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# Nutrition knowledge assessment tools for older adults and their carers: a scoping review

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## Abstract

Poor nutritional intake is common among older adults. Given that nutrition knowledge is an important determinant of eating behaviour and nutritional status, understanding areas of inadequate knowledge can guide educational interventions to reduce risk of nutritional deficiencies and promote healthy ageing. This review investigated tools assessing general nutritional knowledge of older adults and their carers. Following the Joanna Briggs for Scoping Reviews guidelines, 4 databases (MEDLINE, CINAHL, Global Health and Embase) and grey literature were searched. Studies of any type containing general nutrition knowledge assessment tools for older adults or their carers were included. In total, 6934 articles were identified, of which 24 met the eligibility criteria, and 23 unique nutrition knowledge assessment tools were included. Of these tools, 14 were original, 6 were modified from other tools and 3 used dietary-related responses from national dietary survey questions. 6 tools were developed for carers (mostly nurses) and 17 tools for older adults. Tools had between 4 and 110 items. The most common topics for general nutrition knowledge questions were related to nutrients and roles, food sources of nutrients, and diet–disease relationships. 8 tools were developed prior to 2000. Most studies did not specify or assess psychometric properties of the tool, with only 9 (38 %) and 6 (26 %) studies testing for reliability and validity, respectively, and only 1 tool was considered reliable. Additional research for the development of reliable and validated tools or the validation of existing tools to assess nutrition knowledge of older adults and their carers is needed across different healthcare settings.

**Key words:** **Nutrition education: Instruments: Programmes: Elderly: Health professional education**

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## Introduction

The worldwide ageing population has increased, with the number of older people aged 65 years and older predicted to double to 1·5 billion in 2050[1,2]. Even though there has been an increase in average life expectancy, the health span, or period of life during which individuals are in good health, has not mirrored the same trajectory[3]. As a result, interest in promoting healthy ageing is growing.

Older adults remain a vulnerable population prone to malnutrition[4], defined by the World Health Organization as 'deficiencies, excesses, or imbalances in a person's intake of energy and/or nutrients'[5]. Both caloric excess and nutrient inadequacy have been shown to be associated with increased risks of age-related chronic diseases and mortality[3,6]. There is accumulating evidence to suggest that prevalence of obesity among older adults is increasing[7–9], and saturated fats, trans fat, added sugars and sodium have been found to be consumed in excess by older adults[10,11]. Risk of protein-energy malnutrition is also prevalent in older adults. A recent systematic review of 240 studies using the Mini Nutritional Assessment estimated that those at risk of protein-energy malnutrition range from 27 % (community) to 50 % (other healthcare settings) of populations[4]. Among older adults, the prevalence of sarcopenic obesity appears to be increasing, with its effects on functional decline, cardiometabolic diseases and mortality potentially more pronounced than sarcopenia or obesity alone[12].

A 2015 systematic review of 37 studies from 20 different countries indicates that community-dwelling older adults do not meet the estimated average requirement of essential nutrients, including vitamin D, thiamin, riboflavin, calcium, magnesium and selenium[13]. The National Health and Nutrition Examination Survey (NHANES) data show that more than 40 % of the US population, aged 51 years and over, did not meet the estimated average or adequate intake for nutrients, including fibre, *n*-3 polyunsaturated fatty acids, calcium, potassium, and vitamins C, A, D, E and K[14]. Another recent US study of 5614 community-dwelling older adults found that almost 90 % had poor-quality diets, with more than 50 % not meeting most dietary guidelines for food groups and nutrients[11]. A higher proportion of institutionalised older adults (35 %) also consume less than the estimated average requirements of protein when compared with community-dwelling and frail elderly (10 %)[15].

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Healthy dietary patterns are associated with improved quality of life[16], self-rated health[16], better health outcomes[17] and reduced mortality[18] among older adults. These healthy dietary patterns are generally rich in plant foods, with a strong focus on the inclusion of vegetables, legumes, fruits and whole grains, with adequate protein intake and lower intakes of meats and processed foods[19]. This results in higher intake of polyphenols, antioxidants and fibre, compounds associated with reduced inflammation[20,21] and oxidative stress[22], with the potential to modulate ageing-related biological pathways[21]. Plant-rich diets have been linked to longer telomere length, an indicator of ageing phenotype and disease risk, in observational studies[23]. Diet also plays a role in the prevention of sarcopenia[24,25], and healthy diet patterns have been associated with lower odds of frailty by a 2019 systematic review of 13 observational studies[26]. In addition, systematic reviews show that healthy diets such as the Mediterranean, Dietary Approaches to Stop Hypertension (DASH) and the Mediterranean-DASH Intervention for Neurodegenerative Delay (MIND) diets may protect against cognitive decline in ageing[19,27–29].

Poor nutritional intake and unhealthy dietary patterns among older adults are influenced by multifactorial determinants[30]. Contributing factors include chronic health conditions, social isolation[31], low socioeconomic status[32], limited healthy food accessibility[11] and financial burden[33]. Poor nutritional intake can also be attributed to age-related physiological and functional changes such as poor appetite[30], early satiety[34], hypogeusia, anosmia[35] and dental issues[36]. Hospitalised elderly patients are susceptible to disease-related undernutrition due to loss of appetite leading to poor oral nutritional intake[37] and weight loss exacerbated by acute illness[38]. In nursing homes, poor nutrition is commonly associated with cognitive and functional impairments, swallowing difficulty and depression[39]. Overall, prolonged poor nutritional intake among older adults is associated with reduced health-related quality of life and increased mortality[40].

Unfortunately, older people often fail to recognise that they are at risk of poor nutrition[41]. Nutrition knowledge, defined as the individual cognitive processes used to identify facts associated with diet, food, nutrition and its effects on the human body[42,43], has been shown to impact dietary behaviours. A systematic review by Barbosa *et al.* (2016) identified 6 of 10 studies demonstrated positive associations between nutrition knowledge and healthy eating habits including increased fruit and vegetable intake, and lower intake of fat, salt and simple sugars[42]. Another systematic review by Spronk *et al.* (2013) investigated the relationship between nutrition knowledge and dietary intake, and found that the majority of studies reported weak ($r < 0{\cdot}5$) but significant positive correlations[44]. Furthermore, participants of lower socioeconomic status were underrepresented in this review, which may have impacted the strength of association. Nevertheless, theoretical models of behaviour change exist which describe the strategies used to elicit behaviour change such as a change in eating behaviour. These include models such as the health belief model, social cognitive theory and the Capability, Opportunity, Motivation, Behaviour (COM-B) model by Michie *et al.*[45]. All of these models describe knowledge as a required precursor to action[45–47]. Although nutrition knowledge itself may not be sufficient to elicit change in eating behaviour, it is a requirement for behaviour change to occur[42,45,48,49].

Although nutrition knowledge is important, older adults are known to have poorer nutrition knowledge compared with younger adults[50]. Educational interventions have the potential to improve nutritional status, especially when coupled with behaviour change techniques, although there is only low quality of evidence from current studies due to methodological limitations[51–54].

Caregivers also have an important role in the care of older adults, as receiving help from caregivers is common in the older age groups owing to functional impairments[55]. Nutrition education interventions for caregivers to improve nutrition knowledge have been associated with improved dietary habits[56,57] and can potentially improve or maintain nutritional status and reduce decline in dietary intake and malnutrition risk among older adults. Additionally, nutrition knowledge of healthcare professionals strongly influences their nutrition care practice and quality of nutrition education provided to their patients[43,58]. Thus, ensuring adequate nutrition knowledge among older adults and their caregivers represents an important step in the process of facilitating and maintaining health.

To reliably assess and compare nutrition knowledge among individuals, determine the effectiveness of nutrition interventions and identify gaps in nutritional knowledge, nutrition knowledge assessment tools (NKATs) are required. Gaining a deeper insight into the gaps in nutrition knowledge of individuals enables the development of more effective nutrition education programmes and interventions[59].

A 2016 systematic review found 25 studies that used questionnaires to assess adults' nutrition knowledge[42]. Another 2020 systematic narrative review identified 33 validated instruments for the assessment of nutrition knowledge of physicians and nurses[43]. However, neither review focused on older adults, and to our knowledge, no study has investigated tools developed to assess general nutrition knowledge for older adults or their carers. Hence, the objective of this scoping review is to investigate tools used to assess general nutrition knowledge of older adults and of their carers across all settings of care.

## Methods

Scoping reviews seek to map a topic within existing literature; summarise and disseminate research findings; or identify research gaps within a wide range of sources and study designs[60]. The framework described by Arksey and O'Malley guided the methodological processes used in this scoping review, which comprised 5 stages: (1) identifying the research question, (2) identifying relevant studies, (3) study selection, (4) charting the data, and (5) collating, summarising and reporting the results[60]. This review was conducted in accordance with the Joanna Briggs Institute guidelines for scoping reviews[61], and followed the Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) checklist[62].

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### *Identifying the research question*

The research question was defined as 'What tools are available to assess general nutrition knowledge of older individuals or their carers?'. Sources were included if they met all of the following eligibility criteria:

1) Older adult population or subpopulation (adults ≥ 60 years old or mean age ≥ 65 years) or their formal (professional caregivers) or informal (family or friends) carers;
2) The tool predominantly (≥50 %) assesses general nutrition knowledge using quantitative measures;
3) NKATs can be sourced with all items specified within the paper, supplementary material or reference list;
4) Any setting including community homes or other institutions (including nursing homes and hospitals);
5) Any study design available in full text and written in English.

We defined general nutrition knowledge as including a range of knowledge on topics such as expert and government dietary recommendations, portion sizes, food groups, nutrient health benefits and sources, healthier food and meal alternatives, relationships between diet and disease, and knowledge to discern common nutritional myths and facts[42]. We excluded studies with a sole focus on specific nutritional topics (e.g. heart disease, osteoporosis or protein-energy malnutrition) or food type (e.g. legumes, dairy foods or whole grains). For this study, NKATs were defined as any instruments developed for the purpose of assessing nutrition knowledge including tools used before and/or after education sessions, and included questionnaires, interviews, surveys, tests, indices, scales and checklists. It was not a requirement for the tool to be validated for inclusion owing to the explorative purpose of this scoping review, although the validation status of each tool was specified. Where reference was made to a NKAT developed or included in another article, the article was sought and included if it satisfied the eligibility criteria. Hence, original tools of modified versions were also included if the full tool was available within the original paper or as supplementary material.

### *Identifying relevant studies*

A 3-step search strategy[61] was adopted and conducted by 2 researchers. An initial scoping search on MEDLINE and CINAHL was conducted to gain familiarity with the scope of literature and identify relevant key search terms (online Supplementary Material 1) for the development of a search strategy. Following review of the search strategy by an experienced librarian, a comprehensive electronic database search was conducted from their inception until September 2020 across the following databases: MEDLINE, CINAHL, Global Health and Embase (see online Supplementary Material 2 for the final MEDLINE search strategy). A second search was conducted from September to November 2020 to further identify potentially relevant sources.

In addition to academic databases, a range of search strategies were developed and conducted in September 2020 across a number of grey literature search engines and databases, including Google and Google Scholar (online Supplementary Material 3). An examination of the reference lists from relevant sources was also undertaken.

### *Study selection*

Records were imported to a reference manager (EndNote, version X9). Single screening of the articles' title and abstract was conducted, followed by retrieval and further screening of full texts of eligible articles by 2 reviewers. Additional sources found through grey literature databases and reference lists were subjected to the same study selection process as the academic database sources. Any disagreements from the screening process were discussed and amended by consensus or further adjudication by a third reviewer. In cases where the full tool was not provided, authors were contacted for the full tool to evaluate whether the tool meets the eligibility criteria for inclusion.

### *Charting the data*

Relevant information from included studies was extracted independently by 2 reviewers using a data charting form. Charted information was then cross-checked to ensure all necessary details were accurate. Authors were contacted for additional details that may not have been reported in the paper, including pilot testing and psychometric properties of the tool. Any disagreements were discussed or resolved by discussion with a third reviewer. The following data were charted: article features (author, year, country), population (older adults or carers), context (community- or institution-based) and features of the NKAT (name, design purpose, details of development or modification, content, structure, number of items, validity and reliability of tool).

### *Collating, summarising and reporting the results*

Information from the data charting form was synthesised into a summary table. Studies were categorised based on the target population of the NKAT (i.e. older adults or carers). Information regarding the development, validity and reliability of each NKAT was classified according to key methodological processes and expert recommendations for developing and validating nutrition knowledge questionnaires, as outlined and summarised by Trakman *et al.* (2017)[63]. The table of charted information included: author(s); year; country; type of setting; NKAT; target population; aim of tool; structure, content and method of administration of tool; development, modification and pilot testing of tool; validity and reliability of tool.

## Results

### *Selection of sources of evidence*

A total of 6934 articles were identified, that is, 6873 references from the database search, in addition to 57 grey literature sources and 4 articles from the reference list search. This resulted in a total of 24 articles, of which 23 NKATs were included in qualitative synthesis[64–87]. The selection process of sources of evidence has been summarised in Fig. 1. Most studies were conducted in the United States[66–69,73,75,78,79,81,83,86], followed by Australia[64,71]

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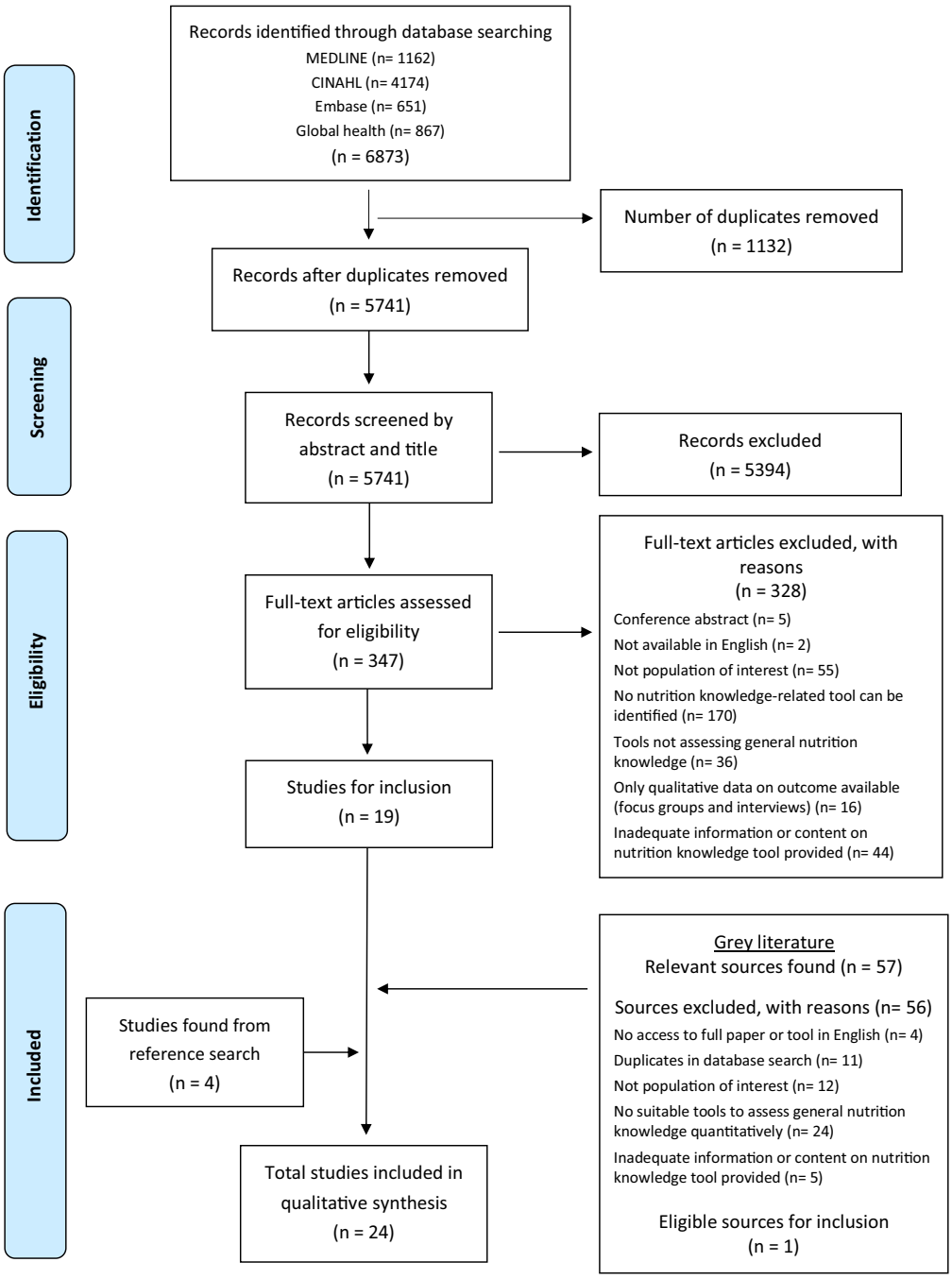



**Fig 1.** PRISMA diagram.

and the UK[74,76], and Israel[65], Scotland[70] Singapore[72], Canada[82], France[80] and Korea[84]. Table 1 summarises the tool characteristics of included studies.

The primary aim of NKATs varied depending on the purpose of the study. Although most studies generally aimed to assess nutrition knowledge of older adults[70,73–76,84] or their carers[64–69] in different contexts, some studies specifically used NKATs to assess change in nutrition knowledge in order to measure the impact of interventions or programmes[78–82]; investigate the relationship between nutrition knowledge and behaviour[71,77]; assess awareness of national dietary guidelines or health expert recommendations[72,83]; or assess knowledge based on nutrition-related responses collected from population health surveys[85–87].

Of the total 23 NKATs, the majority of tools were designed for older adults ($n = 17$), while 6 tools were for carers of older adults, of which 4 were developed specifically for nurses. NKATs were either (i) original or modified versions of original tools ($n = 20$),

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**Table 1.** Summary of included studies with nutrition knowledge assessment tools[64–87]

| Author, year, country | Type of setting | Nutrition knowledge assessment tool | Aim and target population of tool | Structure, content and method of administration of tool | Development, modification and pilot testing of tool | Validity and reliability of tool |
|---|---|---|---|---|---|---|
| Carers of older adults | | | | | | |
| Beattie *et al.* (2014)[64] Australia | Residential aged care facilities | Nutrition knowledge questionnaire | Assess knowledge of staff (including registered nurses, care staff, catering staff) relating to nutritional outcomes in the elderly. | S: 10 items (MCQ)<br>C: A selection of general nutrition knowledge questions<br>M: Pen and paper | Developed based on Stanek *et al.*, 1991[69] and Crogan 1998[66]. | Not reported |
| Boaz *et al.* (2013)[65] Israel | Acute care hospitals | Nutrition knowledge questionnaire (modified from Kobe, 2006[119]) | Assess knowledge of nurses relating to dietary and feeding practices amongst hospitalised elderly patients. | S: 18 items (MCQ)<br>C: Questions were related to dietary and feeding practice and theory for hospitalised elderly patients.<br>M: Not reported | Originally written in English, translated into and administrated in Hebrew, which was deemed accurate by an expert panel. 5 additional questions added to original questionnaire, tested on a small group of nurses. | Not reported |
| Crogan (1998)[66] USA | Nursing homes | Licensed nurse questionnaire | Assess knowledge of nurses relating to assessment and prevention of protein-calorie malnutrition of residents in nursing homes. | S: 50 items (MCQ)<br>C: 4 domains: (1) Nutritional deficiencies of institutionalised elderly (13 items), (2) Effects of ageing on nutritional needs (18 items), (3) Protein-calorie malnutrition (PCM) in the elderly (6 items), (4) Principles of nutritional assessment (13 items).<br>M: Pen and paper | 3 nurses and 3 dietitians drafted nutrition knowledge assessment questions across the 4 domains; content was peer-reviewed with recommendations made. Pre-tested with 4 nurses from another nursing home to add clarity to some items. | V: Established face and content validity<br>R: $C\alpha = 0{\cdot}54$ |
| Penland (2010)[67] USA | Nursing homes | Revised nutrition knowledge questionnaire (NKQ-R) (revised from Crogan, 1998[66]) | Assess nutrition knowledge of nurses in nursing homes. | S: 28 items (MCQ)<br>C: Measures general nutrition knowledge within the 3 domains: (1) Effects of ageing on nutritional needs (10 items), (2) Principles of nutritional assessment (10 items), (3) Nutritional deficiencies of institutionalised older adults (8 items).<br>M: Pen and paper | Questionnaire was revised from Crogan (1998) to reduce respondent burden. | V: Content validity: Content validity Index (CVI): CVI-I (item): 28 of original 50 items, scored CVI-I $\geq 0{\cdot}83$ (at least 5 of 6 experts rated these items as quite or highly relevant) and formed NKQ-R. CVI-S (scale): CVI = 0·94 (exceeded standard acceptability criterion, no further changes suggested).<br>R: Not reported |

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**Table 1.** (*Continued*)

| Author, year, country | Type of setting | Nutrition knowledge assessment tool | Aim and target population of tool | Structure, content and method of administration of tool | Development, modification and pilot testing of tool | Validity and reliability of tool |
|---|---|---|---|---|---|---|
| Ryan (1997)[68] USA | Community | Nutrition knowledge questionnaire (modified from Fanelli and Abernethy, 1986[120]) | Assess nutrition knowledge of primary caregivers of elderly clients in a care programme. | S: 20 items (T/F)<br>C: Nutrition Statements (focused on food sources of nutrients and recognition of food misinformation)<br>M: Telephone interview | 20 statements used to assess nutrition knowledge were extracted from the Nutrition Knowledge Questionnaire by Fanelli and Abernethy, 1986[120]. The original questionnaire was pre-tested with 2 independent groups of 10 seniors to determine common responses and how well the questions were understood[120]. | Not reported for this modified tool |
| Stanek *et al.* (1991)[69] USA | Long-term health care facilities | Nutrition knowledge survey | Assess nurses' dietary knowledge related to the elderly. | S: Fifteen items (MCQ)<br>C: Questions on nutrition knowledge related to the elderly patient<br>M: Pen and paper | Pilot testing conducted with 16 staff nurses at an extended care facility. Rephrasing and addition of questions. | V: Content reviewed by 2 registered dietitians. Item analysis conducted. Specific measures not reported.<br>R: KR-20 = 0·52† |
| Older adults | | | | | | |
| Anderson *et al.* (1988)[70] Scotland | General medical ward | Questionnaire | Assess nutrition knowledge of adult medical inpatients.* | S: 42 items (MCQ and 3 open questions)<br>C: (1) Attitudes to food (1 item), (2) Changes in diet (19 items), (3) Nutrition knowledge (22 items): (i) Familiarity with nutrition terminology (8 items), (ii) Knowledge of principles of current recommendations in relation to main nutrients (8 items), (iii) Understanding the practical food and eating applications of the recommendations (6 items).<br>M: One-to-one interview using printed questionnaire | Pilot testing performed ($n = 30$) with focus on wording and comprehension. | Not reported |
| Brennan *et al.* (2011)[71] Australia | Community | 20-item index (Turrel and Kavanagh, 2006[89]) | Assess nutrition knowledge and to investigate its effect on grocery purchasing behaviour among older adults. | S: 20 items (T/F, don't know)<br>C: Dietary knowledge statements on a range of issues concerning food, nutrition, health and their inter-relationships<br>M: Interview[89] | Items were chosen by an expert panel (dietitians and nutritionists), and progressively refined through discussions until consensus was reached and the final set of items was established[89]. | Not reported |
| Koo *et al.* (2014)[72] Singapore | Community and nursing homes | Nutritional knowledge screening questionnaire | Assess awareness of nutritional requirements based on national healthy eating guidelines among older adults. | S: 4 items (MCQ)<br>C: Recommended servings for food groups from the Health Promotion Board of Singapore<br>M: Interview | Not reported | V: Not validated<br>R: Cα = 0·34 |

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**Table 1.** (*Continued*)

| Author, year, country | Type of setting | Nutrition knowledge assessment tool | Aim and target population of tool | Structure, content and method of administration of tool | Development, modification and pilot testing of tool | Validity and reliability of tool |
|---|---|---|---|---|---|---|
| Mann *et al.* (1988)[73] USA | Community | Nutritional knowledge statements (modified from Fanelli and Abernethy, 1986[120]) | Assess nutritional knowledge of older adults. | S: 20 items (agree/disagree/not sure/don't know)<br>C: Nutrition statements focus on food sources of nutrients<br>M: Designed to be self-administered or interviewed[120] | 20 statements extracted from the Nutrition Knowledge Questionnaire by Fanelli and Abernethy, 1986. The original questionnaire was pretested with 2 independent groups of 10 seniors to determine common responses and how well the questions were understood. | Not reported for this modified tool |
| Moynihan *et al.* (2007)[74] UK | Community | Nutrition knowledge questionnaire (modified from Parmenter and Wardle, 1999[88]) | Assess nutrition knowledge of older adults living in sheltered housing accommodations in socially deprived areas. | S: Fifteen items (MCQ)<br>C: 4 sections: (1) Dietary recommendations (4 items), (2) Sources of nutrients (2 items), (3) Healthiest meal selection (4 items), (4) Associations between diet and disease (5 items).<br>M: Pen and paper | Questions were selected from Parmenter and Wardle (1999)[88], which were tested for content validity on a group of academic nutritionists. Face validity and temporal stability (reliability) were tested on older adults. | V: Tested for face validity ($n = 17$) and cognitive validity ($n = 5$)<br>R: Test-retest reliability: Pearson's correlation $r$ ranged from 0·8 to 1. Internal reliability: correlation coefficient $r$ ranged from 0·61 to 0·71 for the 4 sections. |
| Mwonya *et al.* (1987)[75] USA | Community | Nutrition knowledge test for older adults (NKTOA) (modified from Beavers *et al.*, 1982[121]) | Assess nutritional knowledge of older adults. | S: 24 items (MCQ)<br>C: 6 nutrition-related concepts: nutrient definition, function, food sources of nutrients, food purchasing, diet evaluation and nutrition physiology.<br>M: Pen and paper | Important nutrition concepts for older adults were identified through review of the literature and verified by a nutrition specialist. 24 questions were modified from Beavers *et al.*[121], which was originally developed for parents for young children. Pilot testing was performed with a small group of older adults. The NKTOA was reviewed by an expert panel to determine content accuracy, adequate coverage of content and suitability of the vocabulary used for older adults. | V: Content validity (results not reported)<br>R: KR-20 = 0·66 |
| Parmenter *et al.* (2000)[76] UK<br><br>Wardle *et al.* (2000)[77] UK | Community | Nutrition knowledge questionnaire (Parmenter and Wardle, 1999[88]) | To assess nutrition knowledge across socio-demographic groups in the adult population*.<br>Assess nutrition knowledge to examine its relationship to fruit, vegetable and fat intake across the adult population*. | S: 110 items (MCQ)<br>C: 4 sections: (1) Dietary recommendations (11 items), (2) Food groups (69 items), (3) Food choice (10 items), (4) Diet-disease relationships (20 items).<br>M: Pen and paper | An item pool of 1201 was generated (items were taken from existing questionnaires or developed based on the literature with expert (dietitian) advice to maximise content validity). The item pool was reviewed by a panel consisting of psychologists and dietitians, resulting in 102 items which were pilot tested in a general population sample. | V: Criterion for satisfactory construct validity was met[88]<br>R: Internal reliability: $C\alpha = 0{\cdot}70$–$0{\cdot}97$[88]. Test-retest reliability: Pearson's correlation $r = 0{\cdot}8$–$0{\cdot}97$, overall reliability of 0·98[88] |

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**Table 1.** (*Continued*)

| Author, year, country | Type of setting | Nutrition knowledge assessment tool | Aim and target population of tool | Structure, content and method of administration of tool | Development, modification and pilot testing of tool | Validity and reliability of tool |
|---|---|---|---|---|---|---|
| Pogge and Eddings (2013)[78] USA | Community | Fifteen-item pre-test and post-test | Assess pre- and post-nutrition knowledge to examine the impact of a 12-week Nutrition and Wellness Program for older adults. | S: Fifteen items (13 MCQ + 2 T/F)<br>C: General nutrition topics<br>M: Not reported/pen and paper | Not reported | Not reported |
| Rosenbloom *et al.* (2003)[79] USA | Community | Nutrition pre- and post-test | Assess nutrition knowledge of older adults pre- and post- educational intervention. | S: 19 items (binary T/F options given to nutrition statements)<br>C: Assessed 3 topics based on education programme: (1) Food Guide Pyramid (7 items), (2) Protein (5 items), (3) Fibre (7 items).<br>M: Not specified | Originally, 25 questions were developed based on content of educational lesson plans. Pilot testing performed with older adults ($n = 18$). Total number of questions were shortened based on recommendations. | No validity or reliability testing performed |
| Rousset *et al.* (2006)[80] France | Community | Attitude questionnaire | Assess nutrition knowledge and evaluate the impact of a nutrition information programme in older adults. | S: 24 items divided into 2 parts: 12 items (6-point scale) + 12 items (right/wrong)<br>C: (1) Link between health and food consumption (3 items + 4 items), (2) Perceived control of health (3 items), (3) Perception of sensory change during ageing (1 item), (4) Knowledge about nutrition and proteins (5 items + 8 items).<br>M: Telephone interview | Not reported | Not reported |
| Shannon and Pelican (1984)[81] USA | Community | Nutrition knowledge test | Assess nutrition knowledge of pensioners pre- and post-nutrition information delivery in experimental and control group. | S: 13 items (T/F)<br>C: Content based on nutrition education brochures<br>M: Pen and paper | Not reported | V: Not reported<br>R: KR-20 = 0·66 |
| Southgate *et al.* (2010)[82] Canada | Community | Diet knowledge questionnaire (DKQ) | Assess nutrition knowledge related to educational materials provided to older adult participants in the study. | S: 12 items (5-point Likert scale)<br>C: General nutrition knowledge questions<br>M: Pen and paper | Nutrition knowledge questions developed based on the content of a nutrition risk screening questionnaire (SCREEN II) and a Food for Aging Well booklet. Pilot tested with 5 seniors, focusing on clarity of wording. | V: Not reported<br>R: Kappa: 0·290–0·840. ICC: 0·296–0·808. Cα = 0·42† |

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**Table 1.** (*Continued*)

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|---|---|---|---|---|---|---|
| Thomas *et al.* (2010)[83] USA | Community | Knowledge of health expert recommendations | Assess general nutrition knowledge of older populations relating to health expert recommendations. | S: 7 items (yes/no/not sure)<br>C: Health expert recommendations on different types of foods<br>M: Survey, pen and paper | Not reported | Not reported |
| Yu and Kim (2002)[84] Korea | Community | Nutrition knowledge test | Assess nutrition knowledge in relation to individual health among older adults. | S: 10 items (correct/incorrect/don't know)<br>C: Range of nutrition topics<br>M: Not reported | Included questions were based on other documented materials. Pilot testing of tool not reported. | V: Not reported<br>R: Internal reliability: C$\alpha = 0{\cdot}69$ |
| Tools based on secondary analyses of national health and nutrition surveys | | | | | | |
| Clement and Bonnefond (2015)[85] China | Community | Diet knowledge questions from the 2009 China Health and Nutrition Survey (CHNS) | Assess nutrition knowledge across different social classes* based on data collected from the 2009 CHNS. | S: 10 items (5-point Likert scale)<br>C: Diet-related knowledge statements<br>M: Pen and paper | In this secondary analysis, 10 items from the 2009 CHNS were considered diet-related questions. Survey results from the 10 Likert scales were analysed and scored out of 20 using the Nutrition Knowledge Index developed by authors. | Not reported |
| Howard *et al.* (1998)[86] USA | Community | Nutritional knowledge questions from the 1994 diet and health knowledge survey (DHKS) | Assess older adults' nutrition knowledge and its contribution to diet adequacy based on data collected from the DHKS. | S: 17 items (MCQ)<br>C: Knowledge about foods and the relationship between chronic diseases and diet<br>M: Telephone interview | In this secondary analysis, 19 of the 36 original nutrition-related questions in the DHKS were categorised by nutritionists and registered dietitians as either nutrition knowledge, beliefs, attitudes or none of these. F questions (17 items) assessed nutrition knowledge. | Not reported |
| Wang *et al.*, (2020)[87] China | Community | Diet knowledge questions from the 2004–2015 China Health and Nutrition Survey (CHNS) | Describe nutrition knowledge trends of Chinese older adults between 2004 and 2015 and examine its associations to demographic factors. | S: 12 items (5-point Likert scale)<br>C: Diet related knowledge statements<br>M: Pen and paper | In this secondary analysis, 12 statements were used to measure the participants' dietary knowledge (CHNS 2004, 2006, 2009, 2011 and 2015). Survey results from the Likert scales were scored out of 12. | Not reported |

C, content; Cα, Cronbach's alpha; ICC, intraclass correlation; KR-20, Kuder-Richardson 20 coefficient; M, method of administration; MCQ, multiple choice questions; R, reliability; S, structure; T/F, V, validity.
* Indicates that a subpopulation of the study were older adults.
† Reported as adequate or relatively reliable by the author.

or (ii) based on secondary analyses of national health and nutrition surveys ($n = 3$).

### (i) Original and modified nutrition knowledge assessment tools

Table 2 provides a summary of key characteristics of each NKAT. 20 NKATs were either developed by the authors of the study[64,66,69,70,72,78–84], developed by other authors[88,89], or adapted or modified from pre-existing tools[65,67,68,73–75]. 8 NKATs were developed or modified prior to the year 2000[66,68–70,73,75,81,88], 8 between 2001 and 2010[67,74,79,80,82–84,89], and more recently, 4 between 2011 and 2020[64,65,72,78]. The NKATs varied in the number of items, ranging from 4 to 110 items each.

Community-based settings represented the focus of most NKATs[68,72–75,78–84,88,89]. Within institutional care settings, only 5 tools were developed for use in nursing homes[64,66,67,69,72], and 2 for acute care settings[65,70].

Multiple-choice questions represented the most commonly used tool structure among the NKATs. Other structure types included questions with binary options (true/false or agree/disagree to nutrition statements) and Likert scales.

The most common topics for general nutrition knowledge questions across all tools were related to: nutrients and roles (e.g. benefits of vitamin E[67]), food sources of nutrients (e.g. food sources of vitamin C[75]), diet–disease relationships (e.g. diseases related to the amount of fat[74]; effect of fibre intake on constipation[75]), food groups and recommendations (e.g. recommended daily number of servings of vegetables[72]; recommended intake of milk and dairy products for older adults[69]), and nutritional requirements and recommendations (e.g. changes in calcium requirements for older adults[69]; nutritional requirements for nursing home residents to promote healing of pressure ulcers[66]).

The majority of tools assessed a broad range of general nutrition topics (4 or more)[64–67,69,70,74,75,78,82,88,89], although 2 NKATs assessed only knowledge on food groups and recommendations[72,83].

### (ii) Tools based on secondary analyses of national health and nutrition surveys

3 secondary analyses of large national health and nutrition surveys were considered separately to the tools described above. In these cases, survey responses from a section of a larger survey were extracted with the purpose of assessing nutrition knowledge. Such secondary analyses involved the development of a distinctive scoring system which enabled nutrition knowledge of respondents to be determined.

The China Health and Nutrition Survey (CHNS) consisted of a 12-item section with 10 diet-related knowledge statements and 2 physical activity-related statements. Adult participants expressed their degree of agreement to the statements on a 5-point Likert scale (strongly disagree to strongly agree). The information collected from the responses was analysed by Clement and Bonnefond (2015)[85] to compare nutrition knowledge across different social classes based on the 2009 CHNS. In a similar approach, Wang *et al.* (2020)[87] performed a secondary analysis to describe nutrition knowledge trends and to examine associations between demographic factors and nutrition knowledge, based on responses of older adults from the 2004–2015 CHNS.

Similarly, the 1994 Diet and Health Knowledge Survey (DHKS) directed by the United States Department of Agriculture contained 36 nutrition-related questions. 5 questions, consisting of 17 items, were determined by Howard *et al.* (1998)[86] to assess nutrition knowledge. The data provided by the older adult population in response to the specific items were analysed to determine their nutrition knowledge and its relationship to diet adequacy.

### Psychometric properties of nutrition knowledge assessment tools

With regard to original and modified NKATs, psychometric properties of validity were provided for 6 (26 %) NKATs and reliability for 9 (38 %) NKATs (Table 1). The extent to which validity and reliability of these tools were measured and tested was varied but limited. For instance, the majority of tools were pilot tested in a small sample of the target population[65,66,69,70,73,75,79,82,84,88]; however, only 1 tool was reviewed by an expert panel but without details of content validity provided[89]. Of 6 NKATs that were tested for validity, content validity was most commonly reported[66,67,69,75,88], followed by face validity[66,74]), cognitive validity[74] and construct validity[88].

Less than half the NKATs that were tested for internal consistency reliability (determined by Cronbach's alpha (Cα) and Kuder–Richardson 20 (KR-20) coefficients)[66,69,72,74,75,81,82,84,88] had values below the cut-offs considered adequate, except for the Nutrition Knowledge Questionnaire by Parmenter and Wardle, which achieved adequate internal reliability[88].

The secondary analyses[85–87] relied on different indices or scoring systems to assess nutrition knowledge, although no reliability or validity metrics specific to the components that assessed nutrition knowledge were reported.

## Discussion

This is the first scoping review conducted to explore tools to assess the general nutrition knowledge of older people and their carers. Our findings identified 24 relevant sources with 23 different NKATs (including 3 secondary analyses). The format and structure of the NKATs, as well as the type and breadth of general nutrition topics assessed, differed substantially across the tools. NKATs also generally lacked validity and reliability testing.

The majority of NKATs found in our scoping review assessed knowledge of older adults in the community. The importance of older adults' nutrition knowledge has been highlighted by 3 large cross-sectional studies which showed associations of older adults' nutrition knowledge and healthy dietary intake. Wardle *et al.* (2000) found that, out of 1040 adult respondents (with 23 % of respondents over 65 years of age) in England, those in the highest knowledge quintile were almost 25 times more likely to meet recommendations for fruit, vegetable and fat intake than those in the lowest quintile[77]. A National Health and Nutrition Examination Survey[90] found that adults aged 60 years and older

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**Table 2.** Summary of key characteristics of original and modified nutrition knowledge assessment tools[64–70,72–76,78–84,89]

| | | Carers | | | | | | Older Adults | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Tool Characteristics | | Nutrition Knowledge Questionnaire[64] | Nutrition Knowledge Questionnaire[65] | Licensed Nurse Questionnaire[66] | NKQ-R[67] | Nutrition Knowledge Questionnaire[68] | Nutrition knowledge survey[69] | Questionnaire[70] | 20-item Index[89] | Nutritional Knowledge Screening Questionnaire[72] | Nutrition Knowledge Statements[73] | Nutrition Knowledge Questionnaire[74] | NKTOA[75] | Nutrition Knowledge Questionnaire[88] | 15-item Pre-test and Post-test[78] | Nutrition Pre-and Post-Test[79] | Attitude Questionnaire[80] | Nutrition Knowledge Test[81] | DKQ[82] | Knowledge of Health Expert Recommendations[83] | Nutrition Knowledge Test[84] | Total |
| **Number of items in tool** | | 10 | 18 | 50 | 28 | 20 | 15 | 22 | 20 | 4 | 20 | 15 | 24 | 110 | 15 | 19 | 24 | 13 | 12 | 7 | 10 | N/A |
| **Development or modification of tool (year)** | 1981 - 2000 | | | • | | • | • | • | | | • | | • | • | | | | • | | | | 8 |
| | 2001 - 2010 | | | | • | | | | • | | | • | | | | • | • | | • | • | • | 8 |
| | 2011 - 2020 | • | • | | | | | | | • | | | | | • | | | | | | | 4 |
| **Setting** | Nursing homes | • | | • | • | | • | | | • | | | | | | | | | | | | 5 |
| | Acute care hospitals | | • | | | | | • | | | | | | | | | | | | | | 2 |
| | Community | | | | | • | | | • | • | • | • | • | • | • | • | • | • | • | • | • | 14 |
| **Originality of tool** | Original tool | • | | • | | | • | • | • | • | | | | • | • | • | • | • | • | • | • | 14 |
| | Modified | | • | | • | • | | | | | • | • | • | | | | | | | | | 6 |
| **General nutrition knowledge content** | Nutrients and roles | • | • | • | • | • | • | • | • | | • | • | • | • | • | • | • | • | • | | | 17 |
| | Food groups and recommendations | | | | | | • | • | • | • | | • | • | • | • | • | | | | • | | 10 |
| | Nutritional requirements and recommendations | • | • | • | • | | • | | | | | | | • | • | | • | | • | | • | 10 |
| | Food sources of nutrients | • | • | • | • | • | • | • | • | | • | • | • | • | • | | • | • | • | | • | 17 |
| | Diet-disease relationships | • | • | • | • | • | • | • | • | | • | • | • | • | | • | | | • | | | 14 |

N/A, not applicable.

($n = 3056$) with nutrition information awareness and application had higher diet quality. Taiwan participants aged over 65 ($n = 1937$)[91] who completed the Elderly Nutrition and Health Survey had inadequate knowledge, especially about nutrition and disease and restricted their diets based on traditional practices.

Only 1 NKAT[68] was found for caregivers of older adults in the community. Home-based or domiciliary caregivers play a crucial role in the nutritional care of older adults, which often involve monitoring of dietary intake and hydration, shopping assistance, meal preparation and feeding when necessary[57]. These caregivers spend more time providing care than health-care professionals[92] and may also be better positioned to provide nutrition care for community-dwelling older adults owing to greater awareness of individual needs, preferences and beliefs that could be overlooked by paid caregivers[57]. This, coupled with the finding that carers of community-dwelling older adults lacked adequate dietary knowledge[93], makes assessment of caregivers' nutritional knowledge also crucial. NKATs developed for caregivers within community-based settings could assist in identification of knowledge gaps and misperceptions, which would be useful in guiding nutrition education programmes to optimise nutritional care and health outcomes of older adults.

With the exception of the Nutrition Knowledge Questionnaire used by Beattie *et al.* (2014)[64], no other NKAT intended for carers other than nurses in institutional settings, such as physicians, allied health professionals or food service staff, was found. Healthcare professionals are more likely to interact with patients within institutional settings and therefore have an important role in the nutrition care of older adults. Insufficient knowledge among healthcare professionals in hospital units has been cited as the main barrier for good nutritional management, with 25 % of doctors and nurses reported to have difficulty in identifying undernourished patients requiring nutritional therapy[94]. A systematic review by Zeldman and Andrade (2020)[43] that assessed physicians' and nurses' knowledge of nutrition for adults over 18 years found mean nutrition knowledge scores from 32·5 % (poor) to 72 % (fair), and found scores were lowest for questions related to topics of nutrient digestion, absorption and metabolism, as well as nutrition in chronic diseases and conditions. Studies assessing knowledge regarding specific needs of older adults were not found in this 2020 review[43]. There is evidence to suggest that adequate healthcare professionals' nutrition knowledge and awareness of nutritional consequences faced by older people, as assessed by NKATs, does in fact facilitate appropriate nutrition care and prevent poor nutrition[58].

Given that protein-energy malnutrition rates are estimated to be higher in long-term care or rehabilitation hospitals (29 %), hospitals (22 %) and nursing homes (17·5 %) when compared with community settings (3 %)[4], NKATs developed to assess knowledge specific to protein-energy malnutrition, are also needed. Our scoping review assessed tools about general nutrition knowledge and was not specifically focused on protein-energy malnutrition. Few NKATs incorporating questions related to protein-energy malnutrition in older adults[64,67,95] were identified. Koo *et al.* (2014) found knowledge of daily nutritional requirements was not related to protein-energy malnutrition risk in older adults, but their tool did not include questions related to protein-energy malnutrition[72]. Specific tools such as the Knowledge of Malnutrition – Geriatric (KoM-G) questionnaire, validated for use in nursing homes[96], may be more suitable to assess nutrition-related knowledge of carers of older adults working within institutions. However, given the increasing rates of sarcopenic obesity and associated risks of functional decline[97] as well as beneficial cognitive impacts of diet[27], a focus on assessing general nutrition knowledge is still recommended.

In this scoping review, we found that the majority of NKATs for older adults and their carers were outdated, having been either developed or modified over 10 years ago. The recognition of the role of diet and its contribution to ageing, the characterisation of ageing syndromes such as frailty and sarcopenia, and the role of diet in reducing the risk of cognitive decline indicate updates to NKATs are needed[19,25,26]. In addition, recent progress and developments within the food industry have led to increased food variety and accessibility[98]. Over the past decade, major changes in food consumption trends such as fad diets (e.g. gluten-free and paleo diets[99]), functional foods[100], and food takeaway and delivery[101] have emerged. Additionally, advances in nutritional science and the understanding of diet and health continually inform dietary recommendations, guidelines and policies[98,102,103]. This includes associations between trans fats and coronary heart disease[104], the benefits of higher protein consumption in acute and chronic illness[24] and lower mortality among older people with higher BMI[105,106]. Further, increased production and availability of ultra-processed foods has led to higher consumption of these foods[107], and has been associated with abdominal obesity[108], incident dyslipidaemia[109] and frailty risk[110] among older adults. The need to revise outdated NKATs has been recognised[111] and is evident with the example of the General Nutrition Knowledge Questionnaire by Parmenter and Wardle (1999)[88], which was revised by Kliemann *et al.* (2016)[98] (GNKQ-R) to ensure questions were up to date with current dietary recommendations for the general adult population. Similarly, it is suggested that existing NKATs developed prior to year 2000 should be revised and re-validated to confirm that questions in such tools are reflective of current food trends, nutrition evidence and nutritional priorities.

Ultimately, our findings indicate little recent research in the development and validation of NKATs with a primary focus on the assessment of general nutrition knowledge in older adults or their carers. It is essential that NKATs are validated and reliable, to confirm that the tools are measuring what they intend to measure[63]. Ideally, NKATs should meet psychometric properties of reliability, as well as construct and content validity[112], such as with the application of the COnsensus-based Standards for the selection of health status Measurement INstruments (COSMIN) methodology to standardise and assess what constitutes good content validity[113]. However, our findings show that the majority of NKATs were not validated or tested for reliability, or had inconsistencies in measures used to test psychometric properties. Kouvelioti and Vagenas (2015)[114] also reported similar issues where 70 % of tools assessing nutrition knowledge

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of athletes and coaches lacked validity and reliability. Likewise in a more recent review, Newton *et al.* (2019) reported about 69 % of NKATs used in school-based settings developed for pre-adolescents and adolescents were not validated, with 60 % without reliability testing[115]. Similarly, Spronk *et al.* (2014) reported 8 of 29 (28 %) studies investigating the relationship between nutrition knowledge and dietary intake used validated NKATs[44], whereas Tam *et al.* (2019) detailed only 15·6 % of studies used well-validated NKATs to evaluate effectiveness of education interventions on nutrition knowledge[116]. Lack of reliability and validity testing of NKATs was most likely attributed to the resource- and time-intensive process that comes with validating questionnaires[63]. In addition, the reliability of some NKATs included in this review was reported as adequate by some studies[69,82] despite coefficient values not meeting the cut-offs commonly considered adequate in the literature[63]. This may be due to limitations associated with the use of these statistical values, which can be difficult to interpret and may be inappropriately used to assess reliability for questionnaires of different structure, length and type[63].

### *Strengths and limitations*

We searched multiple databases as well as grey literature sources, allowing a comprehensive overview of the topic, and followed the Joanna Briggs best practice guidelines for scoping reviews.

However, this scoping review has limitations. Firstly, a number of potentially relevant articles were excluded because the full form of the NKAT was not available or not provided by the cited reference, within the paper or as supplementary material (i.e. only sample questions were available, or actual questions were not listed). Secondly, our search was limited to studies or NKATs in English language only. Thirdly, only tools that predominantly assessed general nutrition knowledge were included in this review. Tools that primarily focused on assessing other areas of nutrition-related areas (e.g. nutrition or health literacy, understanding of food labelling, nutrition attitudes, beliefs and behaviours) and knowledge on specific topics (e.g. heart disease or protein-energy malnutrition) were excluded. Finally, this review only focused on tools that collected quantitative responses (e.g. those that have a definitive correct answer). As knowledge is multidimensional, consideration of other data collection methods, such as focus groups and interviews, may also be required to obtain a more comprehensive assessment of nutrition knowledge.

### *Future directions and conclusion*

This review has demonstrated that a variety of nutrition knowledge assessment tools developed for older adults and their carers exist for use within community- and institution-based settings. However, the majority of tools had unknown, or lacked, adequate validity or reliability. Therefore, nutrition knowledge scores should be interpreted with caution when administered to older adults or their carers. Further research is needed to validate existing or develop new nutrition knowledge assessment tools to ensure adequate validity and reliability, as well as to reflect current evidence, food trends and policies influencing nutrition knowledge. Development of tools to assess knowledge related to elderly nutrition is also needed for a range of healthcare professionals and informal caregivers providing care for older adults. Further research into these areas, including types of knowledge required[117] as well as behaviour change strategies, can guide evidence-based nutrition education programmes and public health campaigns to more effectively reduce the risk and burden of nutritional deficiencies and promote healthy ageing. In addition to general nutrition knowledge tools, specific tools to assess knowledge of risks for and treatment of protein-energy malnutrition may be needed. Ensuring adequate nutrition knowledge among older adults and their carers represents an important step towards improved quality of life and better health outcomes among the ageing population. This must not be overlooked, particularly in light of the recent coronavirus disease 2019 pandemic where consumption of a healthy diet is more important than ever for vulnerable population groups (including the elderly) as they are at the greatest risk of poor health outcomes and mortality[118].

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## Supplementary material

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