses were represented by the diagrammatic models and 7 additional statements. Of these 73 statements, consensus was achieved for 47 (64%). Most areas of consensus (43 of 47, 91%) supported the statement, while expert consensus indicated that 4 statements were incorrect. The assessment of BMI was supported as an important component of a healthy lifestyle, with scores reflecting the World Health Organization categories.²² When CAPL participants are presented with their individual scores, it was agreed that the population mean or the recommended guideline (if available) should also be presented.

Of the 17 Delphi participants who were presented with a model of their individual responses, 11 (65%) agreed that the model was an accurate representation of their recommendations. Of the 6 that did not agree, 3 provided qualitative comments and minor corrections (eg, assigning 1 individual protocol a slightly higher relative importance) which would enable them to support the model. Consensus (17 of 19; 89%) was obtained for using the revised CAPL model (Figure 4) developed through the model fit analysis.⁹ The model depicting relative item and domain importance (Figure 3) was supported by 74% (14 of 19) of Delphi participants. Three Delphi participants were neutral to using the group model and 2 preferred their individual model. Based on these results, the CAPL scoring should assign higher relative importance to the “daily behavior” and “physical competence” domains. One expert remained strongly opposed to the concept of an overall physical literacy score.

The Delphi participants reached consensus that all CAPL participants should complete the same obstacle course regardless of age. They also agreed that obstacle course scores should be interpreted relative to age, and that timing the obstacle course would not hinder skill performance. Agreement that the time and skill score should be assigned equal importance was 1 expert short of consensus. While consensus was achieved for the obstacle course concept, 2 motor skill experts strongly disagreed with this approach, indicating that skill should be assessed without a time element. Delphi participants nearly all agreed (1 person short of consensus) that the proposed obstacle course scoring system was complex, requiring the examiner to have a physical activity/human kinetics background.

After Round 3, expert opinion remained diverse for 24 statements (see [Online Supplementary Material](#)), primarily in relation to the obstacle course assessment of motor skill. Delphi participants could not agree on the number of obstacle course practice trials or whether the obstacle course requirements should differ with age, or if children should be made aware of the scoring criteria.

Discussion

Recognizing the importance of physical activity to child health, in both the short and long term, this work sought to refine the conceptual CAPL model and the CAPL protocols within each domain. The goal was to support the development of a valid assessment of children's capacity for a healthy, active lifestyle, that is, their physical literacy. We also sought to identify the relative importance between individual protocols and the composite

domain scores, to inform the subsequent development of the CAPL scoring and reporting system.

The knowledge and experience of the Delphi panel members was a major determinant of the resulting recommendations and the composition of the Delphi panel must be considered when interpreting these results. Although we used relevant search terms from the published literature to develop the original list of experts invited to participate, the subgroup of invitees who completed all 3 rounds of the Delphi process were predominantly North American males with expertise in the physical activity and physical competence domains. Their areas of expertise likely influenced recommendations regarding relative item importance within the CAPL composite scores. It is also possible that the male-dominated panel may have more strongly supported the physical measures because of sociocultural factors that socialize males toward physical performance and females toward psychological variables.²³ These limitations may have been mitigated through the seniority and impressive publishing experience of the Delphi participants.

The revised conceptual CAPL model developed through this process (Figure 4) emphasizes that physical literacy is a complex and diverse concept.²⁴ In keeping with the factor analysis completed on the recommendation of the Delphi participants, there are overlapping domains representing motivation, physical competence (including fitness and motor skill measures) and knowledge. This conceptual model is supported by research indicating that effective physical activity interventions increase knowledge and motivation for a healthy, active lifestyle, in addition to building the skills needed for behavior change.²⁵ By assessing a broad spectrum of factors that influence physical literacy, we believe that the CAPL may be suitable for a variety of purposes and in a variety of contexts. While the CAPL was designed to assess groups of children, it may also be suitable for individual evaluations. If so, the assessment results may identify target areas for health promotion interventions at both individual and group levels. By enabling effective evaluations of childhood physical literacy, the CAPL will support greater recognition of children's physical literacy deficits and the development of enhanced intervention designs. Further research is required to determine whether the CAPL can be effectively administered and interpreted by generalist leaders (eg, parent, classroom teacher) or whether specific training in physical activity or physical education is required. Ultimately, adoption of the CAPL model for physical literacy assessment will depend on its applicability to different populations and contexts beyond those represented by the Delphi participants. Use of the CAPL protocols will be determined by their accuracy, reliability, and ease of use, as well as the match between assessment goals and the results obtained.

The CAPL model developed through the Delphi process (Figure 4) aligns with current definitions of physical literacy that recognize the need for a balance of motivation and confidence, knowledge and understanding, and physical competence in developing physically literate individuals.^{1,24,26} It also reflects the model fit analysis that was completed on the recommendation of the Delphi panel. The CAPL model indicates that physically literate individuals will lead a healthy, active lifestyle if they have the required physical competence, motivation, and knowledge to support that behavior. Thus, the “daily behavior” domain is represented as encompassing the motivation and confidence, physical competence, and knowledge and understanding domains. The revised model also suggests that physical activity is a complex behavior, being influenced on different levels by a variety of interacting physiological and psychological factors.²⁷ The Delphi panel achieved consensus that this model was an appropriate representation for the assessment of childhood physical literacy.

When asked for recommendations regarding the calculation of domain and overall scores based on the CAPL results, the Delphi panel appeared to make a contradictory recommendation. For CAPL score calculations, our Delphi panel recommended greater relative importance be given to domain scores for daily behavior and physical competence rather than motivation and knowledge measures. This recommendation for assigning differential weights within composite scores does not align with the domains within the revised CAPL model, which are represented by circles of similar size. Both the CAPL model and differential weights for scoring achieved consensus among our Delphi group.

The suggested weighting of protocols and domains within calculated composite scores (Figure 3) was based on the collective expertise of our Delphi participants. In making their recommendations, Delphi participants considered factors such as practical assessment constraints, known protocol limitations and biases, and the stronger psychometric evidence for objective rather than self-report measures.^{28,29} As such, the recommended weightings may reflect the limitations among tools currently available to measure some constructs. In addition, although motivation and knowledge are commonly included in models of physical literacy, our Delphi participants felt that the evidence base is currently stronger for the physical competence and daily behavior components.^{1,30–32} This finding underscores the importance of additional work to further develop and validate measures of physical literacy motivation and knowledge. The panel's recommendation was that the weighting between domains be monitored as CAPL data are collected. The goal would be to revisit the weighting of domains within the overall physical literacy score once a larger, internationally representative database of results had been obtained.

The Delphi panel consensus (at least 75% agreement) recommendations in support of a theoretical model with equal domains but unequal weighting of those domains for the calculation of a total CAPL score may reflect the composition and background of the panel members. As indicated, participating panel members were primarily from the fields of physical activity and physical competence assessment. Based on their backgrounds, the Delphi members would be expected to have much greater familiarity and experience with physical activity and physical competence instruments and protocols. Future research should investigate whether a panel composed of a balance of experts from each of the 4 CAPL domains would provide similar recommendations.

This work succeeded in reaching consensus on the relative importance of individual protocols within composite domains and overall physical literacy scores, allowing score values to be assigned. These relative values should then be criterion-referenced relative to the desired level of physical literacy associated with a healthy, active lifestyle to provide meaningful feedback and recommendations for improvement. If reference criteria are unavailable, scores 0.5 and 1.5 standard deviations above the mean would be designated as representing an acceptable physical literacy level. This definition assumes that "normal" or "average" values in the current population do not correspond with adequate physical literacy. CAPL administrators and participants should be able to choose the desired level of feedback depending on the purpose of the assessment. Options should enable individual protocol results, composite subdomain (eg, fitness) or domain (eg, physical competence) scores, and/or an overall physical literacy score. Such flexibility of scoring and interpretation would allow the CAPL to be implemented in diverse environments and adapted for multiple purposes.

Opinions were diverse related to the obstacle course assessment of motor skill. Statistical comparisons of the different scoring

procedures proposed by Delphi participants are recommended to determine the most appropriate method. Two experts in motor skill development and competence strongly believed that determining skill quality should be the sole purpose of the assessment, and that children should complete the obstacle course without the potentially negative impact of time pressure. However, 5 of 7 (71%) Delphi participants with expertise in motor skill development and competence and 17 of the 19 panel participants (89%) supported the obstacle course as a measure of motor skill. Analyses should be undertaken to determine whether 1, 2 or 3 practice trials are required to obtain a valid and reliable obstacle course score.

Limitations

The recommendations from this study should be considered preliminary and are intended as a foundation for future research on physical literacy assessment. The Delphi process for rating individual statements resulted in some conflicting recommendations. For example, potential limitations associated with existing measurement protocols resulted in support of a balanced theoretical model (Figure 4) but weights for proposed scoring procedures (Figure 3) that relied more heavily on objective measurement protocols. The feasibility of the CAPL protocols and scoring procedures for population surveillance, the training/expertise required by appraisers, and the ecological validity of the CAPL should be investigated through future research.

Efforts were made to create an international panel of cross-disciplinary experts from within the domains represented in the original CAPL model. However, the willingness of selected experts to participate in the process could not be controlled, which created the potential for bias in the expertise and feedback provided. The final panel included experts from each CAPL domain, but the number of panel members was not equally distributed (Table 1).

The need to conduct Round 2 in 2 parts created some confusion and a departure from the accepted Delphi procedure of repeating previous rounds until consensus is achieved. However, the fact that Delphi participants agreed that the individual model created was an accurate representation of their preferred scoring method (or would be, with minor corrections) suggests that the novel methodology used was acceptable and did not alter the outcome or influence the consensus achieved in Round 3.

Conclusions

CAPL offers a model of physical literacy assessment that can support a measurement tool for monitoring the capacity for a healthy, active lifestyle among children 8 to 12 years of age. The revised CAPL model is aligned with commonly accepted definitions of physical literacy.^{1,2,24} The proposed assessment protocols have established validity and reliability and are known correlates of physical and mental health, both during childhood and life long.^{8,9,30,31} The CAPL protocols are grouped within 4 primary domains: motivation and confidence, physical competence, knowledge and understanding, and daily behavior. Domain scores can also be combined to calculate an overall physical literacy score. The Delphi participants in this study assigned greater relative importance to the objectively measured domains. They also recommended that examiners be able to choose the assessment components used and the level of feedback provided to participants.

Future work will create a scoring system based on these recommendations, progressively evaluating and revising the scoring system as necessary as more physical literacy data become available. Ongoing review and monitoring will ultimately determine the validity of the CAPL total and domain scores. Additional research

is required to ensure the reliability and validity of the obstacle course as an assessment of motor skill. Appropriate methods for calculating a physical literacy score when data are missing, because a participant was absent or unable to complete an assessment element, are also required. The need for a modified scoring system to accommodate children with disabilities or medical conditions should also be investigated.

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References

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- ## References
- Whitehead M. *Physical Literacy Throughout the Lifecourse*. London, U.K.: Routledge Taylor & Francis Group; 2010.
 - Tremblay MS, Lloyd M. Physical literacy measurement: the missing piece. *Phys Health Educ J*. 2010;76(1):26–30.
 - Penney D, Chandler T. Physical education: what future(s)? *Sport Educ Soc*. 2000;5(1):71–87. doi:10.1080/135733200114442
 - Marsden E, Weston C. Locating quality physical education in early years pedagogy. *Sport Educ Soc*. 2007;12(4):383–398. doi:10.1080/13573320701600621
 - Delaney BJ, Donnelly P, News J, Haughey TJ. *Improving Physical Literacy*. Belfast, Ireland: Sport Northern Ireland; 2008.
 - Haydn-Davies D. How does the concept of physical literacy relate to what is and might be the practice of physical education. *Br J Teach Phys Educ*. 2005;36(3):45–58.
 - Colley RC, Garriguet D, Janssen I, Craig CL, Clarke J, Tremblay MS. Physical activity of Canadian children and youth: accelerometer results from the 2007 to 2009 Canadian Health Measures Survey. *Health Rep*. 2011;22(1):15–23. PubMed
 - Public Health Agency of Canada. The benefits of physical activity: for children/youth. 2005; <http://www.phac-aspc.gc.ca/pau-uap/fitness/benefits.html#1>. Accessed November 9, 2008.
 - Longmuir PE. Understanding the physical literacy journey of children: The Canadian Assessment of Physical Literacy. *J Sport Sci Phys Educ*. 2013;65(October):277–283.
 - Lloyd M, Colley RC, Tremblay MS. Advancing the debate on “fitness testing” for children: perhaps we’re riding the wrong animal. *Pediatr Exerc Sci*. 2010;22(2):176–182. PubMed
 - Longmuir PE, Boyer C, Lloyd M, Yang Y, Boiarskaia E, Zhu W, Tremblay MS. (2015). The Canadian Assessment of Physical Literacy: methods for children in grades 4 to 6 (8 to 12 years). *BMC Public Health*, 15, 767. doi:10.1186/s12889-015-2106-6
 - Clemes SA, Biddle SJH. The use of pedometers for monitoring physical activity in children and adolescents: measurement considerations. *J Phys Act Health*. 2013;10(2):249–262. PubMed
 - Craig CL, Cameron C, Tudor-Locke C. CANPLAY pedometer normative reference data for 21,271 children and 12,956 adolescents. *Med Sci Sports Exerc*. 2013;45(1):123–129. PubMed doi:10.1249/MSS.0b013e31826a0f3a
 - Beets MW, Bornstein D, Beighle A, Cardinal BJ, Morgan CF. Pedometer-measured physical activity patterns of youth: a 13-country review. *Am J Prev Med*. 2010;38(2):208–216. PubMed doi:10.1016/j.amepre.2009.09.045
 - Hsu CC, Sandford BA. The Delphi technique: making sense of consensus. *Pract Assess, Res Eval*. 2007;12(10):1–8.
 - Gupta UG, Clarke RE. Theory and applications of the Delphi technique: a bibliography (1875–1994). *Technol Forecast Soc Change*. 1996;53(2):185–211. doi:10.1016/S0040-1625(96)00094-7
 - Marques AI, Santos L, Soares P, et al. A proposed adaptation of the European Foundation for Quality Management Excellence Model to physical activity programmes for the elderly: development of a quality self-assessment tool using a Delphi process. *Int J Behav Nutr Phys Act*. 2011;8:104. PubMed doi:10.1186/1479-5868-8-104
 - Palisano R, Rosenbaum P, Walter S, Russell D, Wood E, Galuppi B. Development and reliability of a system to classify gross motor function in children with cerebral palsy. *Dev Med Child Neurol*. 1997;39(4):214–223. PubMed doi:10.1111/j.1469-8749.1997.tb07414.x
 - Bulger SM, Housner LD. Modified Delphi investigation of exercise science in physical education teacher education. *J Teach Phys Educ*. 2007;26(1):57–80.
 - Patton MQ. *Qualitative Evaluation and Research Methods*. 2nd ed. Thousand Oaks, CA: Sage Publications; 1990.
 - Mirwald RL, Baxter-Jones ADG, Bailey DA, Beunen GP. An assessment of maturity from anthropometric measurements. *Med Sci Sports Exerc*. 2002;34(4):689–694. PubMed doi:10.1097/00005768-200204000-00020
 - World Health Organization. Growth reference 5–19 years: BMI-for-age (5–19 years). 2007; http://www.Who.int/growthref/who2007_bmi_for_age/en/ Accessed November 5, 2013.
 - Pedersen DM. Perceived relative importance of psychological and physical factors in successful athletic performance. *Percept Mot Skills*. 2000;90(1):283–290. PubMed doi:10.2466/pms.2000.90.1.283
 - Mandigo J, Francis N, Lodewyk K, Lopez R. *Position Paper: Physical Literacy for Educators*. Ottawa, Ontario, Canada: Physical and Health Education Canada; 2009.
 - Murillo Pardo B, Bengoechea EG, Generelo Lanaspá E, et al. Promising school-based strategies and intervention guidelines to increase physical activity of adolescents. *Health Educ Res*. 2013;28(3):523–538. PubMed doi:10.1093/her/cyt040
 - Higgs C. Physical literacy: two approaches, one concept. *Phys Health Educ J*. 2010;Spring:6–7.
 - Kohl HW, Hobbs KE. Development of physical activity behaviors among children and adolescents. *Pediatrics*. 1998;101:549–554. PubMed
 - Connor Gorber S, Tremblay M, Moher D, Gorber B. Diagnostic in obesity comorbidities: a comparison of direct vs. self-report measures for assessing height, weight and body mass index: a systematic review. *Obes Rev*. 2007;8(4):307–326. PubMed doi:10.1111/j.1467-789X.2007.00347.x
 - Prince SA, Adamo KB, Hamel ME, Hardt J, Gorber SC, Tremblay M. A comparison of direct versus self-report measures for assessing physical activity in adults: a systematic review. *Int J Behav Nutr Phys Act*. 2008;5:56. PubMed doi:10.1186/1479-5868-5-56
 - Janssen I, LeBlanc AG. Systematic review of the health benefits of physical activity and fitness in school-aged children and youth. *Int J Behav Nutr Phys Act*. 2010;7:40–56. PubMed doi:10.1186/1479-5868-7-40
 - Lubans DR, Morgan PJ, Cliff DP, Barnett LM, Okely AD. Fundamental movement skills in children and adolescents: review of associated health benefits. *Sports Med*. 2010;40(12):1019–1035. PubMed doi:10.2165/11536850-000000000-00000
 - Stodden DF, Goodway JD, Langendorfer SJ, et al. A developmental perspective on the role of motor skill competence in physical activity: an emergent relationship. *Quest*. 2008;60(2):290–306. doi:10.1080/0336297.2008.10483582