

Review Article

Identifying Physicians' and Nurses' Nutrition Knowledge Using Validated Instruments: A Systematic Narrative Review

Jamie Zeldman, Jeanette Mary Andrade*

Food Science and Human Nutrition Department, University of Florida, Gainesville, USA

Email address:

jzeldman@ufl.edu (J. Zeldman), jandrade1@ufl.edu (J. M. Andrade)

*Corresponding author

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Abstract: Physicians and nurses, who are knowledgeable in nutrition, improve patients' health outcomes. However, limited information is provided about the areas of nutrition they are knowledgeable in. This review sought to identify physicians' and nurses' nutrition knowledge through validated instruments. A systematic narrative review of the literature was conducted. Three databases - PubMed Central, Science Direct and Embase databases were searched from 1990 until December 2019. Retrieved studies were screened through a predetermined inclusion criterion and data extraction of included studies occurred. Quality assessment and risk of bias of included articles was completed. Thirty-three articles met the inclusion criteria. Instruments to identify nutrition knowledge varied among each study. Mean percentages of nutrition knowledge were between 32.5% correct to 72% correct. Nutrition knowledge was highest in the areas of nutrients' roles, and food sources/macronutrients, whereas knowledge was lowest in the area of providing medical nutrition therapy. In general, physicians and nurses who were older, considered a specialist, held an advanced degree and/or had more years of practice had higher nutrition knowledge scores. Overall, literature about physicians' and nurses' nutrition knowledge is heterogeneous and scant as well as the instruments used to measure this knowledge. Within these limits, nutrition knowledge may be improved in certain areas.

Keywords: Nutrition Knowledge, Validated Instruments, Physicians, Nurses

1. Introduction

In 2016, globally, 71% of deaths were attributed to non-communicable diseases (NCDs) – cardiovascular disease, cancer, diabetes, and chronic lung diseases [1]. Even though there are several modifiable risk factors that contribute to NCDs, one that is identified the most is a poor nutritious diet (e.g. low consumption of fruits, vegetables, whole grains and high intake of processed meats, refined sugars, salt) [2–4]. The combination of inadequate nutrition interventions and poor nutritional management contribute to the development and progression of these NCDs, which often leads to longer hospital stays and subsequent increases in healthcare costs [5]. For instance, among the Canadian adult population, the risk of cardiovascular disease was reduced by 4% and total

premature death rate was reduced by 5% with adults consuming at least five servings of fruits and vegetables daily [6]. Furthermore, it was estimated that more than 30,000 deaths could have been delayed or avoided if the population consumed a diet that aligned with the dietary guidelines [7]. One approach that may help individuals consume a nutritious diet is physicians and nurses educating their patients about nutrition.

Patients prefer physicians to inform them about nutrition and the relation of their diet to the prevention and treatment of diseases [8–11]. However, insufficient nutrition knowledge has been one of the main barriers to providing adequate, high quality nutritional care, to their patients [12–15]. After a 1989 report showed a lack of nutrition curriculum in medical schools, the 1990 National Nutrition Monitoring and Research Act empowered medical schools to

include nutrition in the curriculum [16]. Nonetheless, more than half of graduating medical students [17] and nurses [18, 19] reported that the time dedicated to nutrition education is inadequate. Furthermore, the nutrition care practices of physicians and nurses is strongly influenced by their nutrition knowledge [20]. Nutrition knowledge, though, is a concept that may be interpreted in various ways.

Nutrition knowledge is defined as the ability to identify basic facts about food and nutrients and the effect on one's body [21, 22]. Nutrition knowledge is determined by a minimum of two of the following concepts: food groups, balanced diets, current dietary guidelines, sources of nutrients, storage and preparation of food, use of food labels, and the relationship between nutrition and disease [21–24]. For physicians and nurses, these general concepts are generally discussed in their medical and nursing schools, yet the time devoted to these topics are limited and may only be presented once in their two- or four-year curriculum [18, 25–27]. For at least physicians, they may be introduced to specific nutrition information such as biochemistry (e.g. carbohydrate metabolism) and vitamin deficiency states (e.g. iron-deficiency anemia). Although, there lacks more formal nutrition education that integrates a biochemical issue or deficiency to nutrients or a diet to improve their nutritional status [25]. Even though physicians and nurses may not perceive they receive adequate nutrition education in a formal institution, they may acquire nutrition knowledge through other mechanisms such as continuing education, conferences, or independent reading of scientific nutrition literature [28–32]. Other factors that may contribute to nutrition knowledge is years of practice in their respective field and age [30]. Regardless of the method to which a physician and nurse has been exposed to nutrition information, it is critical to assess that knowledge, through validated instruments.

Validating an instrument determines the degree the instrument measures what it is supposed to measure. The validation process is complex and time intensive, however, to ensure quality of data from an instrument, it is necessary. There are three main methods to validate an instrument – content, criterion-related, and construct. An instrument that has been deemed validated should contain the following components: simplicity and viability, reliability and precision in the words, adequate for the problem intended to measure,

reflects an underlying theory or concept to be measured, and is capable of measuring change [33–35]. Even though an instrument may have undergone rigorous validation for a specific population, that instrument may only be valid for that population. 34 For example, a nutrition knowledge questionnaire has been validated for health professionals in the United States. If this instrument was to be used for health professionals within Central America, it must undergo another validation process to ensure it can be used on that population. Several nutrition knowledge instruments currently exist to determine nutrition knowledge among physicians and nurses. Although, the instruments used might not have been validated, thus the results have to be interpreted with caution. Therefore, the purpose of this systematic narrative review was to identify physicians' and nurses' nutrition knowledge through validated instruments.

2. Methods

This systematic review was conducted following the Preferred Reporting Items for Systematic Review and Meta-analysis (PRISMA) [36]. Neither humans nor animals were involved in this study, therefore no IRB approval was acquired.

2.1. Search Strategy

By guidance from the protocol of Cochrane [37], one researcher (J. Z.) utilized three databases: PubMed Central, Science Direct and Embase to find eligible articles between January 1 1990 until December 15 2019. In the Medical Subject Headings (MeSH) a combination of using 'or' and 'and' were used to search for the articles. Selection of the articles had to include nutrition knowledge, validated instruments, and physicians/nurses, as indicated in table 1.

According to Bramer and colleagues [39], the first 100 articles that appear from the search is the most relevant. Thus, the researcher used this approach for this review. Additionally, the researcher used a lateral searching technique to identify additional studies [40]. This included finding studies through relevant articles listed, checking reference lists and tracking citations. Electronic search results were downloaded into Covidence [38], a software to assist in screening and removing duplicate articles.

Table 1. Systematic Review Search Terms Used.

Nutrition knowledge: The search terms included any of the following: “nutrition information”, “nutrition education”, “nutrition knowledge”
AND
Validated instruments: The search terms included any of the following: “Surveys”, “Questionnaires”, “Instruments”, “Validation”, “Reliability”
AND
Physicians: The search terms included any of the following: “doctors”, “physicians”, “practitioners”, “generalists”
AND/OR
Nurses: The search terms included any of the following: “nurses”, “registered nurses”, “nurse practitioners”

2.2. Inclusion Criteria

Studies were included if they were descriptive, in the English language, available in full-text and aimed at

identifying nutrition knowledge of physicians and nurses. Participants had to be 18 years or older and physicians and/or nurses. Studies had to utilize validated instruments to identify nutrition knowledge. Primary outcomes had to include

measurement of nutrition knowledge.

2.3. Exclusion Criteria

Conference abstracts, posters, books, studies that included an intervention, published protocols, non-validated instruments, health professionals/students other than physicians and nurses, outcomes not identifying nutrition knowledge and studies reported in languages other than English were excluded.

2.4. Data Extraction

All titles and abstracts were screened independently by two reviewers (J. Z. and J. G.) and full-text studies that were considered relevant were included for further review. Two reviewers (J. Z. and J. G. or J. M. A) independently reviewed all full-text articles and any discrepancies were resolved with consensus. The primary discussion surrounded the instruments and identification of nutrition knowledge. Data from the studies that satisfied the eligibility criterion were collected onto Microsoft Excel [39]: 1) first author's last name, 2) quality and risk of bias, 3) location, participants and size, 4) nutrition knowledge instrument, 5) validation/reliability of instrument, 6) nutrition knowledge outcomes, 7) areas of nutrition knowledge and 8) demographic factors and associations with nutrition knowledge.

2.5. Quality and Risk of Bias Assessment

Quality and risk of bias assessment of the studies used in this review followed the Academy of Nutrition and Dietetics (AND)'s Quality Criteria Checklist. This checklist consisted of two parts: relevance and validity. The first part, relevance, is defined by four parts and is used to determine a study's usefulness to the nutrition profession. If the responses to all four questions were "yes" the researcher progressed to the validation questions. However, if the response to any of the four questions was "no", the article was removed from this review. The second part, validity, is defined by 10 domain questions and is used to determine the quality and risk of bias of each article. The 10 domain questions address the article's research question, subject selection, study population, withdrawals, blinding, intervention/exposure, outcomes, analysis, conclusion of support, and likelihood of bias [40, 41]. A complete description of each criterion is found in the AND's Evidence Analysis Manual [41].

For the validity part of the checklist, responses were either 0 (yes), 1 (no), 2 (unclear), or 3 (not applicable). If responses to at least five validity criteria were yes (0), the article was deemed high quality (+). If responses to at least six criteria were no (1), the article was deemed low quality (-). If determined low quality, the article was removed from further analysis. If responses to four validity criteria were no (1) or unclear (2), the article was determined neutral (Θ) [41].

Three researchers (J. Z., J. M. A and S. S.) independently reviewed the articles and critically evaluated them based on the Quality Criteria Checklist. Inter-rater reliability was then

determined using a quadratic weighted Cohen's kappa to account for the degree of disagreement among raters [42]. Each reviewer's response to each question of the Quality Criteria Checklist was entered into SPSS v26 [43] to determine inter-rater reliability. Interpretation of the Cohen kappa results were as follows: values ≤ 0 indicate no agreement; 0.01–0.20 indicate none to slight agreement; 0.21–0.40 indicate fair agreement; 0.41–0.60 indicate moderate agreement; 0.61–0.80 indicate substantial agreement; and 0.81–1.00 indicate almost perfect agreement [42].

2.6. Quality and Risk of Bias Assessment

Considering the heterogeneity of the studies, a descriptive analytical approach was deemed acceptable for the quantitative data as opposed to a statistical or meta-analytical approach.

3. Results

3.1. Search Results

A total of 764 articles was identified initially after removal of duplicates. A total of 33 peer-reviewed articles was accepted as seen in Figure 1.

3.2. Characteristics of Studies

Studies were conducted in the United States (n=7) [29, 44–49], Saudi Arabi (n=4) [50–53], Australia (n=3) [54–56], Canada (n=3) [57–59], Israel (n=2) [60, 61], Korea (n=2) [62, 63], Turkey (n=2) [64, 65], Austria (n=1) [66], Denmark, Sweden, and Norway (n=1) [67] Ethiopia (n=1) [68], Finland (n=1) [31], Ghana (n=1) [30], Greece (n=1) [69], Qatar (n=1) [70], South Africa (n=1) [32], Sub-Saharan Africa (n=1) [71], and Taiwan (n=1) [72]. Participants in these studies were either physicians (n=12) [44, 49–51, 53, 58, 59, 64, 69–72] or nurses (n=19) [29–32, 45–48, 52, 54–57, 60–63, 65, 66]. Two studies included both physicians and nurses [67, 68]. The smallest sample size was 59 [51] and the largest sample size was 4, 512 [67], the average sample size was 350 participants. Response rates for the number of instruments received varied greatly across all 33 studies (15% to 100%) [47, 53, 54].

All studies sought to determine nutrition knowledge of physicians and/or nurses. Studies also associated the nutrition knowledge with demographic variables such as gender, years of practice, education level, and/or specialty field (n=24) [29, 30, 44–48, 50, 52–56, 60–67, 69, 70, 72].

3.3. Nutrition Knowledge Instruments

Nutrition knowledge instruments were either adapted and modified (n=22) [32, 45, 47–58, 60–64, 67, 69, 70] or developed for the study (n=11) [29–31, 44, 46, 59, 65, 66, 68, 71, 72]. The methods used to validate these instruments were face and/or content validity among content matter experts such as dietitians, physicians, and/or nurses. The nutrition knowledge portion of the instruments ranged from three

items [57] to 50 items [29, 47, 48] and varied among multiple-choice (n=25) [30, 32, 44–54, 56, 59, 60, 63–66, 68–72], true or false (n=4) [30, 49, 54, 62] and/or Likert scales (n=7) [31, 55, 57, 58, 61, 67, 71]. Four studies administered the instrument online [49, 53, 55, 71] while the other studies used paper-based instruments.

The instruments used focused on general nutrition knowledge such as food and nutrition principles, nutrient deficiencies, malnutrition, practices of nutrition assessment, nutrition-related resources, general knowledge about weight

management, nutrition in the life cycle, and the role of diet and disease. For studies that focused on nutrition knowledge, an overall nutrition knowledge score was calculated. Each correct answer was assigned one point, with the maximum score being the number of items in the questionnaire. Three studies grouped nutrition knowledge scores into categories: poor (<10), moderate (10–14), or very good (15–20) [70]; poor (<8), mediocre (9–12), good (13–16), or very good (17–20) [64] and inadequate (≤ 12) or expert (≥ 12) [69].

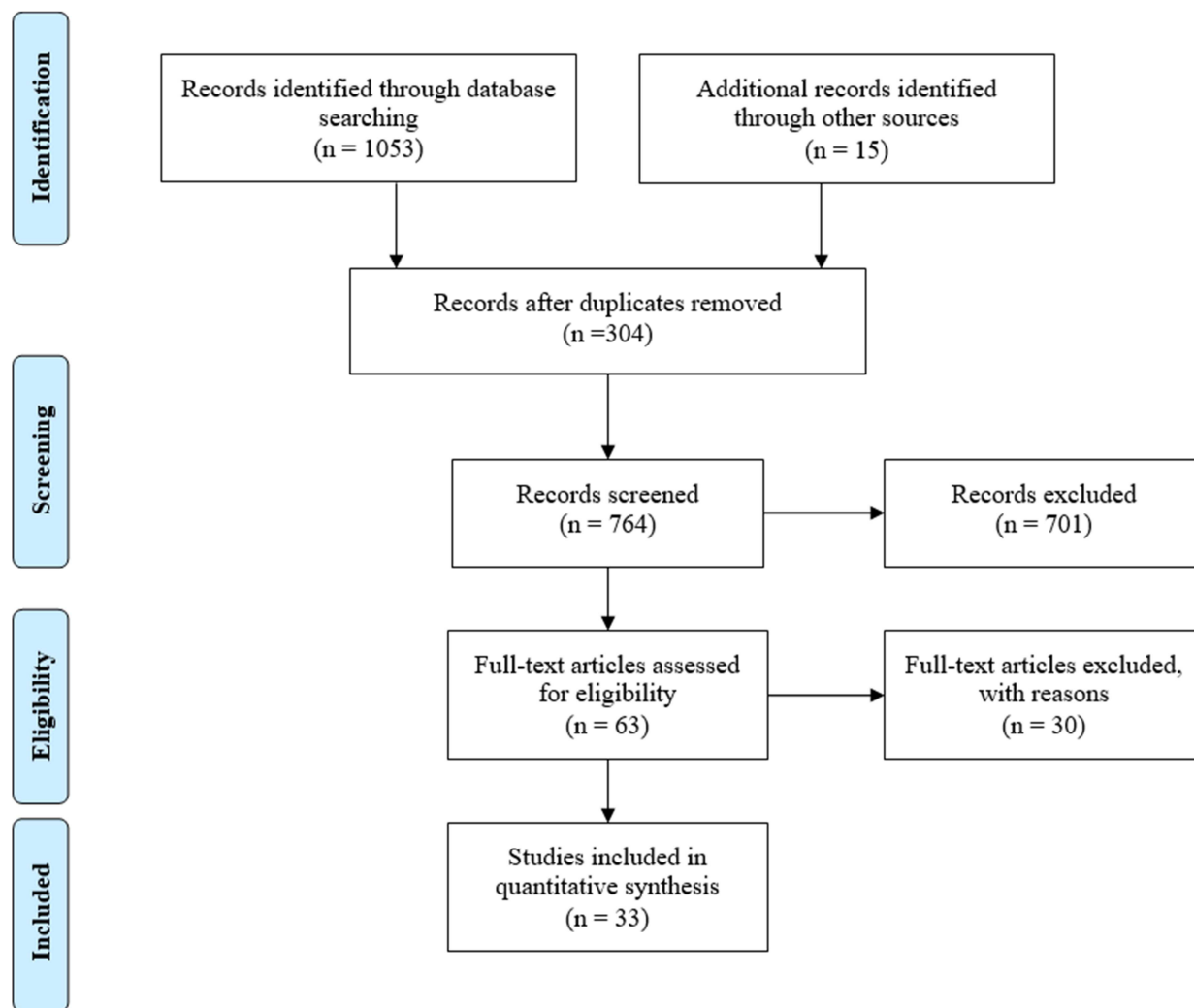


Figure 1. Article Extraction Process.

3.4. Nutrition Knowledge Outcomes

Mean percentages of nutrition knowledge ranged from 32.5% correct [48] to 72% correct [31]. Across the studies, the following nutrition areas were the most known (>70% of respondents answered the questions correctly): nutrition for patients in critical care condition (n=7) [45, 52, 55, 57, 58, 63, 65]; nutrition throughout the life span (n=5) [29, 31, 60, 61, 66]; food sources and impact on health (n=8) [30, 49–51, 53, 59, 64, 71]; identification of fat sources (n=3) [44, 56, 70]; micronutrient deficiencies and impact on health (n=7) [29, 32,

50, 53, 56, 59, 70]; and role of vitamins and minerals (n=4) [32, 56, 64, 73]. On the contrary, the least known (<50% of respondents answered the questions correctly) areas were: digestion, absorption and metabolism of nutrients (n=3) [32, 47, 56]; food safety (n=1) [32]; nutrition labeling (n=1) [32]; nutrition management of disease states and/or conditions (n=22) [30–32, 44, 45, 50, 52, 54, 56, 59, 60–70, 73]; and presence of macronutrients in food sources (n=5) [49, 51, 53, 59, 70] as seen in table 2.

Table 2. Results of Articles included in this Review (n=33).

Author (year)	Location/ Population	Number of knowledge items	Mean Percentage Correct	Areas of knowledge	Demographics and Increased nutrition knowledge
Alkhalidy (2019)	Saudi Arabia Physicians (N=117)	18	50%	-Most correct responses: Fat and salt intake; risk factors -Least correct responses: Smoking and cardiac risk	Significant associations among older physicians ($p=0.01$), 3 or more years of employment ($p=0.04$), higher education level ($p<0.01$)
Al-Numair (2004)	Saudi Arabia Physicians (N=59)	16	51.7%	-Most correct responses: folate to prevent neural tube defects; nutrients to prevent thrombosis -Least correct responses: Excess protein and calcium; soluble fiber and blood cholesterol	None reported
Al-Schwaiyat (2013)	Saudi Arabia Nurses (N=200)	31	58.8%	-Most correct responses: nutrition and diabetes; fiber diet and obesity risk -Least correct responses: reducing fat intake	No significant association, but female nurses had higher scores compared to male nurses (56% vs 51%)
Al-Zahrani (2009)	Saudi Arabia Physicians (N=125)	16	52.1%	Most correct responses: Role of vitamins and minerals; fruits, vegetables and cancer risk -Most correct responses: cardiac prevention for obesity; salt and fat intake	Age and years in practice inversely correlated ($p<0.01$)
Ameh (2019)	Sub-Saharan Africa Physicians (N=174)	16	63%	-Least correct responses: smoking and cardiac risk	None reported
Bauer (2015)	Austria Nurses (N=458)	19	65.6%	-Most correct responses: consequences and signs of malnutrition -Least correct responses: treating malnutrition; body mass index	No differences for gender ($p=0.80$) or age ($p=0.25$). Significant associations for practicing more than 6 years ($p<0.001$)
Boaz (2013)	Israel Nurses (N=106)	18	51.9%	-Most correct responses: hemoglobin and elders; nutrition requirements and trauma -Least correct responses: feeding and fistulas; body mass index	No associations with age, years of experience, or gender. Positive statistical association in length of time from migrating to Israel ($r=0.21$; $p=0.09$)
Crogan (2000)	United States Nurses (N=105)	50	65%	Most correct responses: nutritional deficiencies; protein-calorie malnutrition -Most correct responses: folate to prevent neural tube feeding; BMI categories	No associations of formal nutrition education
Daradkeh (2012)	Qatar Physicians (N=136)	20	63.9%	-Least correct responses: Fats in eggs; glycemic index of foods	Significant associations of males, specialized in the field or had >10 years post university education ($p<0.05$)
Duerksen (2015)	Canada Physicians and residents (N=428)	4 scenarios	53%	>50% of providers identified the correct nutrition solution	None reported
Duerksen (2016)	Canada Nurses (N=345)	3 scenarios	64%	>60% of nurses identified the correct nutrition solution	None reported
Endevelt (2009)	Israel Nurses (N=159)	8	69%	-Most correct responses: calcium and elders; importance of calories -Least correct responses: Alzheimer's disease and obesity and cholesterol	Significant associations of nurses younger than 40 years of age ($p=0.04$)
Flynn (2003)	United States Internists and cardiologists (N=639)	9	31%	Least correct responses: fats in olive and canola oils; diets impact on cardiac disease	Significant associations of cardiologists compared to internal medicine specialists ($p<0.001$)
Grammatikopoulou (2019)	Greece Physicians (N=115)	20	70%	Least correct responses: macronutrient calories; complications of refeeding syndrome -Most correct responses: foods impact on chronic disease	Significant associations of attending continuing education about nutrition ($p=0.002$)
Harkin (2019)	United States Physicians (N=236)	10	70%	-Least correct responses: foods high in soluble fiber and omega 3	No associations
Hu (1997)	Taiwan Physicians (N=326)	26	58.7%	-Most correct responses: nutrient functions; pregnancy nutrition -Least correct responses: nutrition	Significant associations of female physicians, 35 years and younger, non-smokers ($p<0.05$)

Author (year)	Location/ Population	Number of knowledge items	Mean Percentage Correct	Areas of knowledge	Demographics and Increased nutrition knowledge
Ilmonen (2012)	Finland Nurses (N=650)	33	72%	assessment Most correct responses: food allergies; vitamin D supplementation	None reported
Kable (2015)	Australia Nurses (N=79)	10	68%	Least correct responses: weight management and physical activity	No associations of where nurses worked (rural vs urban)
Kgaphola (1997)	South Africa Nurses (N=99)	40	35%	-Most correct responses: functions and sources of nutrients; meat substitutions -Least correct responses: causes of weight gain; reading nutrition labels	None reported
Kim (2009)	Korea Nurses (N=221)	4	48.4%	-Most correct responses: appropriate nutrition support; energy requirements -Least correct responses: interpreting blood laboratory results; body mass index	Significant associations of those nurses who wanted nutrition education compared to those who do not want it (p<0.05)
Lindseth (1990)	United States Nurses (N=176)	50	32.5%	Not stated	Significant associations between years since graduating (>6 years) (p<0.005) and practice area (p<0.001)
Lindseth (1994)	United States Nurses (N=71)	50	64%	-Most correct responses: cultural nutrition; regulatory considerations -Least correct responses: digestion, absorption, and metabolism of nutrients	No associations of employment or education levels (p>0.05). Significant associations of cultural/regulator agency (p=0.03)
Martin (2014)	Australia Nurses (N=181)	18	56.4%	Respondents differed in how to care for chronically ill patients	Significant associations of nurses >50 years of age (p=0.016); nurses with >7 years of experience (p=0.001); nurses of normal or underweight (p=0.036))
Mogre (2017)	Ghana Nurses (N=104)	26	54%	-Most correct responses: preventing malnutrition -Least correct responses: signs and symptoms of malnutrition	Significant associations among years as a nurse (p<0.001) and trained in nutrition guidelines (p=0.004)
Mowe (2008)	Denmark, Sweden, Norway Physicians and nurses (N=4512)	4	58%	Respondents who had more positive attitudes about their nutrition knowledge provided correct answers	Significant associations of Denmark respondents compared to other countries (p<0.001)
Ozcelik (2007)	Turkey Physicians (N=210)	20	48.1%	-Most correct responses: importance of fruits and vegetables; energy value of fat -Least correct responses: alcohol and soluble fiber's impact on cholesterol	Significant associations of older (p<0.001); who specialized (p<0.05); practiced in the field for a length of time (p<0.001)
Park (2011)	Korea Nurses (N=506)	42	58.4%	Least correct responses: dietary approaches to reducing/preventing chronic diseases	Significant associations with >11 years of experience (p<0.05); master's degree (p<0.05)
Perry (1997)	United States Nurses (N=97)	14	40-50%	-Most correct responses: number of days on clear liquids -Least correct responses: calorie needs for enteral nutrition	Significant associations who were at higher grades (p<0.05)
Schaller (2005)	Australia Nurses (N=103)	48	60.2%	-Most correct responses: vitamins/minerals role; fats in food -Least correct responses: non-essential amino acids; lactating nutrient needs	Significant associations of older nurses (>36 years of age) ((p=0.004); more experience (>10 years) (p=0.024); held diploma/general nurse training (p=0.029)
Stanek (1991)	United States Nurses (N=95)	15	60%	Respondents had difficulty with all questions	No associations between age, years of experience, level of nutrition education
Tafese (2015)	Ethiopia Nurses, trained health care workers, physicians (N=355)	13	55.5%	-Most correct responses: using malnutrition chart correctly -Least correct responses: detecting and treating malnutrition	None reported
Temple (1999)	Canada Physicians (N=84)	16	63.1%	-Most correct responses: folate to prevent neural tube defects; thiamin deficiency in alcoholics -Least correct responses: excess	None reported

Author (year)	Location/ Population	Number of knowledge items	Mean Percentage Correct	Areas of knowledge	Demographics and Increased nutrition knowledge
Yalcin (2013)	Turkey Nurses (N=302)	20	49.4%	protein and calcium loss; soluble fiber and impact on cholesterol -Most correct responses: symptoms of catheter infection; enteral access types -Least correct responses: complications and method of enteral nutrition support	No associations of nutrition education (p=0.289). Significant associations of those who provide nutritional assessment (p=0.012); had a graduate degree (p=0.000).

3.5. Associations Between Nutrition Knowledge and Demographics

Twenty-five studies determined associations between nutrition knowledge and demographic variables such as age, gender and educational level. Higher nutrition knowledge was associated with age (n=7) [50, 53, 55, 56, 61, 64, 72]; gender (n=2) [70, 72]; immigrating to the country (n=1) [60]; years in practice (n=10) [30, 48, 50, 53, 55, 56, 62, 64, 66, 70]; held an advanced degree (n=4) [53, 56, 62, 65]; pursued nutrition education and/or training (n=4) [30, 63, 65, 69]; and specialized in an area (n=5) [44, 45, 48, 64, 70]. However, discrepancies existed among age as two studies found associations between nurses who were <40 years of age [61, 72] and three studies showed associations between nurses who were >50 years of age and had higher nutrition knowledge [55, 56, 64]. One study did not specify the age of the nurses and the association [50]. The same discrepancy existed between gender and higher nutrition knowledge in which one study identified an association between females having higher nutrition knowledge [72] and

one study identifying that males had higher nutrition knowledge [70]. Ten studies found no associations between demographics and nutrition knowledge [29, 46, 47, 49, 52, 54, 60, 65, 66, 69] and two studies identified associations between providing nutrition in a clinical setting to higher nutrition knowledge [60, 67] as seen in table 2.

3.6. Quality and Risk of Bias

Thirty-two studies were considered high-quality as more than 5 out of the 10 validation questions had a response of yes. One study was considered neutral as 4 out of the 10 validation questions had a response of no or unclear. The most common factors that influenced the validity of these studies were the lack of different study groups and lack of studies reporting statistics with levels of significance. The overall Cohen kappa scores was 0.76, which demonstrates substantial agreement among the researchers [42].

4. Discussion

This systematic narrative review sought to identify the nutrition knowledge within specific areas through validated instruments. Studies used validated surveys that were either adopted and modified from prior surveys or else initially developed. Instruments, though, varied between studies as well as the type of nutrition knowledge that was to be assessed.

Mean nutrition knowledge percentages ranged from a low of 32% correct responses to a high of 72% correct responses.

All studies utilized validated instruments that were either in its original form or adapted and modified from previous studies to assess nutrition knowledge [74]. For those studies that designed their own instrument, previous nutrition knowledge instruments were not appropriate based on their research objectives. Although there are advantages to composing study-specific instruments, such as including only questions that are relevant to the purpose of the study, utilizing a non-validated questionnaire may lead to results that are difficult to compare with those obtained from previous studies [21]. It is also important to recognize that although an instrument may have been validated in its original state, a further validation study is necessary upon altering the original form [21]. For nutrition knowledge instruments specifically, it is likely that constructs will need to be modified due to new dietary recommendations being published [21]. Additionally, because studies were conducted across different continents and countries, instruments needed to be modified to reflect that specific population. Based on the studies within this systematic narrative review, if studies were utilizing modified and adapted instruments, a form of face, content, or construct validation took place among content matter experts. Once those instruments were further modified, they had undergone pilot studies using a sample of the population to ensure the instrument was not only valid, but also reliable. However, few studies illustrated the mechanisms to validate and ensure reliability of these modified instruments, thus it is not known if these instruments were valid and reliable among the population. The same strategies (e.g. content matter experts and pilot study among sample population) were used for newly developed instruments. Although, these studies also lacked in providing the validity and reliability results. Because most of the instruments were adapted, some validity may have been lost upon modification if the adapted instrument did not undergo an additional validation study. Nevertheless, although the instruments may have been adapted to accurately reflect the chosen population of physicians or nurses, the content of the instruments seemed to provide insight of the health professionals' nutrition knowledge.

With regards to the instruments in general, it is important to recognize the importance of representativeness and validity in relation to response rate. Representativeness refers to how well the sample population compares with the actual population of interest [75]. In the case of this systematic narrative review, it is important to inquire whether the sample

size of the physicians and nurses utilized is adequate to represent the actual population of physicians and nurses in each respective geographical location. Sample sizes and response rates varied greatly across the studies, which may be in part due to different recruitment methods utilized. For the studies that mentioned a response rate, the average response rate was 58% and ranged from 15% [54] to 100%, leaving a nonresponse rate of 42% [47]. A response rate of approximately 60% or more is indicated to be the goal of researchers [75], suggesting that the studies utilized in this review, on average, had appropriate response rates. Nonetheless, research has shown that studies with lower response rates are sometimes capable of yielding more accurate results than studies with high response rates [76]. Therefore, there is not a direct correlation between response rate and validity, indicating that low response rates in some of the studies do not automatically mean the study results have lower validity [76].

Physicians and nurses had higher knowledge regarding the topics of nutrition for critical care patients, nutrition during the life span, the role of vitamins and minerals, and/or food sources/macronutrients and the impact on health. On the other hand, nutrition knowledge among physicians and nurses was lower in the topics of nutrition management for chronic diseases/conditions, digestion and absorption and metabolism of foods, and/or presence of macronutrients in foods. Furthermore, physicians and nurses who were specialists (e.g. geriatric or cardiologists), had more years of practice experience, had higher nutrition knowledge compared to physicians and nurses who were not specialists and had less years of practice experience.

Mean scores on the nutrition knowledge instruments ranged from poor, 32.5% correct [48], to fair, 72% correct [31], indicating that there is a gap in nutrition knowledge among physicians and nurses. Further analysis from these studies illustrated that certain demographic differences such as specializing in an area, interest in nutrition education, years in practice or positive attitudes towards nutrition or providing nutrition information to patients resulted in higher nutrition knowledge scores overall. Some factors such as age and gender resulted in different nutrition knowledge scores, in which studies showed that male [70] or female [72] physicians and nurses or those younger than 40 years of age [61, 72] or those older than 50 years of age had higher nutrition knowledge scores [55, 56, 64]. Even though there may have been a discrepancy between age and gender from the studies, commonalities were that those physicians and nurses held positive attitudes towards nutrition, provided nutrition information to their patients, specialized in an area, took more nutrition classes in their professional studies and/or pursued continuing education specifically in nutrition [61, 70, 72]. Thus, it is difficult to conclude age or gender is directly associated with knowledge as other mediators may play a role in one's knowledge.

Although physicians and nurses had high nutrition knowledge scores from certain topics such as importance of nutrition during critical care and role of vitamins and minerals,

they had low nutrition knowledge scores related to digestion, absorption and metabolism of nutrients and proper nutrition for chronic diseases/conditions. Nutrition is vital to the maintenance of health and the prevention of many diseases [3–5]. Nutrition interventions have been shown to decrease morbidity, mortality, human suffering, and medical costs [5, 77]. Adequate nutrition knowledge is necessary for patients to adopt appropriate dietary habits and is predictive of dietary intake change [78]. If health professionals lack appropriate nutrition knowledge themselves, they subsequently lack the expertise to provide high quality nutrition care and education to patients.

Lack of nutrition knowledge among physicians and nurses may in part be related to the extent of nutrition training in professional school, as well as in continuing education of health professionals. There is evidence that medical graduates do not receive sufficient training in nutrition throughout the world [5, 18, 25–27]. In 1985, the US National Academy of Sciences recommended a minimum of 25 hours of nutrition education in medical schools [79]. Three decades later, in 2015, only one-quarter of US professional schools meet those recommendations [26]. Similar scenarios have been observed in other countries, as well. For instance, two of the five medical schools in Greece do not possess a nutrition course [80]. Outside of the financial burden involved in implementing nutrition training in professional schools, a major obstacle is that there is a lack of specialized physicians and nurses who are trained in nutrition [80].

It is important to note that this systematic narrative review focused on physicians and nurses only. Therefore, it is not appropriate to suggest that there is a gap of nutrition knowledge among all health professionals conclusively. An additional limitation is that although all instruments were validated and created to assess nutrition knowledge, they did vary from study to study. Many of the studies used instruments that were adapted and modified, which, as mentioned previously, may have decreased the validity of the instrument if no further validation study was conducted. Nonetheless, the use of different instruments is also a strength of this review. Different instruments assessing the same concept provided diverse responses, yet still proved to show that nutrition knowledge was subpar across all the studies. An additional strength is that this systematic narrative review included no restriction on geographical location. This is important in that all studies on the topic of interest were considered, and lack of nutrition knowledge among health professionals is not only a problem nationwide but is also a problem globally.

5. Conclusions

This review provided insights to the areas of nutrition knowledge among physicians and nurses. Instruments used to assess nutrition knowledge varied but were shown to be validated and reliable. Further studies need to be conducted to assess nutrition knowledge of other health professionals outside of physicians and nurses, but it is evident that

advanced nutrition education needs to be better integrated into professional schools and graduate programs. Additionally, continuing nutrition education should be required for all health professionals to ensure the most current nutrition recommendations are being implemented.

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