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A sequential, exploratory, mixed-methods approach for development and validation of a context-specific knowledge, attitude and practice questionnaire on micronutrients for literate mothers of school-age children

Archana Konapur[1], Madhavan Nair Krishnapillai[2,†], Balakrishna Nagalla[3,†] and SubbaRao M Gavaravarapu[1,*]

[1]Media, Communication & Extension Group, Extension & Training Division, National Institute of Nutrition (ICMR), Jamai-Osmania PO, Tarnaka, Hyderabad, Telangana, India: [2]Micronutrient Division, National Institute of Nutrition (ICMR), Tarnaka, Hyderabad, Telangana, India: [3]Division of Biostatistics, National Institute of Nutrition (ICMR), Tarnaka, Hyderabad, Telangana, India

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Abstract

Objective: To develop and validate a context-specific comprehensive knowledge, attitude and practice (KAP) questionnaire for literate mothers on factors affecting micronutrient status of 6–10-year-old children.

Design: Sequential exploratory mixed-methods study using focus group discussions (FGD) and psychometric validation.

Setting: Seven randomly selected villages with >500 households with three to five family members each, in Ghatkesar sub-district, Medchal district, Telangana state, India.

Participants: Literate mothers from middle-income households with at least one child (6–10 years) for FGD (*n* 44), for testing the internal consistency (*n* 80) and for test–retest reliability (*n* 30).

Results: The themes for FGD were diet diversity, micronutrients, cooking and eating practices, national programmes and sunlight exposure. Knowledge among caregivers about sources of micronutrients, deficiency symptoms, cooking/eating practices was low, while attitude towards diet diversity and sunlight was good. Non-availability of fruits and vegetables was a barrier to diet diversity. About 72 % of the questions from the item pool were based on FGD. After content validity, 125 items were selected for the questionnaire which, upon psychometric validation, was reduced to an eighty-eight-item questionnaire with difficulty index of 0·10–0·91, discrimination index of 0·09–0·68, Cronbach's α of 0·78 (reliability of knowledge and attitude) and 0·50 (practice). A Bland–Altman plot showed good agreement between test and retest scores.

Conclusions: The questionnaire developed and validated using a sequential exploratory mixed-methods approach can be used for assessing KAP on micronutrients and factors affecting consumption of diverse diets in rural Indian households.

Keywords
Focus groups
Knowledge, attitude and practice questionnaire
Psychometric analysis
Micronutrients
Diet diversity

Enabling communities and consumers to choose a healthy diet is dependent on the food system, which influences population health. Micronutrient malnutrition is a global health issue and represents a major challenge to social and economic development in developing countries[1]. National surveys such as the National Family Health Survey-4 in India estimate the death rate among children under 5 years of age at 50 per 1000[2]. The main reason is insufficient food intake leading to deficiencies of both macronutrients and micronutrients. Medium- and short-term strategies to combat micronutrient deficiencies, such as fortification and supplementation respectively, have been adopted worldwide. Although these strategies have been successful in reducing specific clinical forms of micronutrient deficiencies in the population, subclinical forms of vitamin A deficiency are still prevalent[3]. However, there is a need for a more comprehensive, long-term sustainable approach for addressing multiple

† Retired.

*Corresponding author: Email gmsubbarao@yahoo.com; gmsubbarao@ninindia.org

micronutrient deficiencies. Diet diversification, which provides a package of micronutrients along with nutrition education, is considered a sustainable strategy[4].

The diets of school-going children in lower- and middle-income countries are deficient in micronutrients, the major factor being lack of diet diversity, more so in rural areas. In India, the rural diet survey revealed that the consumption of all five food groups is less than 50 % of recommended intake, except for cereals, across all age groups[5]. Evidence-based interventions are the need of the hour, to fundamentally bring about a sustainable social and behavioural change regarding micronutrient malnutrition. In order to set quantifiable goals and priorities for reducing micronutrient malnutrition through diet diversification, data must be collected not only on dietary intake but also on local availability, accessibility and affordability of foods, to enable purchase and consumption of a diversified diet by all people as well as the target population. This information is crucial in developing and assisting public health interventions targeting behaviour change through dietary diversification to combat micronutrient malnutrition globally.

The success of public health interventions in resource-limited settings depends critically on our understanding of the socio-anthropological and economic aspects of the context in which these interventions are implemented[6–8]. For promoting dietary diversification and to push people towards consumption of micronutrient-rich foods, one has to understand the current knowledge, attitudes and practices (KAP) prevalent in the community. Understanding the inadequacies in KAP prevalent in the community aids in developing targeted nutrition communication interventions specific to the target population. The targeted nutrition communication intervention, when implemented in the community, will bring the needed change in the practice of the target population. KAP of the people, in turn, depends on other factors such as level of education, cultural beliefs and practices, income, availability, proximity to markets and affordability.

There is realization that the poor association between nutrition knowledge and dietary intake may be due to the poor assessment of knowledge as one of the major hindering factors[9]. The development of validated and customized KAP tools is a demanding and continuous process which is neglected/out of the focus of most interventions. Thus, the need for valid and reliable tools in nutrition education research for assessment of knowledge is now well recognized. Therefore, the present study attempted to develop a KAP questionnaire specific to micronutrients and factors affecting micronutrient status in rural areas of Telangana state, India, using qualitative data. The purpose of developing the KAP questionnaire was to use it as an intervention assessment tool in an ongoing communication intervention project on promoting diet diversification to improve micronutrient status in rural households.

Methodology

Approvals

The study employed a mixed-methods, sequential exploratory approach for development and validation of the KAP questionnaire. Permission was obtained from the District Collector and Department of Women and Child Welfare, Government of Telangana, India. Supervisors of the Integrated Child Development Scheme (which is an Indian public health-care system providing basic health care including nutrition education and supplementation for pregnant and lactating women and children under 5 years of age) and village heads (Ghatkesar sub-district) were approached and seven villages with >500 households were included for the study. The purpose, methodology and their crucial role in the study were explained and discussed with them. The study was registered at the Clinical Trial Registry of India (CTRI registration number CTRI/2015/06/005836). As per the norms of the Institutional Ethics Committee of the National Institute of Nutrition, Hyderabad (which cleared the protocol; 08/I/2014), written informed consent was obtained from the participants.

Study site

The present study was conducted in Ghatkesar sub-district, Medchal district, Telangana state, India. Ghatkesar has 44 004 households with a population size of 188 380, 71 % literacy and a sex ratio of 926 women:1000 men. Out of fifteen villages in Ghatkesar, seven villages with >500 households (Aushapur, Annojiguda, Kondapur, Edulabad, Yamnampet, Ankushapur and Korremula) were randomly selected for conducting the study. The study area met the inclusion criteria of: (i) availability and accessibility to the food market as it is near the national highway; (ii) majority of the families residing there were expected to be middle-income families; and (iii) 10–15 % of the population was expected to have a child aged 6–10 years in the household.

Study design

There were two distinct phases, qualitative and quantitative, in the development of the KAP questionnaire. In the qualitative phase, literature was reviewed to prepare an item pool and focus group discussions (FGD) were conducted to get an overview of existing knowledge and practices. In quantitative phase, the item pool was tested for its validity, internal consistency and reliability (Fig. 1).

Qualitative data collection phase

Focus group discussions

Participants. FGD were conducted among participants from the randomly selected villages of Aushapur, Annojiguda, Kondapur and Edulabad. The inclusion criteria for

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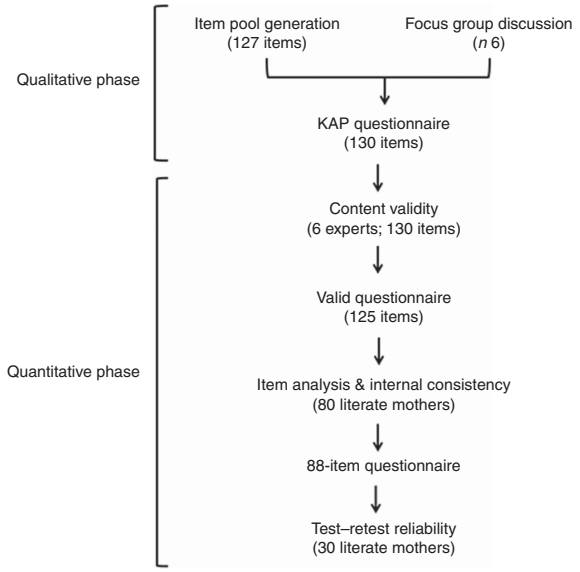

Fig. 1 Study design: sequential exploratory mixed-methods approach (KAP, knowledge, attitude and practice)

the participants included a household with a 6–10-year-old child, a literate mother and a middle-income family (Standard of Living Index >24) with family size of three to five members. Although the number of FGD to be conducted was not predetermined, it was decided to conduct no new FGD at the point of data and theoretical saturation, which are defined as criteria where conducting further FGD with a new group of participants would not yield new information and new themes, respectively[10]. According to the standard format, the number of participants in each FGD should be six to twelve for utmost participation in the discussion[11,12]. In the present study, data and theoretical saturation were reached at six FGD. In all groups, there were six to eight participants, except in one FGD where there were twelve. The total number of participants in this qualitative phase of research was forty-four.

Conducting focus group discussions. The standard method of conducting FGD was followed[11,12]. Briefly, a theme guide was conceived with five major themes: (i) micronutrients (including food sources, bioavailability and deficiency symptoms); (ii) diet diversification (including availability, accessibility and affordability); (iii) cooking and eating practices (frequency of foods purchased and prepared); (iv) national programmes (vitamin A drops, iron tablets, iodized salt, services for beneficiaries at *anganwadi* centres); and (v) sunlight exposure (time and duration of physical activity). Each theme had open-ended questions and probes for discussion (Table 1).

FGD were conducted by a team consisting of a trained moderator and two note-takers[13]. The meeting was arranged at the local *anganwadi* centre and community halls. The entire discussions were carried out in the local language (Telugu). The FGD lasted for 35–45 min. Mothers sat in a semi-circle with the moderator at the centre. After explaining the purpose of the study, written consent to participate in the discussion was obtained. With the permission of the participants, all the discussions were video/audio-recorded except one FGD, where the participants did not agree to video-record the discussion.

Table 1 Discussion points included in the theme guide for conducting focus group discussions with rural, literate, middle-income mothers of school-age children (6–10 years), Ghatkesar sub-district, Medchal district, Telangana state, India (*n* 44)

Key questions and probes
Diet diversification
What does healthy food mean to you?
Probes:
Is there any food which has all the nutrients? Or there is a need for a combination of foods to get all the nutrients?
How often do you cook/eat varieties of foods in a single day?
Micronutrients
What do you know about vitamin and minerals?
What do you feel about vitamins and minerals levels in your body?
Can you name few foods rich in vitamins or minerals?
Probes:
Can you name few vitamins and minerals?
What are the various symptoms of their deficiency decreased levels in the body?
Which food is good for proper eyesight? It is rich in which vitamin?
Cooking and eating practices
Where do you purchase fruits, vegetables, milk, flesh foods?
Do you wash vegetables before the preparation of food?
Do you consume tea/coffee/milk?
Probes:
How frequently are fruits and vegetables purchased?
Are nutrients lost if vegetables are cut and washed?
At what time do you usually drink tea/coffee/milk?
National programmes
Did you consume iron–folic acid tablets when you were pregnant?
Do you use iodized salt? How do you identify it?
Probes:
Why do you think it is given to children?
Why are iron–folic acid tablets given to pregnant women?
Why iodized salt should be used?
Sunlight exposure
What do you think about sunlight?
Is there any health benefit from sunlight?
Do you go outdoors exclusively to get sunlight?
Probes:
Is sunlight important or not?
Do you think you get nutrients from sunlight?
On what occasions do you generally go outdoors?

The participants were engaged with ice-breaking questions, such as 'What foods do your children like the most?' and 'Are green leafy vegetables grown in your village?', prior to beginning the session, to make them comfortable with the discussion and also to identify active participants. The discussion started with the themes included in the questionnaire and probes were applied wherever needed. No specific order of the questions in the themes was followed; whatever order was convenient at the time of conducting the FGD was used. Non-participant observers took notes and recorded videos simultaneously. The discussion ended with clearing participants' queries on nutrition and a vote of thanks.

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Analysis

Coding. A summary of the FGD was written down immediately after every discussion by the focus group team. Transcripts were prepared using field notes/video recordings on the same day. These scripts were in turn compiled into individual reports, organizing raw data into codes. A grounded theory approach was used to manually code the data with open and axial coding. At first, we looked for distinct concepts and categories in the data (open coding), which formed the basic themes of analysis. Using the codes developed at the first level, the researchers re-read the transcripts and categorized statements that fit to themes of analysis (axial coding). Quotes from the transcripts that addressed these themes were flagged, and the ones that were in complete contrast with others were included. Majority responses of the mothers to the questions and probes during the FGD were considered for deleting, retaining, modifying and adding in the item pool.

Item pool generation. The item pool consisting of 132 KAP questions was formulated based on a review of the literature[9,14–18] and discussion with nutrition experts, with four major domains. The domains under which questions were categorized were: (i) diet diversity; (ii) micronutrients; (iii) cooking and eating practices; and (iv) sunlight exposure. The micronutrients focused upon were iron, zinc, calcium, vitamin A, vitamin D, folate and vitamin B_{12}, deficiencies which have been documented among 6–10-year-old children in India[19].

Development of the knowledge, attitude and practice questionnaire. Responses of mothers to the questions and probes during the FGD were considered for making the item pool contextual. Questions in each domain which were never heard by the mothers were deleted. Some of the questions retained in the item pool were reframed to make them more understandable to the mothers. A few new questions that were not initially present in the item pool were also added. Some questions on a few topics, which had not been included earlier because they were thought to be too elementary, had to be added as the FGD revealed that such knowledge was not uniform. For example, in one FGD, all mothers knew that a branded salt available in that village is iodized, but one mother did not know that branded salt is iodized and only a few mothers knew the function of iodine. As caregivers had low knowledge on micronutrients, the majority of the new questions were added in the micronutrients domain, followed by cooking and eating practices, diet diversification and sunlight exposure. This resulted in a new 132-item KAP questionnaire, which was subjected to content analysis (Table 2).

Quantitative validation phase

Content validity

The KAP questionnaire was subjected to content validity by six experts drawn from various fields like nutrition (*n* 1), dietetics (*n* 2), psychology (*n* 1), medicine (*n* 1) and communication (*n* 1). The experts rated each question on a 4-point Likert scale that included different parameters such as relevance, clarity, simplicity and ambiguity.

Content validity index. The content validity index (CVI) was computed as the number of experts giving a rating of either 3 or 4, divided by the total number of experts who rated the questions. An item with CVI > 0·8 was retained[20,21].

The questionnaire was translated into the regional language, Telugu, using the forward–backward translation method. After translation, the questionnaire was pre-tested among five members from the study area with the same inclusion criteria but who were not a part of the main study.

Psychometric validation

Sample size. Estimating a 20 % increment in nutrition knowledge score, with a moderate effect size of 0·5 based on previous studies[22–26] on health and education interventions in different community groups, with 95 % confidence and 80 % power, the required number of households was 160 with 20 % dropout rate in the ongoing project (CTRI registration number CTRI/2015/06/005836). As per the literature[27], a sample size of fifty is sufficient to test the internal consistency of a questionnaire. As the sample size for the ongoing project is 160, the internal

Table 2 Number of items in the questionnaire during the process of testing the validity and reliability of the knowledge, attitude and practice questionnaire

Domain	Item pool (*n*)	Deleted items (*n*)	Retained and modified items (*n*)	Newly added items (*n*)	Total items after FGD (*n*)	Total items after content validity (*n*)	Items retained after testing for internal consistency (*n*)
1. Diet diversification	17	11	6	15	21	20	11
2. Micronutrients	36	24	12	42	54	43	30
3. Cooking and eating practices	62	46	16	26	42	35	22
4. Sunlight exposure	12	10	2	11	15	27	25
Total items (*n*)	127	91	36	94	132	125	88

FGD, focus group discussion.

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consistency of the questionnaire was tested in sub-samples of eighty participants. With a correlation (r) of 0·5 considering 95 % CI and 80 % power, the required sample size for reliability testing using the test–retest method was twenty-nine (thirty participants were recruited).

Administration of the questionnaire. Households meeting the inclusion criteria were approached and the questionnaire was administered by the investigators in the interview mode to the individual mothers at their households in their leisure period between 09.00 and 13.00 hours. The questionnaire was administered with an instruction to answer only if they knew the answer, and to select the option 'don't know' if they were unsure of the answer. They were also instructed to stop the questionnaire administration if any question was not understood by them, and those questions were repeated and asked until they were understood. The time taken to complete the 132- and eighty-eight-item questionnaires was approximately 30 and 20 min, respectively. On average, six to eight households were visited per day to administer the questionnaire.

Item difficulty. The item difficulty was determined by the total number of correct responses to the test item. Item difficulty index (p) was calculated by using the formula: $p = R/T$, where R is the number of correct responses and T is the total number of responses. An item was considered difficult or easy when $p < 0{\cdot}20$ or $p > 0{\cdot}80$, respectively[28].

Item discrimination. Item discrimination compares the number of high scorers and low scorers who answer an item correctly. It is the extent to which items discriminate among respondents in the high and low scorers. A total test was scored, the scores were rank-ordered, and 25 % of the highest and lowest scorers were selected. The number of correct answers in the highest 25 % was subtracted from the number of correct answers in the lowest 25 %. This result was divided by the number of people in the larger of the two groups; the resulting value was considered the item discrimination index (D)[29,30]. A value $D = 0{\cdot}20$–$0{\cdot}29$ was considered acceptable, $D = 0{\cdot}30$–$0{\cdot}39$ as good and $D \geq 0{\cdot}40$ was considered excellent as per available literature[31].

Internal consistency. The rational equivalence method using Cronbach's α was employed to assess the reliability of the test. Cronbach's α estimates the reliability of test scores with respect to (i) how well the individual items of the scores fit together and (ii) whether they assess the same construct. It assesses the intercorrelations of the items in the test and the correlations of the items with the test overall. A value $\alpha < 0{\cdot}70$ is considered low and a value $\alpha > 0{\cdot}70$ is considered adequate[32].

Test–retest reliability. The eighty-eight-item KAP questionnaire was administered twice among thirty mothers to test the stability of the questionnaire over time. The mothers were kept unaware of the retest, which was done two weeks after the test. The differences between the two measurements were plotted against the means of the two measurements by the Bland–Altman method[33].

Scoring. All questions were closed-ended and had multiple choices, except three questions that were open-ended. There was only one correct answer to each question. The responses were scored by awarding a mark of 1 to the correct answer and a mark of 0 to an incorrect answer. The quality of individual items in the questionnaire was measured in terms of item difficulty, item discrimination and internal consistency.

Statistical analysis

Statistical analysis was not done for qualitative data, because those data were analysed based on the majority responses of the respondents. Statistical analyses for quantitative data were done using the statistical software package IBM SPSS Statistics version 24.0. Item analysis (item difficulty index p, item discrimination index D, Cronbach's α) was done for psychometric validation of the eighty-eight-item questionnaire. The Bland–Altman plots were constructed using the MedCalc statistical program version 12.5.0.0 (MedCalc Software, Acacialaan, Belgium).

Results

Representative responses of the FGD participants are provided in Table 3. The insights from FGD which were used to prepare items in the KAP questionnaire are given in Table 4. In general, rice, milk, sugar and roots were consumed daily; green leafy vegetables and flesh foods were consumed once weekly; pulses, eggs, fruits and tubers were consumed twice weekly; and other vegetables three times weekly. The reasons for not consuming a diversified diet daily were either the respective foods were not available in the village market or dislike by the children in the households. The most prepared breakfast items included *idly* (fermented steamed rice cake), *dosa* (fermented pancake), *upma* (semolina porridge), bread, jam, milk and biscuit. The foods mostly liked by the children included carrot, onion, potato, chicken, fish, apple, banana, grapes, watermelon and mango. The foods purchased most frequently in the weekly market included potato, onion, tomato, ladies' finger, banana, apple, grapes, papaya, watermelon, mango and all other seasonal fruits.

Quantitative data

Based on the FGD, the 127 KAP questions in the item pool were modified into a 132-item KAP questionnaire, which was subjected to content analysis and further reduced to a 125-item KAP questionnaire (Table 2). About three-quarters (72 %) of the questions from the item pool were based on FGD.

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Table 3 Representative comments of the rural, literate, middle-income mothers of school-age children (6–10 years) on the focus group discussion themes, Ghatkesar sub-district, Medchal district, Telangana state, India (*n* 44)

Theme	Quotes
1. Diet diversification	'Balanced diet is important. It has proteins and vitamins. Everything should be included in children's food. All varieties should be given. Even if we eat balanced diet daily, there will be no effect. Eating a balanced meal for 4–5 times a week is okay.' (Woman, 30 years, village 05)
	'Nutritious food is important. It has vitamins and minerals. Green leafy vegetables, milk and egg are good for health.' (Woman, 25 years, village 03)
	'Along with rice, we cook only one curry. If we prepare dhal [pulses], then we don't prepare curry. In a day, only once we cook vegetable curry.' (All caregivers, village 02)
	'Daily I don't give fruits to children. Only when we bring fruits [from Ghatkesar sub-district or weekly market], that day and next day we give fruits to children.' (Woman, 26 years, village 02)
2. Micronutrients	'Micronutrients are those which cannot be seen from eyes.' (Woman, 26 years, village 02)
	'Vitamin D makes bones stronger. Eyesight will be affected with vitamin A deficiency, night blindness occurs.' (Woman, 30 years, village 02)
	'Spinach also has vitamins; it should be eaten for eyesight and blood. Banana improves digestion, but I heard that eating banana makes us fat.' (Woman, 25 years, village 03)
	'Eyesight will be affected due to vitamin C deficiency.' (Woman, 28 years, village 03)
	'With calcium deficiency, bones will break!' (Woman, 29 years, village 02)
3. Cooking and eating practices	'I don't boil vegetables. I cook directly. After cutting vegetables, without boiling vegetables we season it. If boiled in water, iron will go. So, vegetables are not boiled. If boiled, vitamins will go. I always close the vessel with lid while cooking.' (Woman, 28 years, village 03)
	'People say that children will get cold if guava is eaten. We are afraid, that's why we don't give it to children.' (Woman, 28 years, village 03)
	Availability
	'We get fruits from Uppal [4 km from the study village]. They [fruit vendor] come sometimes.' (Woman, 20 years, village 02)
	'On Fridays they [fruit vendor] come.' (Woman, 22 years, village 02)
	'It will it be good if market happens twice a week. We can get fresh vegetables and fruits.' (All caregivers, village 02)
	Affordability
	'Food should be eaten compulsorily right. So even if the price increases, we bring same quantity of foods. When the price of dhal increases we cannot stop feeding our children with dhal. It is difficult because dhal is important for children. Now non-veg [flesh foods] price has increased, it's 500 Rs per kg. Instead of buying non-veg, we will buy more dhal.' (Woman, 30 years, village 05)
	'They [children] eat only fruits liked by them. I give apples to my children. So what if they are costly? Children like apples, so we purchase and give what is liked by our children.' (Woman, 25 years, village 03)
	'We all belong to middle-class families sir! All members in the family do not get all foods to eat. For children I give whatever is there at home. I give milk compulsorily to my kids. We give fruits to children only [if the fruit is costly or if price of fruits increases]. Only onion and tomato I have reduced [due to increased rates of late]. Dhal is compulsory daily [even if the price increases].' (Woman, 28 years, village 02)
	'At least 1/2 kg we buy dhal even price is high, and I prepare dhal alternate days that time.' (Woman, 25 years, village 02)
4. Sunlight exposure	'Doctor said that from sunlight we will get vitamins. Vitamin C or D, I don't remember sir. Nobody knows it clearly sir. If you tell us, we can know it sir. If we get exposed to sunlight in the early morning, there will be no problem in eyesight.' (Woman, 28 years, village 02)
	'We get vitamin D from sunlight. Five minutes of exposure is enough.' (Woman, 25 years, village 02)
	'It is good to expose to sun till half an hour after sunrise, after that the temperature of sun will be high.' (Woman, 30 years, village 05)
5. National programmes	'There is very much difference between common salt and iodized salt. Common salt will be black in colour. Iodized salt is fresh. Iodized salt improves height and make brain sharper.' (Woman, 31 years, village 05)

Psychometric validation

Following psychometric validation, the 125-item questionnaire was further reduced to eighty-eight items. The item difficulty index p for knowledge questions ranged from 0·10 to 0·91. There were five relatively easy questions ($p = 0{\cdot}81$–$0{\cdot}91$) and five difficult questions ($p = 0{\cdot}07$–$0{\cdot}12$), with all the rest being in the desirable range of difficulty.

The item discrimination index D for knowledge questions ranged from 0·09 to 0·68. Nineteen questions had $D > 0{\cdot}40$, five questions had $D > 0{\cdot}30$ and five questions had $D > 0{\cdot}20$.

A Cronbach's α value of 0·78 was obtained for the knowledge and attitude questions, whereas $\alpha = 0{\cdot}50$ was obtained for practice questions, which are considered adequate and low, respectively. The Bland–Altman plots showed a mean bias of 1·9, 04 and 0·4 for the knowledge, attitude and practice questions, respectively, with few outliers, and had a good agreement between test and retest scores (Fig. 2(a)–(c)). The final questionnaire consisted of eleven, thirty, twenty-two and twenty-five items on diet diversity, micronutrients, cooking/eating practices and sunlight exposure, respectively.

Discussion

The present study adopted two-phase exploratory methods to develop a comprehensive KAP questionnaire that

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Table 4 Insights from the focus group discussions (FGD) that were used to develop items for the knowledge, attitude and practice questionnaire

Theme	Existing knowledge and practices of mothers	Desirable knowledge and practices related questions included in the questionnaire based on FGD findings
Diet diversification	• Only one accompanying dish is prepared along with rice daily • Pulses, green leafy vegetables, other vegetables, milk and eggs were perceived to be healthy for children • Used only one type of oil: either groundnut oil or sunflower oil	• Why a variety of foods should be eaten daily • Frequency of consumption of a diversified diet • Nutrient sources of different foods • Identification of a balanced diet • Types of oil used
Micronutrients	• Aware of the terms 'vitamins' and 'minerals' • Could name a few micronutrients such as vitamins A, B, C and D, iron and calcium, when probed • Knowledge about only few functions of macronutrients • Iodized salt is used and identified by the logo of a smiling sun on the packet	• Name one vitamin and mineral • Food sources of micronutrients • Health benefit of using iodized salt • Micronutrient status of their family members • Foods to be consumed for growth and development • Functions and deficiency symptoms of micronutrients • Bioavailability of iron and vitamin A
Cooking and eating practices	• Breakfast was prepared by few people • Snacks such as milk, biscuit, carrot or any fruit were given to children • Wash vegetables first and then cut • Closed the vessel with a lid while cooking • Could not give fruits daily to their children	• Number of meals and types of snacks consumed • Frequency of washing fruits and vegetables • Cooking practices that prevent nutrient loss • Foods disliked by children
	Barriers identified for not practising diet diversity:	
Availability	• Perishable foods like fruits, green leafy vegetables, other vegetables, fish are available once or twice weekly, apart from oil and milk which are available daily in the village • Non-perishable foods are available daily • All seasonal fruits were available during different seasons	Reason for not consuming a diversified diet: not available in the household daily
Accessibility	• Retail shops and weekly markets were at walkable distance	Did not include any question in the questionnaire
Affordability	• If the price of the food rises, they do not compromise on the quality and variety of food, but would rather decrease the frequency of preparation of the inflated food or purchase half the amount than usually purchased, and children are given priority	Reason for not consuming a diversified diet: not affordable
National programmes	• Aware of the facilities provided at *anganwadi* centre for children under 5 years of age • All their children received vitamin A drops; mothers received iron–folic acid tablets during their pregnancy	Did not include any questions in the questionnaire
Sunlight exposure	• Exposure to sunlight is essential, especially for pregnant women, and provides proper vision to the newborn baby • It is good to get exposed to sunlight early in the morning for a minimum of 5 min and maximum of half an hour	• Health benefit of sunlight exposure • Time of sunlight exposure • Area of sunlight exposure

captured inherent inabilities of mothers to practise a diversified diet to satisfy the micronutrient status of 6–10-year-old children. First, FGD-based qualitative data provided contextual understanding of the community's ability to absorb and practise nutrition knowledge. In the second phase, a psychometrically validated KAP questionnaire was developed. This KAP questionnaire can be a valuable assessment tool and can contribute to public health nutrition policy.

The food people consume is affected by a large number of interrelated factors, including food availability, food accessibility and food choice, which in turn are influenced by geography, demography, disposable income, socio-economic status, urbanization, globalization, religion, culture, marketing and consumer attitude. Dietary diversification is considered one of the long-term sustainable strategies to combat micronutrient malnutrition globally. However, due to the lack of understanding of contextual factors that lead to the success of such interventions, there is a need for critical evaluation of (i) the level of awareness/knowledge and perceptions of the target population and (ii) barriers at community and individual level; apart from certain extraneous factors like availability, affordability and accessibility for practising dietary change[34]. This in turn could be due to a lack of context-specific validated tools that consider all these aspects.

A review of a large number of studies measuring nutrition knowledge revealed that most instruments that

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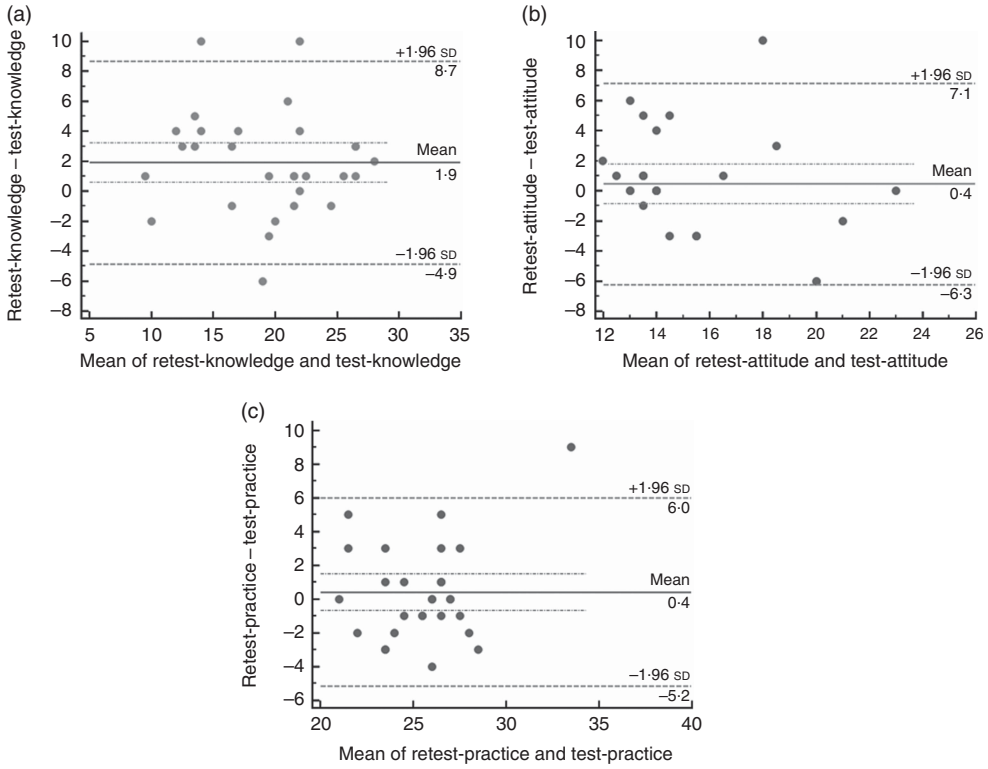

Fig. 2 Bland–Altman plots showing the agreement between test and retest scores on (a) knowledge questions, (b) attitude questions and (c) practice questions of the eighty-eight-item knowledge, attitude and practice questionnaire on micronutrients and factors affecting micronutrient status among rural, literate, middle-income mothers of school-age children (6–10 years), Ghatkesar sub-district, Medchal district, Telangana state, India (*n* 30). The differences between the retest and test scores were plotted against the means of the two scores and the limits of agreement were calculated. ——— represents the mean difference between the retest and test (bias); – – – represent the 95 % CI of the bias; — — represent the upper and lower 95 % limits of agreement.

have been applied to measure nutrition knowledge have not been validated[35]. Some authors reported a pilot investigation[36–42] in which the questionnaire was tested. Several studies have reported using only pre-tested questionnaires for collecting data on nutrition knowledge, but they have avoided mentioning the statistical or methodological steps in developing such questionnaires[15,16,43–46]. The importance of a structured approach to establishing the validity and reliability of a questionnaire, especially on micronutrients, was emphasized by Augustine *et al.*[9]. The KAP questionnaires used in earlier studies were general nutrition KAP questionnaires focusing on dietary recommendations and diet–disease relationships[40,41,47–49] or have concentrated on a specific aspect of nutrition such as fat[39], fat, fibre and cholesterol[50], or micronutrients[9,16] alone. These, although useful, may not provide information on KAP in the context in which the target population is situated.

Studies evaluating KAP on nutrition often adapt questionnaires from elsewhere, without conducting formative research in the study area[16,51,52]. For framing the questions themselves, formative research was seen to be the most helpful phase in the current study. Although a few studies have used a mixed-methods approach in assessing KAP on nutrition, the questionnaires have not been validated[51]. The KAP questionnaire in the current study is developed and validated based both on qualitative and quantitative data obtained from formative research. Therefore, unlike the earlier studies which had questions only on micronutrients, fat and food group knowledge, we consider ours is one of the early approaches to have adopted a holistic methodology in developing a comprehensive context-specific questionnaire. Additionally, our study looked not only into context in the formative phase, but also used appropriate quantitative analysis methods to ensure the consistency and reliability after examining the validity.

FGD aided in deleting, retaining, modifying and adding a few questions in the 127 questions in the item pool, resulting in a new 132-item KAP questionnaire which was subjected to content analysis. The basis for deletion of questions from the item pool in each domain was that either they were too basic or the participants had never heard of that particular concept (such as foods rich in vitamin B_{12}, which vitamin helps in cognitive development). The item pool used for the questionnaire development addressed the micronutrients that had an established evidence of dietary deficiency such as iron and vitamin A[5].

The Cronbach's α for the entire KAP questionnaire was 0·70 (not reported), which is an acceptable value

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according to Nunnally[53]. When tested for individual constructs – knowledge, attitude and practice – the Cronbach's α of knowledge and attitude remained the same (>0·70) but for the practice construct α was 0·50. The low Cronbach's α for the practice construct could be due to various reasons. The primary reason appears to be due to fewer questions per domain in the practice construct as compared with the overall number of questions in the KAP questionnaire. Cortina[54] reported that internal consistency is sensitive to the number items in the questionnaire and it is likely to increase with increase in the number of items. Therefore, a low α value of one construct in the questionnaire could end up affecting the internal consistency of the questionnaire as a whole[54,55]. Moreover, the questions in the practice construct were diverse and there was scope for a lot of inconsistency in responses as multiple answers were possible. Multidimensionality of answers could have resulted in low Cronbach's α. Although deleting a few items in the practice construct improved α to 0·65, they were purposely retained because they would be useful to assess the impact of the nutrition education intervention in the next phase of the study. Similar Cronbach's α was reported in a review conducted by Stone *et al.*[56], wherein the Strengths and Difficulties Questionnaire (SDQ) had a total Cronbach's α of 0·81, but the individual α values ranged from 0·53 to 0·81.

There are no cut-off values set for Cronbach's α for an acceptable reliability. For instance, although Nunnally[53] recommended a minimum α value of 0·70 for pilot studies and 0·80 and 0·90 for basic and applied research, respectively, other contemporary researchers characterized reliabilities of 0·60 and 0·70 as good or adequate[57,58]. However, for exploratory studies, lower Cronbach's α values were considered acceptable[59]. Considering the multidimensionality of the practice construct in the questionnaire, the authors consider an α value of 0·50 for the practice construct to be acceptable.

A novelty of the questionnaire is the inclusion of the theme on sunlight exposure. Considering the pandemic deficiency of vitamin D and its importance in maintaining bone health, the authors believed that inclusion of questions pertaining to sunlight exposure will be a benefit in the study, as sunlight is the major source of vitamin D. Another novelty of the questionnaire is the inclusion of questions on barriers to diet diversification such as availability, affordability and accessibility, which were essential yet ignored in the earlier questionnaires (see online supplementary material).

A question related to iodine was not included in the questionnaire initially, expecting that the respondents will have awareness regarding iodized salt owing to the universal salt iodization programme which has been in place in the country for decades now. However, the FGD revealed that the majority of mothers were unaware of the health benefits of iodized salt. Hence, a question related to iodine was included in the questionnaire. The questionnaire also covered cooking and eating practices that influence bioavailability of micronutrients, such as washing green leafy vegetable prior to cutting them, consuming tea and coffee within 1 h of food consumption, and consumption of vitamin C-rich foods along with iron-rich foods[60].

The combination of FGD and item pool helped in identifying the most appropriate items for inclusion in the questionnaire. FGD aided in understanding the current knowledge on micronutrients, the food scenario in the community, attitudes towards consumption of a diversified diet, underlying factors preventing consumption of a diversified diet, cooking practices and sunlight exposure. The options provided for each question in the item pool were modified according to the responses given by the participants in FGD.

The selection of questions from the item pool after content validity was difficult. The expertise of the panel regarding the domains tested, the anticipated difficulty level of the item and the essentiality of the information to be obtained for the intervention were considered while selecting questions. Questions that did not fall under an acceptable range of item difficulty were still considered for inclusion based on the qualitative understanding of the context, which was possible through the formative component of the study. Similarly, a few questions related to specific micronutrients that were earlier part of the item pool had to be modified because the FGD revealed that respondents knew more about the foods than the nutrients they contained. The authors felt that the terms 'vitamins' and 'minerals' would sound more like jargon to the respondents because they were relating food groups to a specific body function without even knowing about the micronutrient content of the same. For instance, when they were asked to identify the vitamin that was responsible for proper vision, most respondents could not specify vitamin A, but had an idea that consuming foods such as green leafy vegetables and carrots would help improve vision although they had no idea that they contained vitamin A. Therefore, the question 'Can you identify the vitamin that helps in proper vision?' was modified to 'Identify foods that help in proper vision'. Likewise, a few questions in the item pool which earlier dealt with food sources and deficiency disorders of vitamin B_{12}, folate, zinc and calcium also had to be modified. Thus, 'Can you identify the mineral that improves height, weight and cognitive development?' was replaced by 'What are the food groups that should be consumed for proper height, weight and cognitive development of children?'. This indeed is a useful observation that would help build appropriate communication tools and messages to create awareness about these nutrients in the intervention phase of the study.

Questions that were felt to be inappropriate were deleted from the item pool and questions that were felt to be ambiguous by the expert panel members were modified. Thus, care was taken to select items which were

simple and easily understandable to rural literate mothers of the middle-income group.

Respondents were not practising diet diversity daily at their households. So, based on the results of the FGD, questions related to identification of a balanced diet, such as frequency of variety of foods to be consumed daily, were included in the questionnaire. Questions related to food sources and deficiency symptoms were included in the questionnaire as respondents were not aware of them. Caregivers were also not aware of their family's micronutrient status and they did not know what to do if they were deficient in some nutrient. So, questions pertaining to attitude towards their micronutrient intake and status were included.

As cooking and eating practices were not properly followed by a few mothers, questions related these were also included in the questionnaire. When probed on availability, accessibility and affordability for a diversified diet, it was revealed that availability of fruits in villages was a major hindrance to practising diversity, so questions related to those were also included in the questionnaire. FGD revealed that children were given importance during distribution of foods in all households, irrespective of food inflation. Further, all middle-income households were selected in the study, expecting a middle-income family to afford a diversified diet; hence, questions related to affordability were not included in the questionnaire.

Mothers had a positive attitude towards sunlight exposure. As the majority of mothers were aware of the importance of sunlight exposure, only questions related to time of day and duration for sun exposure were included in the questionnaire, as none of them were aware of these aspects. Thus, the selected eighty-eight-item questionnaire is a useful tool among rural literate mothers of the middle-income group to test KAP on micronutrients and factors affecting micronutrient status of 6–10-year-old children.

Strengths and limitations

The strength of the current study lies in the fact that all prerequisite steps of a mixed-methods approach were followed. Although the questionnaire deals with micronutrients and diet diversity, it is specific to the context and may not be directly suitable in other contexts and cannot be generalized. We consider that the methods employed and the documentation of the same would be a positive addition to the existing body of literature. The stepwise methodology is replicable in developing questionnaires in other contexts too. The small sample size need not be seen as a limitation because it is appropriate in the context of the study.

Conclusion

The sequential, exploratory, mixed-methods approach assisted in viewing the context of the study from multiple perspectives. Integrating qualitative and quantitative methods enhanced the understanding of knowledge gaps and facilitators and barriers of diet diversification. These findings will have implications for structuring the social behaviour change communication intervention model in the next phase of the study.

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Supplementary material

To view supplementary material for this article, please visit https://doi.org/10.1017/S1368980019000521

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