

# Pedi-R-MAPP: The development of a nutritional awareness tool for use in remote paediatric consultations using a modified Delphi consensus

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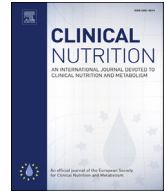




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## Original article

## Pedi-R-MAPP: The development of a nutritional awareness tool for use in remote paediatric consultations using a modified Delphi consensus



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## SUMMARY

**Background & aims:** The Remote Malnutrition Application (R-MAPP) was developed during the COVID-19 pandemic to provide support for health care professionals (HCPs) working in the community to complete remote nutritional assessments, and provide practical guidance for nutritional care. The aim of this study was to modify the R-MAPP into a version suitable for children, Pediatric Remote Malnutrition Application (Pedi-R-MAPP), and provide a structured approach to completing a nutrition focused assessment as part of a technology enabled care service (TECS) consultation.

**Methods:** A ten-step process was completed: 1) permission to modify adult R-MAPP, 2) literature search to inform the Pedi-R-MAPP content, 3) Pedi-R-MAPP draft, 4) international survey of HCP practice using TECS, 5) nutrition experts invited to participate in a modified Delphi process, 6) first stakeholder meeting to agree purpose/draft of the tool, 7) round-one online survey, 8) statements with consensus removed from survey, 9) round-two online survey for statements with no consensus and 10) second stakeholder meeting with finalisation of the Pedi-R-MAPP nutrition awareness tool.

**Results:** The international survey completed by 463 HCPs, 55% paediatricians, 38% dietitians, 7% nurses/others. When HCPs were asked to look back over the last 12 months, dietitians ( $n = 110$ ) reported that  $5.7 \pm 10.6$  out of every 10 appointments were completed in person; compared to paediatricians ( $n = 182$ ) who reported  $7.5 \pm 7.0$  out of every 10 appointments to be in person ( $p < 0.0001$ ), with the remainder completed as TECS consultations.

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Overall, 74 articles were identified and used to develop the Pedi-R-MAPP which included colour-coded advice using a traffic light system; green, amber, red and purple. Eighteen participants agreed to participate in the Delphi consensus and completed both rounds of the modified Delphi survey. Agreement was reached at the first meeting on the purpose and draft sections of the proposed tool. In round-one of the online survey, 86% (n = 89/104) of statements reached consensus, whereas in round-two 12.5% (n = 13/104) of statements reached no consensus. At the second expert meeting, contested statements were discussed until agreement was reached and the Pedi-R-MAPP could be finalised.

**Conclusion:** The Pedi-R-MAPP nutrition awareness tool was developed using a modified Delphi consensus. This tool aims to support the technological transformation fast-tracked by the COVID-19 pandemic by providing a structured approach to completing a remote nutrition focused assessment, as well as identifying the frequency of follow up along with those children who may require in-person assessment.

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## 1. Introduction

Remote consultations fall under the umbrella term telemedicine, defined by the World Health Organisation (WHO) as *'the delivery of health care services, where distance is a critical factor, by all health care professionals using information and communication technologies'* [1]. Remote health care technology is hugely complex and inclusive of a wide range of capabilities including the delivery of synchronous and asynchronous telehealth, use of mobile applications, telephone services, text messaging applications, transmission of data from wearable and implantable biosensors, and patient-generated health data deployed within an integrated electronic patient record [2]. Although the use of remote consultations is seen as a way to enhance face to face visits, barriers for use include i) technological complexity issues, ii) clinician and patient acceptance of using this means of consultation, and iii) health care professional (HCP) confidence and training in using technology [2–4].

Prior to the pandemic, the WHO [1] alongside the medical community and health services worldwide, had ambitions to improve access to health care for all sectors of society. Particularly individuals who are hard to reach due to geographical barriers and vulnerable groups, e.g. children, through the widespread implementation of technology enabled care services (TECS) [5,6]. Implementation of these types of services would usually be completed over time with robust process framework for use in place, with associated training and evaluative report of the efficacy of processes used with these consultations and associated health care outcomes [2]. However, because of the global health crisis, the implementation of these services has been fast-tracked, fundamentally changing the way HCPs deliver health care including those for children. Nutrition focused consultations for children usually include a review of i) anthropometry, ii) biochemistry and clinical status, iii) dietary intake and changes in nutritional status linked to nutritional intervention, iv) goal setting with the provision of verbal or written information to caregivers and v) follow-up [7,8]. Several surveys have been completed considering the use of TECS by HCPs, which have documented high levels of satisfaction [3]. Shriqui-Kaufman et al. reported that 45% of dietitians had no formal training in alternative nutrition counselling via TECS and that the majority of TECS was delivered by telephone and half delivered through an online platform. Those with less experience were more likely to report lower satisfaction scores; suggesting that experience, knowledge acquisition and training were key drivers for confidence around the completion of a remote nutrition focused assessment [3,9]. Recommendations to

improve confidence and support for dietitians using TECS include the development of "scripts" or tools to optimise the completion of a nutrition focused assessment [3,10].

Decision making field guides available for use in paediatrics in community settings include the World Health Organization Integrated Management of Childhood Illness (WHO-IMCI) [11], and iterations of the Academy of Nutrition and Dietetics Nutrition Care Process [12]. The WHO-IMCI guidelines were developed with the aim of reducing variation in practice and promoting the delivery of high-quality care within primary care in a limited resource environment. The IMCI case management series use a stepwise approach to assessment including, i) assessing the child's illness, ii) classifying the illness based on these signs, iii) identifying treatment, iv) treating the child, v) counselling the caretaker and vi) providing follow up care. Responses to each section of the process are RAG rated (i.e. red, amber, green) providing a visual interpretation to the assessor of the results with amber (some concern) and red (significant concern), along with actionable health care recommendations [11]. The IMCI approach has been used in various nutritional pathways including congenital heart disease (CHD) [13], human immune deficiency virus (HIV) and acquired immune deficiency syndrome (AIDS) [14], and updated to include considerations for the prevention of overweight/obesity [15]. Across all sectors there is increasing concern about the subsequent long-term consequences of COVID-19 pandemic on nutritional status of vulnerable groups, particularly children with the well described increase in sedentary behaviour and obesogenic diets [16]. To our knowledge, a nutrition awareness tool using a RAG rating approach incorporating the double burden of nutrition to guide nutrition decision-making processes has not yet been incorporated into a readily available electronic format for children as part of a remote consultation in a community setting.

Krznarić et al. [17] developed the Remote Malnutrition Application (R-MAPP) for desktop to support HCPs' working in the community to complete remote nutritional assessments and provided practical guidance for nutritional care for adults.

To better support HCPs working in paediatric primary health care to complete a nutrition focused assessment via TECS, the goal of this study was to adapt the R-MAPP into a version suitable for children and young people i.e., Pediatric Remote Malnutrition Application (Pedi-R-MAPP). The aim of this was to provide a format to systematically obtain nutrition information that guide HCPs in the development of i) personalised nutrition care plans when using TECS consultations and ii) providing guidance with regards to the need for in-person assessment and iii) frequency of follow up.

## 2. Methods

### 2.1. Modified Delphi consensus

This study uses standard Delphi consensus methodology first described by Dalkey et al. [18] and updated by Fitch et al. [19] along with modified Delphi methods described by Woodcock et al. [20]. In brief, a Delphi consensus is a process using multiple steps including; a narrative review of the literature, development of the tool, selection of the expert panel, the rating process including documentation required for the first and second round of anonymous voting, initial and final meeting moderation and finally overcoming methodological issues relating to statements where consensus was not achieved. The aim of which is to convert individual opinions into group consensus, based on the premise that consensus of a group is more accurate than those of the individual. This ensures there is transparency regarding areas of consensus and non-consensus [18,19,21]. The modified Delphi method used in this study, to develop the Pedi-R-MAPP comprised of ten steps [18–21] (Fig. 1).

## 3. Methods

### 3.1. Step 1, 2 and 3: permission to adapt the R-MAPP tool, narrative literature review and development of draft nutrition awareness tool Pedi-R-MAPP

In the first instance, the project study group sought permission from the authors of the R-MAPP [17] to adapt this into a paediatric version. In brief, the R-MAPP provides a simple guide to be used as part of a nutrition-focused assessment during a video or voice call and is intended for use in a primary care setting to identify patients at risk of malnutrition and therefore ensure nutrition care is optimised.

The content of the Pedi-R-MAPP was evidence based. A narrative literature review was conducted by LVM and RM using a systematic approach to the development and completion of the literature search. The NICE Healthcare Databases Advanced Search website (<https://hdas.nice.org.uk/>) was used as a tool to complete multiple searches within nine databases available, including the Cumulative Index to Nursing and Allied Health Literature (CINAHL), PsycInfo, British Nursing Index, Pubmed, EMBASE, EMCARE, Health Management and Information Consortium, Allied and Complimentary Medicine and Medline. The search included peer reviewed literature relating to i) nutrition awareness of paediatric nutrition in a community setting, ii) food security and iii) growth monitoring as part of a remote consultation and iv) principles outlined in the WHO-IMCI guidelines (Supplementary File 1: Library search). Abstracts were reviewed for eligibility by LVM using Ryyan.ai software (<https://www.ryyan.ai/>), with full texts selected for further review. Issues regarding eligibility of articles to be include in the narrative review were resolved by a second reviewer (RM) where needed.

With the permission of the R-MAPP [17] authors a small working group of investigators (LVM, JJ, RMB, ASD, NC) sought to adapt the R-MAPP tool providing a simple nutritional assessment tool based on a traffic light system of green (no concern), amber (some concern) red (significant concern) and purple (overnutrition) [11,15] before it was presented at the first expert stakeholder meeting. In brief the proposed Pedi-R-MAPP tool comprised of eight sections; 1) General information about the child, 2) Presence of long term condition, 3) Assessment of recent changes in growth, 4) Assessment of nutritional intake, 5) Assessment of food insecurity, 6) Presence of changes in physical activity, 7) Presence of clinical concerns that suggest an urgent medical review is required, and 8) Development of nutrition care plan. Depending on the provided answers, a nutrition awareness plan is proposed based on the colour rating described above.

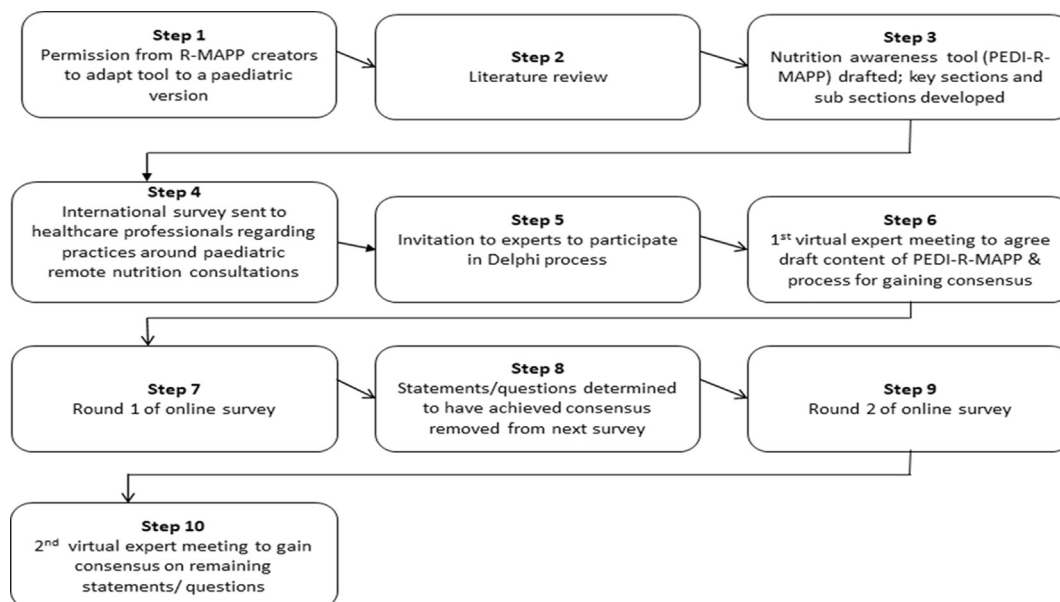


Fig. 1. Ten step process in the development of Pedi-R-MAPP nutrition awareness tool.

### 3.2. Step 4: international survey of practice regarding paediatric remote nutrition consultations

To understand how international practices of remote nutrition consultations may have changed since March 2020, an anonymous survey was developed which included sections on i) HCP demographics, ii) area of practice e.g., hospital, community and role in nutrition screening, iii) changes in practice related to growth monitoring and parental access to equipment and iv) future training and education. A URL link to the survey was distributed, using snowball sampling, through British Dietetic Association Paediatric Group, South African Dietetic Association, participants of the Delphi consensus and other individuals known to some authors (LVM, NC, LP), between May 10 and June 30, 2021. Completion of the survey was voluntary and electronic consent was obtained through the online survey (Supplementary File 2: Survey).

### 3.3. Step 5 and 6: expert invitation and an initial virtual expert group meeting to agree the content of the nutrition awareness tool to be used in the modified Delphi process

An initial e-mail outlining the project and study design and inviting participants to take part in the study was sent to a group of recognised experts (n = 18) in the field of nutrition awareness, child health and paediatric nutrition from different regions in the world.

### 3.4. First virtual expert meeting

The adult R-MAPP tool was modified following an evidence review, the results of which were presented at the first expert meeting held on March 5, 2021, with the purpose of i) discussing and reviewing the initial draft Pedi-R-MAPP nutrition awareness tool, ii) establishing agreement behind the nutritional principles incorporated from the available evidence, into the nutrition awareness tool and iii) outlining the process for gaining consensus (Table 1). In terms of the process for achieving consensus of the nutrition awareness tool content consensus was set *a priori* at 75% agreement within any one of the available actions (keep, remove or modify the question). Responses with “no opinion” were excluded from the percentage agreement calculations [20].

### 3.5. Step 7, 8 and 9: Delphi on-line questionnaire and iterative changes to the draft of the Pedi-R-MAPP tool

Google Forms was used to create the anonymous structured questionnaire (Supplementary File 3: Delphi survey round one). The questionnaire was administered to the expert group via a URL link and open for a period of one week (March 17–20, 2021). Participants were asked to vote on each question/statement within the Pedi-R-MAPP, in turn electing to; “keep”, “remove”, “modify the question” or state “no opinion”.

Categorical response options were used to ensure panel members were clear about the significance of their vote and to ensure the results were actionable with regards to what the final Pedi-R-MAPP tool should include. For each of the sections, a free text box was included for the expert panel to recommend modifications to a question/statement or suggestions for the inclusion of additional questions/statements [20–22]. For questions where consensus to “keep” or “remove” or “modify” was not achieved; written comments were examined, and suggested modifications were included to be voted on in the second survey. Questions that did not achieve consensus were included in the second survey.

### 3.6. Round 2: Delphi on-line questionnaire

As part of the second survey participants were informed, about three sets of question/statements; 1) a set of questions/statements to keep by consensus, 2) a set of questions to remove by consensus and 3) a set of questions/statements where consensus to keep or remove was not achieved, which would be discussed during the second virtual expert meeting. Participants were asked to review the aggregated agreement percentages for each of the questions/statements where consensus had not been achieved and to vote on whether to “keep”, “remove”, “modify the question” or state they had “no opinion”. The second survey was open from the (23 March – 2 April 2021).

### 3.7. Step 10: second expert meeting to gain agreement for remaining questions and finalise the content of the nutrition awareness tool

Prior to the final meeting participants were sent a PDF version of the Pedi-R-MAPP including the percentage of responses and actions for all the questions, and a list of statements where consensus was not achieved. The purpose of this meeting was to i) review questions/statements where there was no-consensus, ii) agree to “keep” or “remove” a question/statement and ii) agree on the final content of the Pedi-R-MAPP tool [18–21].

## 4. Statistical analysis

Mean and standard deviation (SD) was used to summarise the data. Categorical variables are expressed as frequencies and percentages. Non-parametric tests such as Mann Whitney and Chi square tests were used to examine differences between outcome variables reported in the international survey. Statistical analysis was performed by GraphPad 9 (San Diego, CA, USA). A *p* value of <0.05 was considered statistically significant.

## 5. Results

### 5.1. Step 1, 2 and 3: permission to adapt the R-MAPP tool, literature review and development of draft nutrition awareness tool Pedi-R-MAPP

The authors of the R-MAPP [17] tool provided permission to adapt the adult tool into a paediatric version. Seventy-four articles [10,11,23–94] were identified through the literature review to help generate the questions/statements of this tool which informed the draft Pedi-R-MAPP tool (Fig. 2). Using a focused literature search, the draft Pedi-R-MAPP nutrition awareness tool was based on existing evidence in addition to the nutrition focused approach described in the WHO-IMCI guidelines using a traffic light system of green (no concern), amber (some concern), red (significant concern) and purple (overnutrition) [11,15].

### 5.2. Step 4: international survey of practice regarding paediatric remote nutrition consultations

In total, 463 HCPs completed the survey; 55% (n = 253) were Paediatricians, General Practitioners & physicians practicing in other specialties 38% (n = 176) dietitians, 4% Nurses (n = 19) and 3% (n = 15) other including health visitors. HCP respondents practiced in the following countries in order of recorded responses (n = 416); Turkey (n = 118), United Kingdom (n = 85), Spain (n = 62), Croatia (n = 40), United States (n = 25), South Africa (n = 25), Israel (n = 22), Russia (n = 21), Philippines (n = 5), India (n = 4), Australia (n = 4), Italy (n = 4). Most respondents reviewed children aged 0–5

**Table 1**  
International survey results characteristics of response presented at percentage and numbers.

Participant's profession (n = 430)		n=				
• Dietitian	• 178					
• Paediatrician	• 194					
<b>Where are patients seen? (n = 430)</b>	<b>Hospital In-patients</b>	<b>Hospital Out-patients</b>	<b>Community</b>			
Dietitian	59% 105	54% 95	36% 63			
Paediatrician	37% 72	58% 113	41% 79			
	p = 0.004	p = 0.5	p = 0.5			
<b>Do children have any of the following? (n = 430)</b>	<b>Increased nutrient losses</b>	<b>Decreased nutritional intake</b>	<b>Increased nutritional requirements</b>	<b>None of these</b>		
Dietitian	69% 122	5% 9	79% 140	5% 9		
Paediatrician	38% 74	10% 20	51% 99	10% 20		
	p < 0.0001	p = 0.6	p < 0.0001	p = 0.6		
<b>When undertaking a remote consultation, do the parents you speak with have the following tools for measurement? (n = 148)</b>	<b>Digital baby scales</b>	<b>All Parents</b>	<b>All/Most Parents</b>	<b>Some Parents</b>	<b>Very Few/None of the Parents</b>	<b>I do not ask/I do not know</b>
Dietitian	0% 0	7% 5	34% 25	48% 35	3% 2	
Paediatrician	0% 0	15% 8	40% 21	38% 20	6% 3	
<b>Length mat</b>	<b>All Parents</b>	<b>All/Most Parents</b>	<b>Some Parents</b>	<b>Very Few/None of the Parents</b>	<b>I do not ask/I do not know</b>	
Dietitian	0% 0	8% 6	7% 5	71% 52	5% 4	
Paediatrician	0% 0	11% 6	32% 17	47% 25	6% 3	
<b>Which of the following negative outcomes on nutritional status have been amplified by the COVID-19 pandemic in your paediatric patients? (n = 307)</b>	<b>Malnutrition</b>	<b>Obesity</b>	<b>Food Insecurity</b>	<b>Eating Disorders</b>	<b>Declining nutritional status</b>	
Dietitian	63% 77	76% 93	63% 77	66% 80	54% 66	
Paediatrician	35% 50	85% 122	15% 21	65% 94	28% 40	
<b>How useful would you find a paediatric nutritional awareness tool specifically designed for use in remote consultations? (n = 299)</b>	<b>Extremely useful</b>	<b>Very useful</b>	<b>Somewhat useful</b>	<b>Not so useful</b>	<b>Not at all useful</b>	
Dietitian	52% 62	22% 26	15% 18	8% 9	4% 5	
Paediatrician	24% 34	36% 50	25% 35	9% 13	5% 7	

years. They were seen in a variety of settings, including inpatients (45%), hospital outpatients (55%), and in the community (38%). HCPs managed children with clinical conditions that i) increased nutrient losses (50%), ii) decreased nutritional intake (74%) and iii) increased nutritional requirements (64%). Most respondents (75%) asked parents to complete weight or height checks at home with digital bathroom scales or a tape measure as the most commonly available tools, during the COVID-19 pandemic. Respondents (74%) thought that a nutrition awareness tool designed for use as part of a remote consultation would be useful to their practice. Eighty-five percent responded that the COVID-19 pandemic had negatively impacted on children's nutritional status, with increased risk of malnutrition including obesity (82%), eating disorders (66%) and undernutrition (48%). When HCPs were asked to look back over the last 12 months, dietitians (n = 110) reported that 5.7 ± 10.6 out of every 10 appointments were completed in person; compared to paediatricians (n = 182) who reported 7.5 ± 7.0 out of every 10 appointments to be in person (p < 0.0001) with the remainder completed as TECS consultations (Table 1).

**5.3. Step 5 and 6: expert invitation and an initial virtual expert group meeting to agree the content of the nutrition awareness tool to be used in the modified Delphi process**

Eighteen participants agreed to participate in the modified Delphi process with all participants completing round 1 and 2 of the modified Delphi survey (Table 2).

**5.4. First expert meeting**

i) *the purpose of the nutrition awareness tool*; experts agreed that the purpose of this tool was to provide a format to systematically obtain nutrition information guiding HCPs as part of a

remote consultation; especially for junior HCPs and those working independently and which children require an in-person review.

ii) *sections of the proposed tool*; participants discussed the questions/statements within the tool and recommendations for iterative changes were audio recorded. Following the first virtual expert panel meeting, a word document of the proposed Pedi-R-MAPP tool was circulated for further comments, and iterative changes were incorporated by some authors (NC, LVM) prior to the first survey (Table 3). Descriptive statistics were used to summarise the responses.

**5.5. Step 7, 8 and 9: Delphi online questionnaire and iterative changes to the draft Pedi-R-MAPP tool**

Following the completion of round 1, 86% (n = 89/104) statements/questions achieved consensus. Several participants recommended removing the disease classifications (n = 11) and replacing them with 3 overarching statements. At the end of the second questionnaire 12.5% (n = 13/104) of statements/questions reached no consensus (Supplementary File 4: Table 2).

**5.6. Step 10: second virtual expert meeting to establish agreement for the following sections/questions to finalise the content of the nutrition awareness tool**

The following sections required expert discussion at the meeting to finalise the content of the tool. (Fig. 3)

- **Section 1: General information about the child (n = 1) agreement was achieved to keep the statement** "Good nutrition is key for healthy growth and development. However, many factors impact on optimal growth including; nutritional adequacy

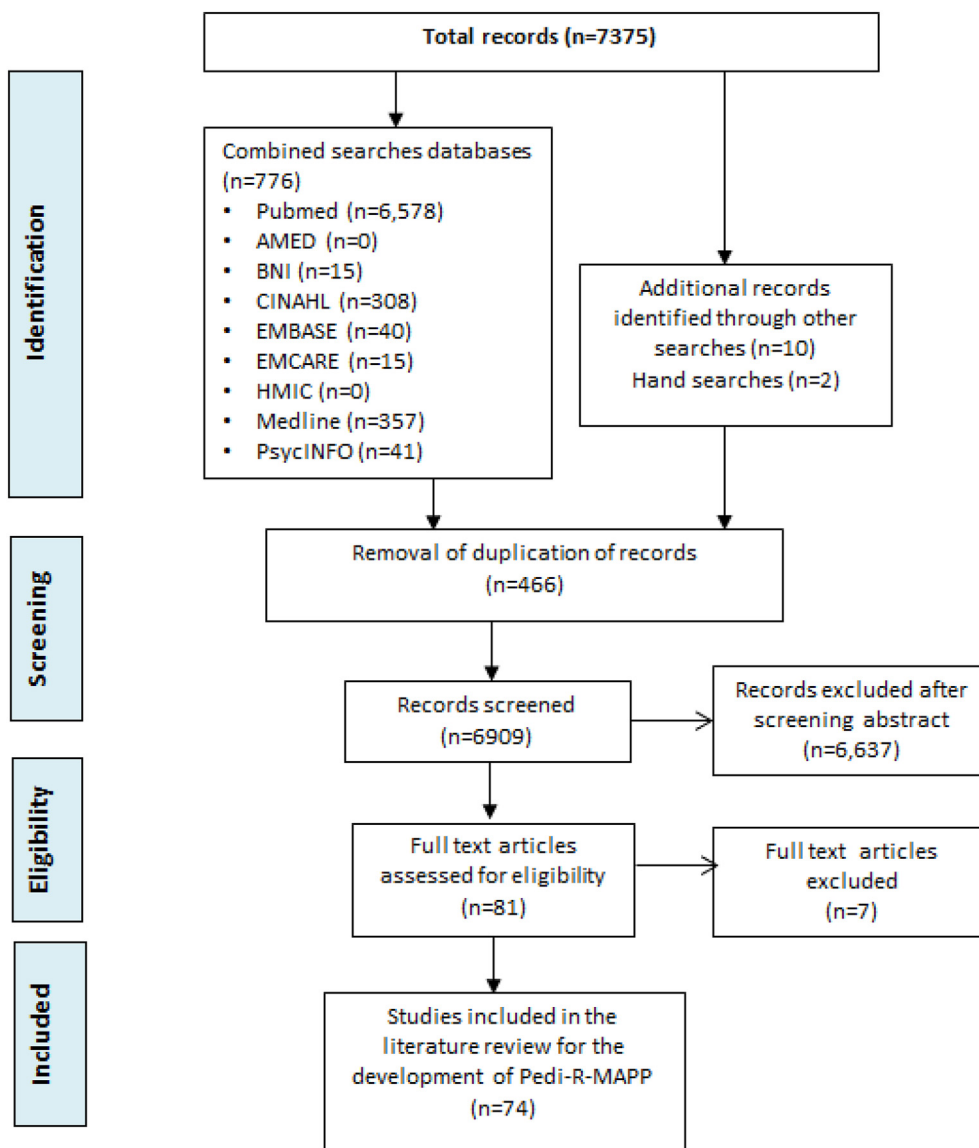


Fig. 2. Search results for literature review of evidence used to develop Pedi-R-Mapp.

**Table 2**  
Demographic characteristic of participants in the modified Delphi consensus.

	Participants (n = 18)
<b>Gender</b>	
Male	7 (39%)
Femalerowhead	11 (61%)
<b>Country of nutrition practice</b>	
United Kingdom	7 (39%)
The Netherlands	1 (5.5%)
Croatia	2 (11%)
Israel	3 (17%)
South Africa	2 (11%)
Canada	1 (5.5%)
Turkey	1 (5.5%)
Belgium	1 (5.5%)
<b>Health care professional role</b>	
Dietitian	5 (27%)
Paediatrician	12 (63%)
Psychology researcher	2 (10%)
<b>Survey round 1</b>	
Survey completion	18 (100%)
<b>Survey round 2</b>	
Survey completion	18 (100%)

**Table 3**  
Draft Pedi-R-Mapp sections and number of statements per section.

Section number	Section Name	Number of statements per section (n = )
1	General information on the child	3
2	Does the child have a long-term condition	12
3	Assess recent changes in growth	17
4	Assess what and how much a child eats and drinks	9
5	Is there enough food at home	3
6	Have there been changes in physical activity	8
7	Are there are any clinical concerns that suggest a medical review is require	7
8	Developing a nutrition care plan	45

(macro- and micronutrients), acute or chronic diseases, access to food and feeding practices e.g. responsive feeding.”

- **Section 3:** Assess recent changes in growth (n = 6) agreement was achieved to retain the statement; retain z scores and add

**PEDI-R-MAPP: A structured approach to completing a nutrition focused assessment as part of a technology enable care service (TECS) consultation in primary practice; identifying the frequency of follow up as well as those children who may require in-person assessment**

<p><b>Section 1:</b> General information about the child</p>	<p><b>Nutrition awareness statement:</b> Good nutrition is key for healthy growth and development. However, many factors impact on optimal growth including; nutritional adequacy (macro- and micronutrients), acute or chronic diseases, access to food and feeding practices such as responsive feeding.</p> <table border="1" data-bbox="368 370 1372 442"> <tr> <td data-bbox="368 370 719 442"> <p><b>Check audio/ video</b> Can you hear/see me?</p> </td> <td data-bbox="726 370 1031 442"> <p><b>Confirm caregiver's identity</b> Name/ Surname</p> </td> <td data-bbox="1037 370 1372 442"> <p><b>Confirm child's name/ age</b> Name/ Surname/DoB</p> </td> </tr> </table> <table border="1" data-bbox="368 451 1372 523"> <tr> <td data-bbox="368 451 619 523"> <p>Colour key to nutrition awareness section advice: No concerns</p> </td> <td data-bbox="625 451 876 523"> <p>Colour key to nutrition awareness section advice: Some concern</p> </td> <td data-bbox="882 451 1133 523"> <p>Colour key to nutrition awareness section advice: Significant concern</p> </td> <td data-bbox="1139 451 1372 523"> <p>Colour key to nutrition awareness section advice: Overnutrition concerns</p> </td> </tr> </table>				<p><b>Check audio/ video</b> Can you hear/see me?</p>	<p><b>Confirm caregiver's identity</b> Name/ Surname</p>	<p><b>Confirm child's name/ age</b> Name/ Surname/DoB</p>	<p>Colour key to nutrition awareness section advice: No concerns</p>	<p>Colour key to nutrition awareness section advice: Some concern</p>	<p>Colour key to nutrition awareness section advice: Significant concern</p>	<p>Colour key to nutrition awareness section advice: Overnutrition concerns</p>	
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<p><b>Section 2:</b> Does the child have a long term condition?</p>	<p><b>Nutrition Awareness statement:</b> Some clinical conditions may be associated with increase risk of children being underweight or overweight.</p> <table border="1" data-bbox="368 629 1372 787"> <tr> <td data-bbox="368 629 571 787"> <p>Does the current condition result in increased losses e.g. vomiting/ diarrhoea?</p> </td> <td data-bbox="577 629 858 787"> <p>Does the current clinical condition result in decreased intake? e.g. poor appetite, symptoms of reflux, dysphagia, food refusal, food insecurity</p> </td> <td data-bbox="865 629 1145 787"> <p>Does the current clinical condition result in increase nutrition requirements? e.g. increased work of breathing, frequent infections</p> </td> <td data-bbox="1152 629 1372 787"> <p>Does the current clinical condition result in reduced energy requirements or increased appetite?</p> </td> </tr> </table> <table border="1" data-bbox="368 795 1372 985"> <tr> <td data-bbox="368 795 619 985"> <p>The child does appear to have an acute or chronic illness leading to i) increased requirements, ii) increased losses or iii) decreased intake resulting in nutritional inadequacy</p> </td> <td data-bbox="625 795 876 985"> <p>The child may have an acute or chronic illness leading to i) increased requirements, ii) increased losses or iii) decreased intake resulting in nutritional inadequacy</p> </td> <td data-bbox="882 795 1133 985"> <p>The child may have acute or chronic illness leading to i) increased requirements, ii) increased losses or iii) decreased intake resulting in nutritional inadequacy</p> </td> <td data-bbox="1139 795 1372 985"> <p>The child may have excessive weight gain due to i) increased energy intake, ii) access to food of poor nutritional quality or iii) reduced physical activity</p> </td> </tr> </table>				<p>Does the current condition result in increased losses e.g. vomiting/ diarrhoea?</p>	<p>Does the current clinical condition result in decreased intake? e.g. poor appetite, symptoms of reflux, dysphagia, food refusal, food insecurity</p>	<p>Does the current clinical condition result in increase nutrition requirements? e.g. increased work of breathing, frequent infections</p>	<p>Does the current clinical condition result in reduced energy requirements or increased appetite?</p>	<p>The child does appear to have an acute or chronic illness leading to i) increased requirements, ii) increased losses or iii) decreased intake resulting in nutritional inadequacy</p>	<p>The child may have an acute or chronic illness leading to i) increased requirements, ii) increased losses or iii) decreased intake resulting in nutritional inadequacy</p>	<p>The child may have acute or chronic illness leading to i) increased requirements, ii) increased losses or iii) decreased intake resulting in nutritional inadequacy</p>	<p>The child may have excessive weight gain due to i) increased energy intake, ii) access to food of poor nutritional quality or iii) reduced physical activity</p>
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<p><b>Section 3:</b> Assess recent changes in growth</p>	<p><b>Nutrition Awareness statement:</b> Regularly plotting growth measures on growth charts provides the opportunity to act. Not all caregivers will have regular access to scales. As such, the aim of this question is to probe whether a child has lost or gained weight.</p> <table border="1" data-bbox="368 1108 1372 1244"> <tr> <td data-bbox="368 1108 858 1244"> <p>Has the parent or another HCP noticed any changes in weight? • No unexpected changes/ normal growth • Increased/ excessive weight gain • Weight loss / static</p> </td> <td data-bbox="865 1108 1372 1244"> <p>Available measurement classifications for age: z-scores for height, weight for height/ body mass index and weight: • Growing well z scores &gt;-1 to &lt;1 • Undernutrition &lt;-2 z scores • Overnutrition &gt;1 score</p> </td> </tr> </table> <table border="1" data-bbox="368 1253 1372 1357"> <tr> <td data-bbox="368 1253 596 1357"> <p>Growth: reassure based on growth assessment the child is growing well</p> </td> <td data-bbox="603 1253 853 1357"> <p>Growth: considerations around slowing of growth and need for stabilisation</p> </td> <td data-bbox="860 1253 1121 1357"> <p>Growth: consideration around the need for weight gain and catch up growth, where appropriate</p> </td> <td data-bbox="1128 1253 1372 1357"> <p>Growth: considerations around the need for weight stabilisation or weight loss</p> </td> </tr> </table>				<p>Has the parent or another HCP noticed any changes in weight? • No unexpected changes/ normal growth • Increased/ excessive weight gain • Weight loss / static</p>	<p>Available measurement classifications for age: z-scores for height, weight for height/ body mass index and weight: • Growing well z scores &gt;-1 to &lt;1 • Undernutrition &lt;-2 z scores • Overnutrition &gt;1 score</p>	<p>Growth: reassure based on growth assessment the child is growing well</p>	<p>Growth: considerations around slowing of growth and need for stabilisation</p>	<p>Growth: consideration around the need for weight gain and catch up growth, where appropriate</p>	<p>Growth: considerations around the need for weight stabilisation or weight loss</p>		
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<p><b>Section 4:</b> Assess what and how the child eats or drinks</p>	<p><b>Nutrition Awareness statement:</b> Too much or too little food intake impacts on children's ability to maintain a healthy weight. It is normal for the amount of food a child eats or drinks each day to vary. However, if they start to eat or drink more or less food regularly, this may lead to nutrition problem.</p> <table border="1" data-bbox="368 1476 1372 1613"> <tr> <td data-bbox="368 1476 651 1613"> <p>Has the child's appetite changed? Are they eating or drinking; more or less than usual?</p> </td> <td data-bbox="657 1476 1003 1613"> <p>Is there an existing nutritional support plan in place? Has the nutrition prescription been reviewed in the last 3 months?</p> </td> <td data-bbox="1010 1476 1372 1613"> <p>Does the child take &gt;30 mins to eat? Is the child eating food from each food group? Does the way in which the child eats or drinks worry the caregiver?</p> </td> </tr> </table> <table border="1" data-bbox="368 1621 1372 1913"> <tr> <td data-bbox="368 1621 596 1913"> <p>Provide feedback as to how the child's current intake is likely to be meeting their nutrition requirements</p> </td> <td data-bbox="603 1621 853 1913"> <p>Nutrition support: if there is an existing nutritional support plan in place for either food fortification or oral nutrition support this should be reviewed. Nutrition support should be considered if no plan is currently in place, with entry and exit criteria for support.</p> </td> <td data-bbox="860 1621 1121 1913"> <p>Nutrition support: if there is an existing nutritional support plan in place for food fortification, oral/enteral or parenteral nutrition, this should be reviewed. Nutrition support should be considered if no plan is currently in place, with entry and exit criteria for support.</p> </td> <td data-bbox="1128 1621 1372 1913"> <p>Specialist nutrition or medical support: if the child is obese z score &gt;2 consider a referral to a specialist service, where available, particularly if weight goals are not achieved</p> </td> </tr> </table>				<p>Has the child's appetite changed? Are they eating or drinking; more or less than usual?</p>	<p>Is there an existing nutritional support plan in place? Has the nutrition prescription been reviewed in the last 3 months?</p>	<p>Does the child take &gt;30 mins to eat? Is the child eating food from each food group? Does the way in which the child eats or drinks worry the caregiver?</p>	<p>Provide feedback as to how the child's current intake is likely to be meeting their nutrition requirements</p>	<p>Nutrition support: if there is an existing nutritional support plan in place for either food fortification or oral nutrition support this should be reviewed. Nutrition support should be considered if no plan is currently in place, with entry and exit criteria for support.</p>	<p>Nutrition support: if there is an existing nutritional support plan in place for food fortification, oral/enteral or parenteral nutrition, this should be reviewed. Nutrition support should be considered if no plan is currently in place, with entry and exit criteria for support.</p>	<p>Specialist nutrition or medical support: if the child is obese z score &gt;2 consider a referral to a specialist service, where available, particularly if weight goals are not achieved</p>	
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Fig. 3. The development of Pedi-R-MAPP using a modified Delphi process.



<p><b>Section 5:</b> Is there enough food at home?</p>	<p><b>Nutrition Awareness statement:</b> Food insecurity may lead to weight loss in otherwise healthy children</p> <table border="1"> <tr> <td data-bbox="359 244 869 340"> <p>Within the past 12 months you worried about whether your food would run out before you got money to buy more</p> </td> <td data-bbox="877 244 1396 340"> <p>Within the past 12 months the food you bought didn't last and you didn't have money to get more</p> </td> </tr> <tr> <td colspan="2" data-bbox="359 351 1396 414"> <p>If the answer to this statement is often true or sometimes: it suggests moderate food insecurity</p> </td> <td data-bbox="877 351 1396 414"> <p>If the answer to this statement and the previous statement is often true or sometimes: it suggests financial hardship &amp; hunger with severe food insecurity</p> </td> </tr> </table>			<p>Within the past 12 months you worried about whether your food would run out before you got money to buy more</p>	<p>Within the past 12 months the food you bought didn't last and you didn't have money to get more</p>	<p>If the answer to this statement is often true or sometimes: it suggests moderate food insecurity</p>		<p>If the answer to this statement and the previous statement is often true or sometimes: it suggests financial hardship &amp; hunger with severe food insecurity</p>		
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<p><b>Section 6:</b> Have there been any changes in physical activity?</p>	<p><b>Nutrition Awareness statement:</b> Children may have a decline in well-being leading to reduced physical activity, increase screen time and poor quality of sleep</p> <table border="1"> <tr> <td data-bbox="359 489 710 606"> <p>Does the child have less energy than before? Is the child less active because they do not feel well enough?</p> </td> <td data-bbox="718 489 1061 606"> <p>Are they less active due to poor motivation? Are they less active due to increased screen time?</p> </td> <td data-bbox="1069 489 1396 606"> <p>Has there been a change in the child's sleeping pattern? Sleeping more or less than usual?</p> </td> </tr> <tr> <td data-bbox="359 617 598 755"> <p>The child is likely to have age appropriate energy levels</p> </td> <td data-bbox="606 617 821 755"> <p>The child may have reduced energy levels due to illness. Consider, where appropriate, prescribing physical activities for the child to participate in</p> </td> <td data-bbox="829 617 1077 755"> <p>The child may have reduced energy levels and poor sleep due to illness. Consider, where appropriate, prescribing some physical activities for the child to participate in</p> </td> <td data-bbox="1085 617 1396 755"> <p>The child may have reduced energy levels due to poor mental health and well-being, tiredness or increased screen time. Consider, where appropriate, prescribing physical activities for the child to participate in</p> </td> </tr> </table>			<p>Does the child have less energy than before? Is the child less active because they do not feel well enough?</p>	<p>Are they less active due to poor motivation? Are they less active due to increased screen time?</p>	<p>Has there been a change in the child's sleeping pattern? Sleeping more or less than usual?</p>	<p>The child is likely to have age appropriate energy levels</p>	<p>The child may have reduced energy levels due to illness. Consider, where appropriate, prescribing physical activities for the child to participate in</p>	<p>The child may have reduced energy levels and poor sleep due to illness. Consider, where appropriate, prescribing some physical activities for the child to participate in</p>	<p>The child may have reduced energy levels due to poor mental health and well-being, tiredness or increased screen time. Consider, where appropriate, prescribing physical activities for the child to participate in</p>
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<p><b>Section 7:</b> Are there any clinical concerns that suggest an urgent medical review is required?</p>	<p><b>Nutrition Awareness statement:</b> As a last step, confirm the presences of any concerning clinical symptoms</p> <p><b>Ask the caregiver if there is the presences of:</b> Vomiting &gt;3 episodes for 3 days; Diarrhoea &gt;5 watery stools in a 24 hr period; new onset swallowing difficulty; new onset thirst, weight loss and changes in frequency of urine/ bowel movements; concerns around child protection or mental health &amp; well being</p> <p>Presence of these symptoms: suggest there should be a referral to a medical practitioner for an urgent review</p> <ol style="list-style-type: none"> <li>1. Child safety: If there are concerns around child protection / safety the child should be referred to a medical practitioner for an urgent review</li> <li>2. Mental health &amp; well-being: Ensure the caregiver and child feel supported by referring them to a medical practitioner for an urgent review</li> </ol>									
<p><b>Section 8:</b> Developing a nutrition care plan</p>	<p><b>Nutrition Awareness statement:</b> As part of any nutrition care plan, consider nutrition goals along with entry and exit criteria for nutrition follow and support</p> <table border="1"> <tr> <td data-bbox="359 1138 502 1936"> <p>Consider.... Discharge from nutrition care as the nutrition goals have been achieved</p> </td> <td data-bbox="510 1138 790 1936"> <p>With the caregiver develop a nutrition care plan which include.... Growth: a time orientated goal for catch up growth (length gain can take up to 8-12 weeks to achieve in children &lt;5 years of age, and longer in those &gt; 5 years of age. Nutrition adequacy: provide dietary counselling and advice as how to increase macro- and micronutrient intake of the child's diet Nutrition support: with the caregiver, review the child's existing nutrition care plan. Amend the plan as required especially if catch up growth is required. 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Fig. 3. (continued).

downloadable resources about z score/centile equivalencies (n = 3), along with BMI >2 z scores and remove length for age and weight more than 2 centiles above the height centiles (n = 3).

- **Section 4:** Assess what and how much a child eats or drinks (n = 3); remove statements around drinking more or less than usual (n = 2) and pictures of food groups (n = 1).
- **Section 6:** Have there been any changes in physical activity (n = 1); remove statement related to reduced activity due to pandemic restrictions.
- **Section 8:** Developing a nutrition care plan (n = 2); include a statement to reflect the caregiver relating to (n = 1) and risk factors for obesity including the quality of food (n = 1).

At the end of the final meeting all participants agreed on the content of the finalised pathway presented (Fig. 3), which will form the basis of the Pedi-R-MAPP tool.

## 6. Discussion

This study presents the results of a modified Delphi consensus which aimed to develop a nutrition awareness tool to support all HCPs working in community/primary care practice. The tool provides a nutrition focused assessment of children and young people, as well as identifying those children requiring an in person medical assessment and suggesting frequency of review. To develop the Pedi-R-MAPP nutrition awareness tool, a modified Delphi consensus process was used and involved paediatric HCPs working across international academic and clinical settings. At the end of round 2 of the Delphi survey, consensus was achieved in all but five areas; four of which resulted in minor changes to the way in which statements were worded. The main area where consensus was not achieved until the final expert meeting related to assessing and classifying growth using centile equivalencies or z scores [95,96]. During the final meeting the group agreed to retain z scores and add downloadable resources about z score/centile equivalencies. This was also reflected in the results of the international survey where over half of the participants reported the benefit of additional training resources on the use of z scores to classify nutrition status as part of a nutrition assessment.

The delivery of TECs consultations in nutrition care can be challenging for HCPs [3,10,97]. The universal challenges reported include; i) dietitians/parents unable to regularly complete anthropometric measurements, ii) reduced interpersonal communication, iii) technical difficulties and iv) challenges around the lack of peer support and clinical skills. Whilst this tool was developed in the wake of the COVID-19 pandemic, consultations using TECs have become embedded within clinical services involving children with a wide range of body habitus i.e. double burden of nutrition [10,98]. Brunton et al. [10] recommended the development of a nutrition awareness tools for use as part of remote consultations. The results from our international survey suggest the use of a nutrition awareness tool as part of TECs consultations would be useful, and tools such as Pedi-R-MAPP could be used to support a nutrition focused consultation through raising nutrition awareness as part of a TECs consultation.

The proposed Pedi-R-MAPP tool comprised of a number of colour coded sections providing HCPs with level of concerns using a systematic approach to a nutrition assessment considering; i) whether the child has a long term condition, ii) changes in growth, iii) reviewing what and how the child eats and drinks, iv) food insecurity, v) changes in physical activity and vi) clinical concerns that suggest an urgent medical review is required. From this the HCP can develop a nutrition care plan based on the colour rating green (no concern), amber (some concern), red (significant

concern) and purple (overnutrition). Several risk factors for childhood undernutrition have been identified, including food insecurity, low dietary diversity/quality, and interruption in school provided meals [99,100]. As one in three children worldwide are not growing at an expected rate, UNICEF proposes through the Innocenti Framework that key aspects of the food systems should be made a priority to facilitate better growth, particularly in low and medium income countries. Within the Pedi-R-MAPP tool, two validated questions were included to determine the likelihood of food insecurity with prompts within the nutrition care plan section to recommend the HCP to sign post the caregiver to seek support. Obesity risk factors associated with the pandemic include cessation in school teaching, reduced physical activity, increased screen time and a decline in mental health and well-being, which if prolonged, may contribute to the rise in non-communicable disease [100]. Other components of the Pedi-R-MAPP tool are dedicated to reflecting with caregivers on aspects around growth, nutrition adequacy, nutrition support, food insecurity, supporting physical activity and health and wellbeing. The risk of remote consultations may be that HCPs misdiagnose deteriorating nutritional and clinical status. In recognition of this, six questions were included, four of which focused on a change in clinical condition, one regarding concerns around child protection and one on mental health and well-being.

There are several limitations to this study including a lack of validation of the content and criterion validity of the nutrition awareness tool in a range of settings where remote consultations are being completed, as well as country specific requirements. Future work will seek to address these limitations by prospectively testing the usability, feasibility and precision of the application in clinical practice. The nutritional principles embedded within the tool represent the best evidence to date, along with the consensus views of leading participants. Although the Delphi process was robust, the expert group was of modest size and may not have represented the expert opinion of a wider audience. However, the results from the international survey would suggest commonality amongst nutritional issues and need for tools to assist in developing a nutritional diagnosis.

The COVID-19 pandemic has provided the opportunity to reduce barriers with regards to TECs and allow HCPs to re-examine traditional models of nutrition focussed assessments and nutrition care plans into TECs modalities. The ongoing challenge for HCPs is how to harness and embrace 'digital disruption' to ensure they understand and adopt the transformation within the digital landscape to remain relevant. As such, it is essential that nutrition services remain relevant by supporting digital healthcare, which is underpinned by the evidence base of literature [4]. The Pedi-R-MAPP tool seeks to support this technological transformation by providing a structured approach to nutrition awareness in children reviewed via virtual consultations; as well as identifying those children who would benefit from an in-person nutrition focussed assessment, in addition to the frequency of review and follow-up.

## 7. Conclusions

We report on the Pedi-R-MAPP tool, developed using a modified Delphi consensus. The tool seeks to provide a structured approach to completing a nutrition focused assessment, in addition to identifying the frequency of follow up with children who may require in-person assessment. Although further study and validation is needed, there is potential for this tool to be embedded within a child's electronic patient health records. When used within a quality improvement framework it may help improve the early recognition of declining nutrition status thereby improving nutritional status of children.

## Statement of authorship

Authors made the following contribution to the manuscript [1]: ZK, DVB formulate the idea for the R-MAPP tool [2], LVM formulated the idea for the adapted Pedi-R-MAPP tool, completed the literature search and initial design [2] LVM, RMB, ASD, JJA, NC further developed the tool for presentation at the expert meetings [4], NC, ASD, JJA, RMB, JH, JK, TN, DM, RS, SA, AGM, ZK, LC, LMC, SC, KG, JM, LVM all completed the modified Delphi consensus [5] LVM drafted the manuscript [6] all authors critically reviewed and revised the manuscript for important intellectual content [7], and all authors provided final approval of the version to be submitted.

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## Ethics

Ethical approval was not required as an anonymous survey was completed along with anonymous voting in the modified Delphi survey rounds. Health care professionals attended the round table meetings voluntarily.

## Conflicts of interest

Professor Darlington and Dr Marino report an unrestricted grant from Abbott Laboratories, during the conduct of the study. Dr Marino report honoraria from ABBOTT Laboratories and Danone - Nutricia outside the submitted work. Professors Vranešić Bender and Krznarić reports personal fees and non-financial support from Abbott Laboratories, personal fees and non-financial support from Fresenius Kabi, personal fees and non-financial support from G-M Pharma-Nutricia, personal fees and non-financial support from Oktal Pharma – Nestle Nutrition, personal fees and non-financial support from Belupo, outside the submitted work. Professor Gerasimidis reports consultancy work for Nestle, Nutricia, Baxter and Abbott Laboratories. Professor Kolacek reports grant pending from BioGaia; honoraria received from for educational presentations from Abbott Laboratories, Abbvie, Abela Pharma, GM Pharma, Nestle, Nutricia, Takeda. Dr Huysentruyt reports board membership for Danone. Dr Meyer reports consultancy for Danone, Abbott Laboratories and Nestle including the development of the CoMISS score, hydrolysed rice formula and research applications; honoraria for academic lectures for Abbott, Nestle, Danone-Nutricia and Mead Johnson; and payment for manuscript preparation for Danone-Nutricia. Professor Beattie, Sharmir, Joosten and Dr's Cooke ML, Guz-Mark, Hulst, Nemet, Niseteo, Selimoglu and Ms Cooke LH and Cader report no conflict of interests.

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## Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.clnu.2022.01.009>.

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