

## Nutrition knowledge assessment studies in adults: a systematic review

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**Abstract** *The objective of this study is to perform a systematic review of published studies that assessed nutrition knowledge in adults, focusing on the methodology and content of these studies. An article search was performed on the Medline, Lilacs, and SciELO databases. The search limits were human studies; English, Portuguese, and Spanish languages; and age (over 19). Inclusion criteria were: cross-sectional studies performed on individuals over 18 years old that assessed the general nutrition knowledge of participants. The methodological quality of the articles was assessed using the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) criteria. The initial search identified 3,623 articles. After reading the titles and the abstracts and applying the exclusion criteria, 25 articles were selected. The results showed that, in most studies, nutrition knowledge was associated with socioeconomic parameters and eating behaviour. Most studies belonged to class B (92%), meeting 50-80% of the STROBE criteria. The studies have revealed a greater tendency to assess the relationship of nutrition knowledge with sociodemographic and economic parameters.*

**Key words** *Knowledge, Food and nutrition education, Eating behaviour, Nutritional status*

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## Introduction

Currently, the major causes of mortality worldwide are diseases that could be prevented with proper nutrition, regular physical exercise, and a healthy lifestyle that includes leisure time, stress management, and personal and environmental care<sup>1</sup>; such diseases are called non-communicable diseases (NCDs). In Brazil, NCDs represent a high burden and contribute to the increased health care costs associated with illnesses such as diabetes, hypertension, obesity, and cardiovascular diseases, among other diseases; the existence of long queues for medical appointments at public health units; an increased need for specialized tests and surgeries; and other additional problems<sup>2</sup>.

In this sense, one aspect that can improve quality of life is increasing the ability of a population to understand health-related phenomena. The knowledge of health outcomes, in particular regarding NCDs and their risk factors, may be useful in avoiding the onset of a disease and can also influence the search for treatment when there is precise information on the established disease<sup>2,3</sup>.

Knowledge may be defined as factual and interpretative information that leads to understanding or that is useful in making decisions or informed actions<sup>4</sup>. In cognitive psychology, 2 types of knowledge can be defined: declarative and processual.

Declarative knowledge is defined as the knowledge of facts and things, the knowledge of 'what is,' for example, knowing that lemons are a good source of vitamin C or that adequate fruit and vegetable consumption may prevent hypertension. Processual knowledge is the knowledge of how actions are undertaken, for example, how to choose which of 2 snacks is healthier or how to eat a balanced diet<sup>5,6</sup>.

Social cognitive theory emphasizes that individual behaviour is determined by the interaction of personal and environmental factors<sup>7</sup>. In this sense, Motta *et al.*<sup>8</sup> explain that the personal experiences of each individual encompass cognitive assumptions that will constitute values and beliefs that, based on the reality and experiences lived by each one of us, will become meaningful and predict future events; thus, behaviour and its consequences are dependent on both conscious individual choices and events that occur in the environment in which individuals live. Therefore, social influences from the environment, a lack of motivation, low self-esteem, and societal

beliefs and traditions are factors that collaborate to inhibit lifestyle changes, particularly regarding food habits<sup>8</sup>.

Based on this premise, educational activities have been developed to disseminate information aimed at changing individual lifestyles, considering that humans build their knowledge day by day based on what they see, hear, feel, and perceive. Humans observe, sort, and select what they consider important for their lives and begin to use what they learn in accordance with their culture. These actions are how humans change themselves and the surrounding world (or resist change)<sup>9</sup>. It is during the performance of their everyday activities that humans improve their actions. According to Paulo Freire<sup>10</sup>: "...what is essential is to do. To dive into an activity and start learning-relearning, creating-recreating..."

With respect to food, knowledge on what should be eaten and the awareness of the importance of healthy food habits are the first steps in altering eating behaviour. However, the relationship between what people know and what they do has been considered "very weak". Knowledge does not stimulate change but instead acts as an important tool when people desire to change, given that knowledge rarely anticipates a behavioural change<sup>11</sup>. From this perspective, nutrition knowledge (NK) may be defined as the individual cognitive process related to information on food and nutrition<sup>12</sup>, and it may have something to do with food selection<sup>13</sup> and success in NCD prevention<sup>14</sup>.

Triches and Giugliani<sup>15</sup> state that individual NK may favour healthy food consumption and thus promote changes in food habits that may reduce the risks of developing NCDs. In a systematic review on the association between NK and dietary intake in adults based on cross-sectional and quasi-experimental, randomised clinical trials, Spronk *et al.*<sup>16</sup> concluded that most studies present a weak association between NK and food consumption. However, according to the knowledge-attitude-behaviour model, knowledge might not produce positive and significant changes in eating behaviour, and it is essential to have a motivation or stimulus to make change occur<sup>17</sup>.

Considering all of the issue noted above, NK assessment is a relevant topic because the level of NK might be associated with eating behaviour, can promote changes in inadequate food habits, and promotes alterations in nutritional status. The objective of this study is to systematically review the literature on studies assessing the level

of nutrition knowledge in adults, focusing on the methodology and content of these studies.

## Methods

This study is a systematic literature review. The question this review aimed to answer is the following: 'What methods are being used in cross-sectional observational studies to assess the level of general NK in adults?'

### Search strategy

Relevant articles were identified in April 2013 by performing a search on three electronic databases: *Medical Literature Library of Medicine* (Medline) via PubMed; *Scientific Electronic Library* (SciELO); and Latin-American and Caribbean Literature (*Literatura Latino-Americana e do Caribe - Lilacs*) via Virtual Health Library (Biblioteca Virtual em Saúde - BVS). Using PubMed as reference, the article search was conducted using the limits 'humans'; 'age' – applying the three available filters 'Adult: 19+ years, Young Adult: 19-24 years, and Adult:19-44 years'; and 'language' – English, Portuguese, and Spanish. When necessary, these limits were adapted to resources available in other databases.

The terms used for the article search were identified in Health Sciences Descriptors (Descritores em Ciências da Saúde - DECS). The following keywords were used: *nutritional status, body mass index, nutrition assessment, food habits, food consumption, knowledge and health knowledge, attitudes, and practice*. The search strategy was organized according to the characteristics of each database. The logical operators *OR* and *AND* were used to combine the terms used for the article search.

### Eligibility criteria

Eligible studies met the following criteria: cross-sectional observational study; participants aged > 18 years, regardless of gender, country, ethnicity, and socioeconomic status; and description of the methodology used to assess the level of general NK.

The following were excluded: review articles; case-control, cohort, ecological, and interventional epidemiological studies; studies with children and adolescents; duplicate studies; exclusively qualitative studies; studies on the development, validation, and reproducibility of

NK questionnaires; studies that assessed specific aspects of nutrition and food knowledge such as only fruits, vegetables, fat, fibres; and articles that did not address NK.

### Article selection

Two authors independently reviewed the title and abstract of the articles identified by the initial search strategy, using the predefined inclusion and exclusion criteria. Disagreements that occurred during the selection step were settled by consensus; if consensus was not reached, more experienced researchers were consulted.

Each study was described based on the following information: year of publication; journal and year in which the study was performed; study location; population; sample size; objective; anthropometric, dietary, sociodemographic, and economic variables; the tools used to assess NK, including how the tools were used; classification and assessment criteria; and associations between NK and the analysed variables.

### Methodological quality assessment

Eligible articles were reviewed by two authors according to the STROBE (*Strengthening the Reporting of Observational Studies in Epidemiology*)<sup>18</sup> criteria. As in Mendes et al.<sup>19</sup>, each of the 22 criteria was given a score of 0 (meets the criterion) to 1 (does not meet the criterion). After assessing all of the criteria, each article received a score from 0 to 22 from each reviewer. The final score was obtained by calculating the mean score of both reviewers. The manuscripts were ordinaly ranked according to their final score. The global score was converted into a percentage to assess article quality and to classify the articles into three categories, according to Mataratzis et al.<sup>20</sup>: A – study meets more than 80% of the STROBE criteria; B – study meets 50-80% of the STROBE criteria; and C – study meets less than 50% of the STROBE criteria. In case of disagreement, two other researchers were consulted.

## Results

A total of 3,623 articles were identified. Following the analysis of titles and abstracts and the application of exclusion criteria, 25 studies were selected for inclusion in this systematic review, as shown in Figure 1. Regarding the assessment of methodological quality using the STROBE<sup>18</sup> criteria, none

of the studies analysed was classified as quality C; 8% (n = 2) and 92% (n = 23) were classified as quality A and B, respectively (Table 1).

The articles reviewed in this study are presented in Charts 1 and 2 by study year/location, sample description, analysed variables, objectives, summary of the tools used for NK assessment and classification, and associations with NK.

### Study year/location

Articles in this area began to be published in 2000 and continued in low numbers until 2003 (a mean number of 1 article per year), returning in 2005 with the studies by Lin and Lee<sup>28</sup> and Schaller and James<sup>32</sup>. From this year on, the mean

number of published articles increased to three articles/year. The studies were performed from 1999 to 2015. However, 36% of the authors (n = 9) did not report the year of the study. Interestingly, the study by Mimiran et al.<sup>43</sup> was performed in 1999, but there is a difference of 11 years between the year in which the study was performed and the year of publication.

The journals with the highest number of published articles were *Asia Pacific Journal of Clinical Nutrition* and *Journal of The American Dietetic Association*, with three articles each (12%).

NK assessment studies were performed on five continents. Brazil is the country with the highest number of studies (n = 4; 16%), followed by the US and Australia, each with 12% (n = 3) of the articles.

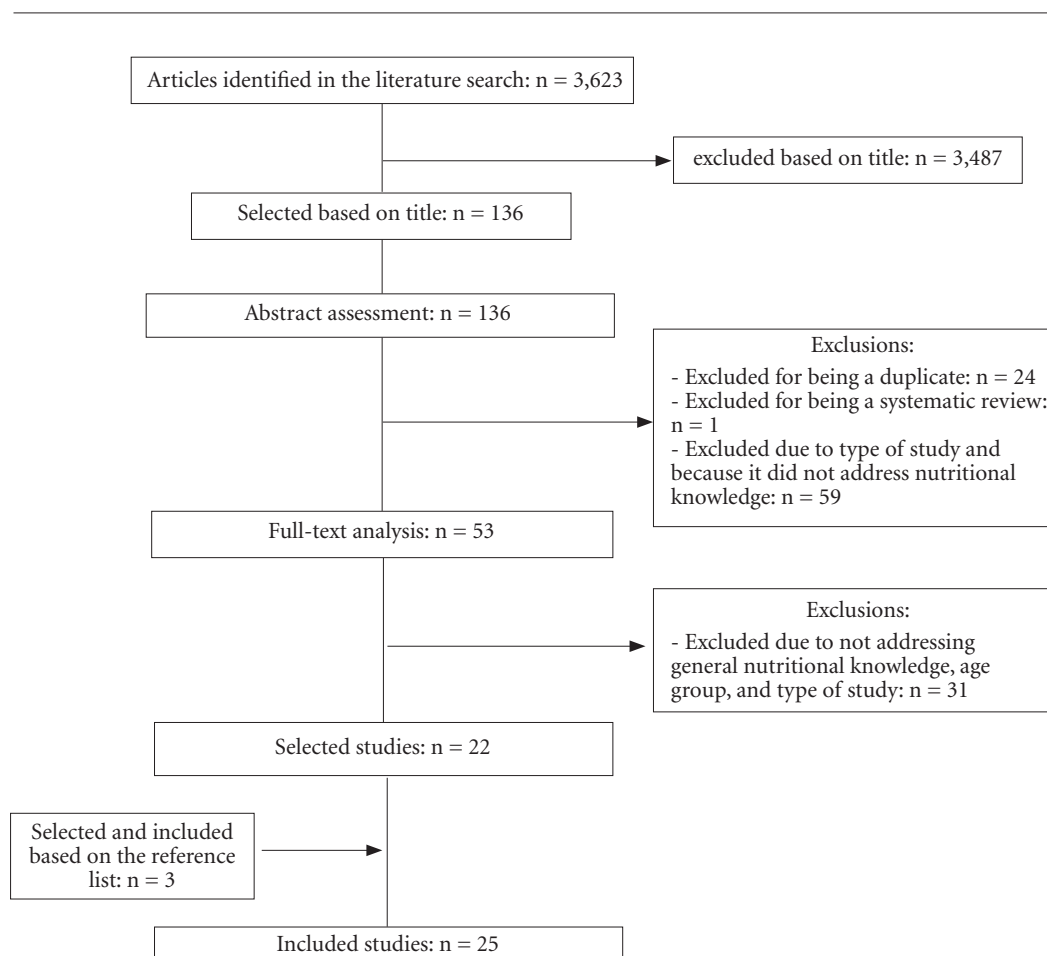


Figure 1. Flowchart of the article selection steps.

**Table 1.** Study quality according to the STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) criteria.

Reference	Points	%	Classification
Oliveira et al., 2009 <sup>21</sup>	11.0	50.0	B
O'Brien and Davies, 2007 <sup>22</sup>	12.0	54.5	B
Nuss et al., 2007 <sup>23</sup>	12.3	55.7	B
Parmenter et al., 2000 <sup>24</sup>	12.5	56.8	B
Pon et al., 2006 <sup>25</sup>	12.5	56.8	B
Spillmann and Siegrist, 2010 <sup>6</sup>	12.5	56.8	B
Freitas et al., 2006 <sup>26</sup>	13.0	59.1	B
Datillo et al., 2009 <sup>27</sup>	13.0	59.1	B
Lin and Lee, 2005 <sup>28</sup>	13.3	60.2	B
Kolodinsky et al., 2007 <sup>29</sup>	13.5	61.4	B
Castro et al., 2010 <sup>30</sup>	13.5	61.4	B
Lin et al., 2011 <sup>31</sup>	13.5	61.4	B
Schaller and James, 2005 <sup>32</sup>	13.8	62.5	B
Holdsworth et al., 2006 <sup>33</sup>	13.8	62.5	B
Wardle et al., 2000 <sup>34</sup>	14.0	63.6	B
Zawila et al., 2003 <sup>35</sup>	14.5	65.9	B
Gámbaro et al., 2011 <sup>36</sup>	14.5	65.9	B
Carrillo et al., 2012 <sup>37</sup>	15.5	70.5	B
Hendrie et al., 2008 <sup>38</sup>	15.8	71.6	B
Al Riyami et al., 2010 <sup>39</sup>	15.8	71.6	B
De Vriendt et al., 2009 <sup>40</sup>	16.5	75.0	B
Galindo Gómez et al., 2011 <sup>41</sup>	16.6	75.5	B
McLeod et al., 2011 <sup>42</sup>	17.0	77.3	B
Mirmiran et al., 2010 <sup>43</sup>	17.7	80.2	A
Kresić et al., 2009 <sup>44</sup>	18.5	84.1	A

### Sample description

In most studies, the population was composed of adults of both genders, aged from 18 to 75 years old; the exceptions are the studies by Zawila et al.<sup>35</sup>, Freitas et al.<sup>26</sup>, Pon et al.<sup>25</sup>, Holdsworth et al.<sup>33</sup>, Nuss et al.<sup>23</sup>, De Vriendt et al.<sup>40</sup>, Castro et al.<sup>30</sup>, Galindo Gomes et al.<sup>41</sup> and McLeod et al.<sup>42</sup>, which were performed with women only. These studies correspond to 36% (n = 9) of the reviewed articles.

The smallest sample size was of 21, and the largest sample was composed of 2,027 participants. It is noteworthy that these samples were obtained almost entirely by convenience.

### Analysed variables and objectives

Most studies did not analyse dietary, anthropometric, socioeconomic, and demographic variables simultaneously; only 32% of the studies

did so<sup>25,26,29,39-43</sup>. However, sociodemographic and economic data were assessed by all studies. Of these, 25% (n = 6) assessed only these data, with the most frequent variables analysed being age, gender, educational level, occupation, income, marital status, number of children, and ethnicity. Regarding nutritional assessment, the most studied variables were as follows: weight, height, body mass index (BMI), waist circumference (WC) and hip circumference (HC), and food consumption. BMI was assessed in all articles that analysed anthropometric data (n = 14). However, WC and HC were analysed simultaneously only by Pon et al.<sup>25</sup> and Mirmiran et al.<sup>43</sup>.

The food consumption assessment tool used in 61.54% (n = 8) of the 13 studies that analysed diet was a food frequency questionnaire (FFQ)<sup>6,25,26,36,39,42-44</sup>.

In general, the objective of the studies was to describe and/or assess NK and to correlate it with nutritional status, eating behaviour, or economic and sociodemographic variables. Although, in 40% of the studies<sup>25,26,31-33,35-38,43</sup>, the authors did not state in the article that one of the objectives was to test the existence of associations, most of them presented data on this matter in the results section.

### Nutrition knowledge assessment tools

A total of 44% (n = 11) of the studies used questionnaires specifically designed for their own investigations<sup>6,23,25,28,31,33,39,41-43</sup>. In general, these assessment questionnaires addressed nutrients (carbohydrates, lipids, proteins, vitamins, minerals, and fibres); the health benefits of food; the diet-disease relationship (obesity, cardiovascular disease, and non-communicable diseases in general); fruits and vegetables; salt; and the food pyramid. The *Nutritional Knowledge Questionnaire* (NKQ)<sup>45</sup> was used by 32% of the studies (n = 8); The NKQ was developed and validated for use in the English-speaking population, aged 18 or over, and assesses knowledge on dietary recommendations, nutrient sources, daily food choices, and the diet-disease relationship. The Harnack et al.<sup>46</sup> NK scale, translated into and validated for Portuguese by Scagliusi et al.<sup>13</sup>, was used in 16% (n = 4) of the articles<sup>21,26,27,30</sup>; this scale assesses knowledge on the diet-disease relationship, the amount of fibres and lipids in food, and the recommendations of fruit and vegetable consumption. Schaller and James<sup>32</sup> studied nurses and used the questionnaire designed by Henderson Sabry et al.<sup>47</sup> specifically for these professionals.

**Chart 1.** NK assessment studies published during the last 10 years: references, sample descriptions, analysed variables, and objectives.

Reference*	Study location/year	Target population	Analysed variables**	Objective
Wardle et al., 2000. <i>Appetite</i> <sup>34</sup>	England 1999	M and W, 18-75 y (n = 1040)	Age, gender, ethnicity, educational level, marital status, work status, occupation	To assess the possible relationship between NK and the intake of fruits, vegetables, and fat
Parmenter and Wardle, 2000 <i>Health Educ Res</i> <sup>24</sup>	England 1999	M and W, 18-75 y (n = 10140)	Age, gender, ethnicity, educational level, marital status, occupation, number of children < 18 years of age still living at home	To analyse NK and its demographic variations
Zawila et al., 2003 <i>J Athl Train</i> <sup>35</sup>	US NI	M, 18-22 y (n = 60)	Age	To assess NK and attitudes related to food intake and nutrition in marathon runners
Lin and Lee, 2005 <i>Asia Pac J Clin Nutr</i> <sup>28</sup>	Taiwan 1999-2000	M and W, > 65 y (n = 1937)	Age, gender, educational level, residential area	To understand NK, attitudes related to nutrition, and attitudes and behaviours related to food restriction in elderly Taiwanese
Schaller and James, 2005 <i>Nurse Educ Today</i> <sup>32</sup>	Australia NI	M and W, 26-50 y (n = 103)	Age and working years	To determine NK among nurses
Pon et al., 2006 <i>Asia Pac J Clin Nutr</i> <sup>25</sup>	Malaya 1999-2001	W, ≥ 45 y (n = 360)	Age, ethnicity, educational level, marital status and income. Weight, height, BMI, WC and HC. Diet using FFQ.	To assess health and NS in urban middle-aged women and to study the relationship between NK and health
Holdsworth et al., 2006 <i>Public Health Nutr</i> <sup>33</sup>	Senegal 2003	W, urban, 20-50 y (n = 3010)	Age, ethnicity, education, working status, economic status. Weight, height and BMI.	To assess knowledge on dietary factors and behaviours related to non-communicable disease.
Freitas et al., 2006 <i>Rev Bras Nutr Clin</i> <sup>26</sup>	Brazil 2005	W, ≥ 18 and ≤ 50 y (n = 153)	Age and religion. Weight, height, and BMI. Diet by FFQ.	To assess NK and food intake frequency among vegetarian and non-vegetarian female university students
Kolodinsky et al., 2007 <i>J Am Diet Assoc</i> <sup>29</sup>	US NI	M and W, 18-20 y (n = 193)	Age and gender. Weight, height, and BMI.	To investigate food habits of university students and their relationship with knowledge of dietary guidance.
O'Brien and Davies, 2007 <i>Health Educ Res</i> <sup>22</sup>	Northern Ireland NI	M and W, 18-65 y (n = 145)	Age and gender. Weight, height, and BMI.	To investigate the correlation between NK level and BMI in individuals residing in urban areas
Nuss et al., 2007 <i>J Am Diet Assoc</i> <sup>23</sup>	US NI	18-35 y (n = 140)	Age, ethnicity, educational level, marital status, and parity. Weight (pre-pregnancy and postpartum), height, and BMI.	To assess NK and its effect on weight retention in women 1-year postpartum
Hendrie et al., 2008 <i>Public Health Nutr</i> <sup>38</sup>	Australia NI	M and W, ≥ 18 y (n = 201)	Age, gender, educational level, marital status, working situation, and number of children	To investigate general NK and its demographic variations
Datillo et al., 2009 <i>Nutrire</i> <sup>27</sup>	Brazil 2008	M and W, 18-59 y (n = 42)	Income. Weight, height, and BMI.	To assess NK and to correlate NK with BMI and educational level
Kresić et al., 2009 <i>Coll Antropol</i> <sup>44</sup>	Croatia NI	M and W, NI (n = 1005)	Gender, educational level, life conditions, and eating arrangements. Diet using FFQ.	To examine the relationship between NK and food intake in university students

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Chart 1. continuation

Reference*	Study location/year	Target population	Analysed variables**	Objective
De Vriendt et al., 2009 <i>Appetite</i> <sup>40</sup>	Belgium 2002	W, 18-39 y (n = 803)	Age, education, life status, occupation, and children/no children. Weight, height, and BMI. Diet using 2DFR.	To assess NK, the role of sociodemographic and lifestyle variables in NK, and the association between NK and eating behaviour
Oliveira et al., 2009 <i>Lécturas Educación Física y Deportes</i> <sup>21</sup>	Brazil NI	M and W, NI (n = 21)	Age and educational level. Weight, height, and BMI.	To assess NK in judo athletes and to identify the factors that can influence NK
Mirmiran et al., 2010 <i>Ann Nutr. Metab</i> <sup>43</sup>	Iran 1999	M and W, ≥ 20 y (n = 826)	Age, educational level, and marital status. Weight, height, BMI, WC and HC. Diet by FFQ.	To describe attitudes, behaviours, and NK; to identify obstacles to healthy lifestyle changes and the need for educational intervention
Castro et al., 2010 <i>Rev. Bras. Ciênc. Esporte</i> <sup>30</sup>	Brazil 2009	W, 20-60 y (n = 60)	Educational level. Weight, height, BMI, and WC.	To assess NK in physically active women and to correlate it with educational level and anthropometric characteristics
Al Riyami et al., 2010 <i>East Mediterr Health J</i> <sup>39</sup>	Oman 2005	M and W, ≥ 60 y (n = 2027)	Age, gender, educational level, marital status, occupation, personal income, and whether participants live with family. BMI. Diet using FFQ.	To assess knowledge and beliefs related to nutrition and food habits
Dickson-Spillmann et al., 2010 <i>J Hum Nutr Diet</i> <sup>5</sup>	Switzerland 2009	M and W, > 18 y (n = 1043)	Age, gender, and educational level. Diet using FFQ.	To assess the prevalence of misconceptions on how to have a healthy diet and correlate these misconceptions with eating behaviour
Galindo Gómez et al., 2011 <i>Arch Latinoam Nutr</i> <sup>41</sup>	Mexico 2002	W, low income, 18-85 y (n = 1245)	Age, educational level, occupation, housing characteristics, expenses, and income. Weight, height, and BMI. Diet using 24HR.	To identify NK, its association with overweight or obesity, and sociodemographic conditions and characteristics
Gámbaro et al., 2011 <i>Arch Latinoam Nutr</i> <sup>36</sup>	Uruguay SI	M and W, 18-70 y (n = 270)	Age, gender, educational level, marital status, number of people in the family and children at home. Diet using FFQ.	To assess NK and frequency of food consumption
Lin et al., 2011 <i>Asia Pac J Clin Nutr</i> <sup>31</sup>	Taiwan 2005-2008	M and W, 19-64 y (n = 1706)	Age, gender and residential area (geographical area).	To investigate NK, attitudes, and behaviour in adults (19-64 years)
McLeod et al., 2011 <i>J Am Diet Assoc</i> <sup>42</sup>	Australia 2008	Primiparae, NI age (n = 527)	Educational level, marital status, occupation, income, place of birth, language spoken at home, children and mother's date of birth. Pre-pregnancy weight and height (self-reported), and BMI. Diet using FFQ.	To assess NK and its association with socioeconomic status and diet quality
Carrillo et al., 2012 <i>J Food Sci</i> <sup>37</sup>	Spain 2010	M and W, ≥ 18 y (n = 200)	Age, gender, educational level and children/no children at home.	To assess knowledge on characteristics of foods that affect health/well-being and its relationship with food labelling

\* *Medline*, *Lilacs* and *SciELO*; \*\* Sociodemographic and economic, anthropometric, and dietary, respectively.

M: men; W: women; y: years; BMI: Body mass index; WC: Waist circumference; HC: Hip circumference; NK: Nutrition knowledge; US: United States of America; NI: No information; NS: Nutritional status; FFQ: Food frequency questionnaire; 24HR: 24-hour recall; 2DFR: 2-day food record.

**Chart 2.** NK assessment studies: applied tools, assessment score, and associations of nutrition knowledge (NK) with analysed variables.

Reference*	Tool/ Use**	NK assessment score	Observed associations (+) positive (-) negative (N) none
Wardle et al., 2000. Appetite <sup>34</sup>	Questionnaire a / Self-administered	NR	(+) NK vs healthy diet (fruits, vegetables) (-) NK vs fat
Parmenter et al., 2000 Health Educ Res <sup>24</sup>	Questionnaire a / Self-administered	NR	(+) NK vs educational level, socioeconomic status, and gender (women > NK)
Zawila et al., 2003 J Athl Train <sup>35</sup>	Questionnaire b / Self-administered	NR	Not specified
Lin and Lee, 2005 Asia Pac J Clin Nutr <sup>28</sup>	Questionnaire b / Interview	NR	(+) NK vs educational level
Schaller and James, 2005 Nurse Educ Today <sup>32</sup>	Questionnaire d / Self-administered	Maximum 48 points	(+) NK vs age
Pon et al., 2006 Asia Pac J Clin Nutr <sup>25</sup>	Questionnaire b / Interview	NK Low 0-9 points; Moderate 10-14 points; High 15-20 points	(+) NK vs educational level, family income, use of vitamin and mineral supplements, and regular physical exercise
Holdsworth et al., 2006 Public Health Nutr <sup>33</sup>	Questionnaire b / Interview	NR	(N) NK vs age, socioeconomic status, literacy, educational level, BMI, and ethnicity. There was better knowledge on the relationship between fat-rich diet and non-communicable diseases
Freitas et al., 2006 Rev Bras Nutr Clin <sup>26</sup>	Questionnaire c / Self-administered	NK Low 0-6 points; Moderate 7-10 points; High > 10 points	The objective of the study was not to establish associations
Kolodinsky et al., 2007 J Am Diet Assoc <sup>29</sup>	Questionnaire e / Self-administered (online)	NR	(+) NK vs healthier food choices
O'Brien and Davies, 2007 Health Educ Res <sup>22</sup>	Questionnaire a / Self-administered	Maximum 10 points on each sub-scale	(N) NK vs BMI
Nuss et al., 2007 J Am Diet Assoc <sup>23</sup>	Questionnaire b / Interview	NR	(+) NK vs age and educational level. Women with > NK had < weight retention 1-year postpartum
Hendrie et al., 2008 Public Health Nutr <sup>38</sup>	Questionnaire a / Self-administered	Maximum 113 points	(+) NK vs gender (women > NK), age (35 years or + > NK), and educational level
Datillo et al., 2009 Nutrire <sup>27</sup>	Questionnaire c / Interview	NK: Low 0-6 points; Moderate 7-10 points; high > 10 points	(+) NK vs BMI (low) and educational level (higher)
Kresić et al., 2009 Coll Antropol <sup>44</sup>	Questionnaire a / Self-administered	Maximum 96 points	(+) NK vs consumption of food servings in accordance with that recommended by the food pyramid

it continues



Chart 2. continuation

Reference*	Tool/ Use**	NK assessment score	Observed associations (+) positive (-) negative (N) none
De Vriendt et al., 2009 Appetite <sup>40</sup>	Questionnaire a / Self-assessment	Maximum 111 points	(+) NK vs educational level, age, and occupation (> NK = better diet/significant increase in fruit and vegetable intake)
Oliveira et al., 2009 Lécturas Educación Física y Deportes <sup>21</sup>	Questionnaire c / Interview	NK: Low 0-6 points; Moderate 7-10 points; High > 10 points	No associations
Castro et al., 2010 Rev. Bras. Ciênc. Esporte <sup>30</sup>	Questionnaire c / Self-administered	Knowledge: Low 0-6 points; Moderate 7-10 points; High > 10 points	(+) NK vs educational level (-) NK vs BMI and WC
Al Riyami et al., 2010 East Mediterr Health J <sup>39</sup>	Questionnaire b / Interview	NR	(+) NK vs educational level Most samples had low NK
Mirmiran et al., 2010 Ann Nutr. Metab <sup>43</sup>	Questionnaire b / Interview	NK: weak < 29 points; medium 29-39 points; appropriate > 39 points	(+) NK vs age 30-49 years, educational level, and gender (female)
Dickson-Spillmann et al., 2011 J Hum Nutr Diet <sup>6</sup>	Questionnaire b / Self-administered (sent by mail)	NR	(+) NK vs gender (women > NK), > vegetable consumption, and educational level (-) NK vs age
Galindo Gómez et al., 2011 Arch Latinoam Nutr <sup>41</sup>	Questionnaire b / Self-administered	No score. Qualitative: incorrect, regular, and correct NK	Correct or regular NK associated with increased risk of overweight or obesity (+) correct NK vs overweight/obesity risk
Gámbaro et al., 2011 Arch Latinoam Nutr <sup>36</sup>	Questionnaire a / Interview	Maximum 106 points	(+) NK vs educational level, > fruit and vegetable consumption, and low consumption of simple sugar- and fat-rich foods
Lin et al., 2011 Asia Pac J Clin Nutr <sup>31</sup>	Questionnaire b / Self-administered	NR	(+) NK vs age and gender (women > NK regardless of age group)
McLeod et al., 2011 J Am Diet Assoc <sup>42</sup>	Questionnaire b / Self-administered	Maximum 17 points	(+) NK vs socioeconomic status and diet quality index
Carrillo et al., 2012 J Food Sci <sup>37</sup>	Questionnaire a + b/ Self-administered	NK: Low 0-18 points; medium 19-36 points; high 37-54 points	(+) NK vs educational level (low NK group not influenced by labels; very technical information)

\* Medline, Lilacs and Scielo; \*\* Type of questionnaire.

<sup>a</sup> Questionnaire of Parmenter and Wardle 45; <sup>b</sup> Questionnaire designed specifically for the study; <sup>c</sup> Questionnaire of Harnack et al.<sup>46</sup> translated into and validated for Portuguese by Scagliusi et al.<sup>13</sup>; <sup>d</sup> Questionnaire of Henderson Sabry et al.<sup>47</sup>; <sup>e</sup> Questionnaire based on the MyPyramid Food Guidance System 48 and on Diet and Health Knowledge Survey by the US Department of Agriculture<sup>49</sup>; NR: Not reported; BMI: Body mass index; WC: Waist circumference; NK: Nutrition knowledge; NCD: non-communicable disease.

Kolodinsky et al.<sup>29</sup> used the questionnaire based on the *MyPyramid Food Guidance System*<sup>48</sup> and on the *Diet and Health Knowledge Survey* from the US Department of Agriculture<sup>49</sup>; it addresses knowledge on energy, total fat, saturated and *trans*, added sugars, fibres, and the importance of keeping a healthy weight and of eating different fruits and vegetables.

How the answers to the questionnaires were assessed is not stated in 44% (n = 11) of the articles. In 28% (n = 7), only the maximum score that could be reached if all questions were answered correctly was given<sup>22,32,36,38,40,42,44</sup>. The remaining 28% classified NK as low, poor, or weak (0-9 points); moderate or medium (7 to 10 points); and high (above 10). These scores varied according to the methodology used by the authors, with different points in the classification scores.

### NK Associations

Associations between NK and socioeconomic and demographic variables (age, gender, educational level, and family income) were identified in 64% of the studies. However, Holdsworth et al.<sup>33</sup> did not find a relationship between NK and education. By contrast, BMI, which was assessed in 56% of the studies (n = 14), was associated with NK in 42.8% of the studies, and such association could be positive<sup>27,41</sup>, negative<sup>40</sup>, and not present<sup>22,33</sup>; in Nuss et al.<sup>23</sup>, women with less than 5% of weight retention (compared to pre-pregnancy weight, assessed by BMI) during the first year postpartum had better NK.

Associations were found between NK and several positive aspects of diet (n = 10): healthy eating<sup>29,34</sup>; increased fruit and vegetable consumption<sup>6,36,40</sup>; and a low intake of simple sugars, fat, and salt, among others<sup>28,36</sup>.

In light of the results presented in Charts 1 and 2, some conclusions, according to the population studied, were: for women, the most important NK determinants were educational level, age, and occupation<sup>40</sup>; nutritional education is important for the elderly, and the development of nutritional education programmes must consider the low educational levels of elderly people<sup>28</sup>; NK is an important target for health education and has the potential to contribute to a better dietary quality<sup>34</sup>; the knowledge of food, nutritional properties, and recommendations on the size and frequency of consumption must be the primary goals of nutritional education programmes throughout the life of individuals<sup>36</sup>.

### Discussion

This investigation is the first systematic review on cross-sectional studies that assessed the level of general NK in adults; however, similarly to Sarno et al.<sup>50</sup>, it was not possible to perform a meta-analysis due to the heterogeneity of the populations, methods, and tools used in these studies.

The identification of 25 articles that met the inclusion criteria demonstrates that NK assessment has been gaining attention among researchers worldwide. Although no year of publication filter has been used to include all of the studies on the topic of interest, publications in this field began recently (year 2000), and the number of articles/year has been increasing since 2005, reaching a mean number of three articles/year, which also demonstrates the current importance of this topic. According to Verbeek et al.<sup>51</sup>, the number of published articles can be used to quantify scientific progress and evolution.

In the assessment of the STROBE criteria, all of the selected articles presented percentages higher than 50%, which corresponded to a classification of A or B. In the studies by Mirmiram et al.<sup>43</sup> and Kresi et al.<sup>44</sup>, which scored 80% and belonged to the STROBE A category, NK was associated with age (p < 0.01), educational level (p < 0.01), and gender (p < 0.05) and with the consumption of food servings in accordance with that recommended by the food pyramid (p < 0.01), respectively.

The fact that studies were performed in countries from five continents; that sample size varied widely among the studies that almost no articles assesses dietary, anthropometric, sociodemographic, and economic variables simultaneously; and that the methods used were different limits our discussion of the results by making comparisons between studies more difficult. Silveira and Santos<sup>52</sup> and Barros et al.<sup>53</sup> have also noted the difficulty of not being able to establish comparisons between results that use different methods. In addition, each article cites its own limitations, which include the following: the use of NK questionnaire not validated for that specific population<sup>35,41</sup>; self-reported data<sup>29,42</sup>; the non-validation of NK questionnaire scoring methods<sup>42</sup>; the sampling technique used<sup>22,33</sup>; the fact that some participants participated in health and nutrition educational programmes<sup>27</sup>; and the sample size – the use of a small sample<sup>27,29</sup>; regarding this last limitation, Schaller and James<sup>32</sup> state that, although the sample size was sufficient to estimate

NK prevalence with proper statistic power, it was inadequate to perform regression analysis. Thus, the limitations of this review, together with those presented by each article, have hampered the compilation and comparison of results; thus, it is important to perform studies on this subject that use tools and methods that are validated and/or adequate to each study.

The analysis of the sociodemographic and economic variables performed by all of the authors indicates that these phenomena are an important and relevant aspect for NK and the general well-being of participants. One study performed in three low-income neighbourhoods of Fortaleza (state of Ceará, Brazil), conducted by the World Bank, assessed the social risk of poverty and found that the risk factors were low educational and social capital levels, family breakdown, and early pregnancy, among others<sup>54</sup>. Poverty exists when part of a population cannot make a sufficient income to have sustainable access to the basic resources (water, health, education, food, housing, income, and citizenship) that ensure a good quality of life. Low socioeconomic status interferes with healthcare and food habits because, by affecting the family structure, life and food quality are also affected<sup>54-56</sup>.

Regarding the tools used for NK data collection, a wide range of tools was used; however, most authors (44%) used a questionnaire designed specifically for their study<sup>6,23,25,28,31,33,35,39,41,43</sup>. Researchers design their own questionnaires to include items relevant to their specific study by considering the characteristics of the population being studied<sup>12,57</sup>. However, if there is already a data collection tool that is appropriate for a particular population, then there is no need to develop another tool (to be applied to another population), provided that the psychometric properties have been reassessed and are considered reliable<sup>57</sup>. Nevertheless, even when different NK assessment questionnaires are used, the content of these questionnaires does not diverge much, and all of them provide a general view of the participants' NK.

Of all the studies that included the cut-off used for NK classification (Chart 2), only those using the NK scale of Harnack et al.<sup>46</sup>, translated into and validated for Portuguese by Scagliusi et al.<sup>13</sup>, have used the same cut-off for NK assessment<sup>21,26,27,30</sup>, which indicates that the dynamics of NK are not well understood.

Regarding the associations between the analysed variables, NK was shown to be asso-

ciated with age, income, and educational level<sup>23,24,28,31,32,37,38,40,42,43</sup>. Nicastro et al.<sup>58</sup>, Obayashi et al.<sup>59</sup>, and Sapp and Jensen<sup>60</sup> also showed a positive association between educational level and the NK questionnaire score, which clearly shows that education is a basic tool for obtaining knowledge on nutrition. According to Zawila et al.<sup>35</sup>, the greater NK observed in females supports the hypothesis that women are more concerned with aesthetic aspects, which leads them to search more for food-related information.

The studies that investigated a possible association with anthropometric data (Chart 2) show different results regarding BMI, and do not suggest a protector effect against increased body mass. Even when the evidence shows that NK may influence food choices, promote the adoption of healthy food habits, and, consequently, prevent an increase in body mass<sup>13,30</sup>, this association is not universal. It is not clear whether NK leads to healthy food habits<sup>13</sup>. According to Dattilo et al.<sup>27</sup>, the available literature on NK and the nutritional status of a population is very limited, and few studies have used dully validated methods.

Regarding dietary aspects, greater NK was generally associated with healthy food choices and habits. However, even if NK might be a factor that improves eating behaviour, it is not the only determinant factor. For example, according to Montero Bravo et al.<sup>61</sup>, a study performed on 105 college students studying health-related subjects (including nutrition) revealed that, even when students thought they had good NK, the NK was not compatible with their food habits. This study demonstrates the complex nature of this research area and explains why conclusions from similar studies are in apparent disagreement; finally, it shows that further studies are necessary to assess the relationship between NK and eating behaviour, particularly due to the limitations observed in some of the articles reviewed in this study.

## Conclusion

Studies assessing the level of nutrition knowledge in adults remain rare and use different assessment tools and scores, in addition to different variables, objectives, and sample sizes, hampering the analysis of its determinant factors. There is a greater tendency to assess the relationship between NK and sociodemographic and economic variables than to assess the relationship between

NK and anthropometric and dietary data, including food habits and choices. Most studies here reviewed present a methodological quality classified as B according to the STROBE criteria, and only few are classified as A, which is compatible with the observed profile.

### **Collaborations**

LB Barbosa assisted with the study design, database search, and manuscript writing; LOS Correia assisted with the study design and manuscript writing and revision; RC Ferreira participated in the database search and manuscript revision; and SML Vasconcelos assisted with the study design and manuscript writing and final revision.

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