

# Assessment of nutrition knowledge among university students: a systematic review

Nawsherwan<sup>1\*</sup>, Ijaz Ul Haq<sup>2,3,4\*</sup>, Qing Tian<sup>3</sup>, Bilal Ahmed<sup>5</sup>, Muhammad Nisar<sup>6</sup>, Hafiz Muhammad Zubair<sup>7</sup>, Areeba Yaqoob<sup>4</sup>, Fatima Majeed<sup>4</sup>, Jahan Shah<sup>8</sup>, Amin Ullah<sup>9</sup>, Suqing Wang<sup>1</sup>

<sup>1</sup> Department of Preventive Medicine, School of Health Sciences, Wuhan University Wuhan 430071, Hubei, China

<sup>2</sup> Department of Public Health & Nutrition, The University of Haripur, Khyber Pakhtunkhwa, Pakistan

<sup>3</sup> School of Food Science, Jiangsu Food & Pharmaceutical Science College, Huai'an 223003, Jiangsu Province, China

<sup>4</sup> Department of Nutrition and Food Hygiene, Nanjing 211166, Nanjing Medical University, Jiangsu Province, P.R. China

<sup>5</sup> School of Pharmacy, Nanjing Medical University, Nanjing 211166, Jiangsu province, PR China

<sup>6</sup> Department of Epidemiology and Public Health, Cholistan University of Veterinary and Animal Sciences, Bahawalpur, Pakistan

<sup>7</sup> Faculty of Pharmacy, The University of Lahore, Lahore, Pakistan

<sup>8</sup> Department of Social Medicine and Health Education, School of Public Health, Nanjing Medical University, Jiangsu Province, P.R. China

<sup>9</sup> Department of Occupational Medicine and Environmental Health, Nanjing Medical University, Nanjing 211166, Jiangsu Province, P.R. China

\* Nawsherwan and Ijaz Ul Haq contributed equally as first authors.

**Abstract.** *Background:* Nutrition knowledge is one of the influential factors which have a significant relation with chronic diseases and diet quality. This study aimed to conduct a systematic review of nutrition knowledge assessment among university students. *Methods:* An online article's search was performed using the PubMed and Web of Sciences search engines. Articles' search criterion included nutrition knowledge assessment related to observational studies among university going students. The article has been presented according to the PRISMA checklist. STROBE (*Strengthening the Reporting of Observational Studies in Epidemiology*) criterion was used for the methodological quality of the included papers. Mann Whitney tests were used for the comparison. *Results:* A total of 1470 articles were retrieved, and in-depth 29 English language articles were selected. The sample size ranges from 63-1037 respondents. Most of the studies didn't report the sampling techniques. The majority of papers (75.9 %) had 50-80 % (category B) STROBE points. There was no significant difference in articles regarding nutrition knowledge published before and after 2000 ( $P > 0.05$ ). *Conclusion:* These studies reveal that over a long period researchers didn't maintain the quality of work in this particular area. The STROBE criterion should be strictly followed for observational studies for good quality work in assessing nutrition knowledge among young population.

**Keywords:** STROBE; General Nutrition Knowledge Questionnaire; cross-sectional study

## Introduction

Nutrition-related knowledge is a significant factor in promoting healthy eating practices, and as a result, lead to the maintenance of healthy or appropriate body

weight [1]. There is a clear link that nutrition knowledge influences food habits, which guarantees the intake of essential nutrients throughout life cycle [2]. Nutrition education, either formally or informally, can build knowledge, might be helpful for appropriate dietary intake.

Nutrition is an essential component of life. The role of nutrition can be seen in everyday healthcare, which further shows a clear connection between nutrition & diet with health. Poor nutrition often leads over and undernutrition or, act as risk factors for additional chronic diseases. Through appropriate nutrition education, non-communicable diseases like obesity-related diseases and conditions can be reduced and managed. For example, diabetes can be well managed with nutrition education by giving knowledge about the carbohydrates and the amount to eat consistently throughout the day. Hypertension can be control or maintained by educating a patient on the DASH diet (Dietary Approaches to Stop Hypertension) [3]. Mediterranean diet showed a decrease or prevention in cardiovascular health, depression, breast cancer, colorectal cancer, obesity, diabetes, asthma, cognitive decline, and erectile dysfunction [4].

All the student population irrespective of their ages must fulfil their appropriate nutrition and physical activity-based recommendations to improve their overall health and learning abilities. It is also essential that college students enhance and maintain healthy eating and lifestyle habits during their study years as these habits are likely to be sustained into maturity or adulthood and have a crucial influence on their overall health in future [5]. According to researchers, nutrition education increases general nutrition knowledge and interactive activities in college students, which further shows the increase of awareness towards good food choices and an excellent way to modify dietary habits [6]. Student's college time is unique and a critical developmental stage for the establishment of health-related behavioral patterns, as they gain new experience and transit from adolescence to adulthood, and increase independence and personal freedom [7]. As in college life, students are usually busy, while they also need to manage and balance different activities. During this crucial stage, many students engage themselves in unhealthful dietary habits like dieting, breakfast skipping, meal skipping, and fast food consumption. Also, minimize their physical activity [8]. Students at the college level usually move away from their family home, spend long hours studying, sometimes take part-time jobs, and pay less attention to the amount and quality of their food. Their diet may

include energy-packed products, such as chocolate bars, chocolates, biscuits, as well as fried products or fast food and tend to use instant meals, which takes only minutes for preparation[9]. A high load of pressure because of academic activities often interfere with the dietary habits of the students as well as [10].

College students do not take the recommended amount of vegetable, fruits, and fiber, and their intake regarding nutrients like fats, sodium, and sugar become high [8] which results in unhealthy dietary patterns and behavioral outcomes [11]. These unhealthy eating habits further lead to non-communicable diseases in the future. Nutrition knowledge, which is an essential factor for the selection of a healthy and nutritious diet [12], may play a pivotal role to reduce this burden of non-communicable diseases. Many studies have been conducted to evaluate the nutrition knowledge among students around the globe. The current systematic review was aimed to qualitative assess the nutrition knowledge among university students. PRISMA checklist has been followed for the presentation.

## Methods

A literature search was performed by the authors from the database "PubMed" and "Web of Sciences" in February 2019. PRISMA guidelines were followed for this systematic review. PRISMA checklist has been given in Supplementary Table 1.

### *Strategy for selection of articles*

The keywords used to find the articles were "Nutrition knowledge, students or college students or university students," "Nutrition-related knowledge, college students or university students." According to the characteristics of the database, the search strategy was organized.

### *Inclusion and exclusion criterion*

Only studies investigating nutrition knowledge in young population of colleges published in English were included in the study. Studies were retrieved with any number of sample size, study design, and gender.

**Table 1.** Description of reviewed articles according to sample size, sampling methods, design and information regarding nutrition knowledge questionnaires

Authors	Country	Sample size	Sampling technique	Target population	Study design	Formal NKQ used	Validated/reliability questionnaires
Phillips, M. G. 1971[21]	England	254	Not mentioned	Medical students	Not mentioned	Self-design	Yes
Pietz et al. 1980 [24]	US	230	Not mentioned	Dentistry students	Not mentioned	Yes	Yes
Allard and Mongeon 1982 [26]	Canada	154	Systematic sample	General College students	Not mentioned	Yes	Yes
Brett et al. 1986 [25]	UK	120	Not mentioned	Medical students and doctors	Not mentioned	Self-design	Not mentioned
Cotugna and Vickery, 1994[22]	US	85	Not mentioned	College students	Not mentioned	Self-design	Not mentioned
Hamm et al. 1995 [23]	US	168	Not mentioned	Hotel and management students	Not mentioned Survey	Self-design	Yes
Hu et al. 1997 [39]	China	528	Not mentioned	Senior medical students	Not mentioned survey	Yes	Yes
Thomas et al. 2006 [40]	US	164	Convenience samples	University students	Not mentioned	Yes	Yes
Kolodinsky et al. 2007[41]	US	200	Not mentioned	College students	Cross-sectional study	Yes	Yes
Kresic et al. 2009 [15]	Croatia	1005	Convenience samples	University students	Cross-sectional study	Yes	Yes
Jesse et al. 2010 [27]	Iran	207	Not mentioned	University football and basketball players	Cross-sectional study	Yes	Yes
El-Sabbah and Badr 2011 [32]	Kuwait	1037	Not mentioned	University students	Cross-sectional study	Self-design	No
Shah et al. 2011 [33]	UK	124	Non-probability purposive sampling strategy	Dental, dietetic and nutrition students	Not mentioned	Self-design	Yes
Alsaffar, A. A. 2012[16]	Turkey	195	Not mentioned	Engineering, nutrition and dietetic students	Validation study	Yes	Yes
Buxton and Davies 2013 [42]	Ghana	166	Not mentioned	Nursing students	Cross-sectional study	Yes	Yes
Chepulis and Mearns 2015[30]	New Zealand	197	Convenience samples	Nursing students	Not mentioned	Yes	Yes

(Continued)

Table 1. (Continued)

Bernardes Spexoto et al. 2015 [31]	Brazil	381	Nonprobabilistic sampling method	Pharmacy and bio-chemistry students	Cross-sectional study	Yes	Yes
Yahia et al. 2016 [43]	US	237	Not mentioned	College undergraduate students	Cross-sectional study	Yes	Yes
Yahia et al. 2016 [17]	US	231	Not mentioned	University students	Cross-sectional study	Yes	Yes
Zaborowicz et al. 2016 [10]	Poland	456	Not mentioned	Humanities, life sciences, and engineering students	Not mentioned	Yes	Yes
Kliemann et al. [18]	UK	4 studies=552	Not mentioned	UK residents, Dietetic and English students, Students and college staffs from London	Validation study	Yes	Yes
Hargrove et al. [44]	Greece	257	Not mentioned	University students	Cross-sectional study	Yes	Not validated
Bottcher et al. 2017 [19]	US	127	Convenience sampling	University students	Validation study	Yes	Yes
Hanna et al. [20]	Australia	67	Convenience samples	University dance and dance performing students	Cross-sectional study	Yes	Yes
Abebe et al. 2017 [28]	Ethiopia	145	Stratified random sampling techniques	Animal and plant sciences students	Cross-sectional study	No	No
El-Ahmady and W1-Wakeel 2017 [29]	Egypt	423	Not mentioned	Pharmacy students	Cross-sectional study	Self-design	Not mentioned
Erdenebileg et al. 2018 [45]	Korea	594	Not mentioned	College students	Cross-sectional study	Self-design	Yes
Ul Haq et al. 2018 [12]	China	701	Not mentioned	Medical students	Cross-sectional study	Yes	Yes
Alkaed et al. 2018 [46]	Kuwait	253	Convenience samples	Adult students	Validation study	Yes	Yes

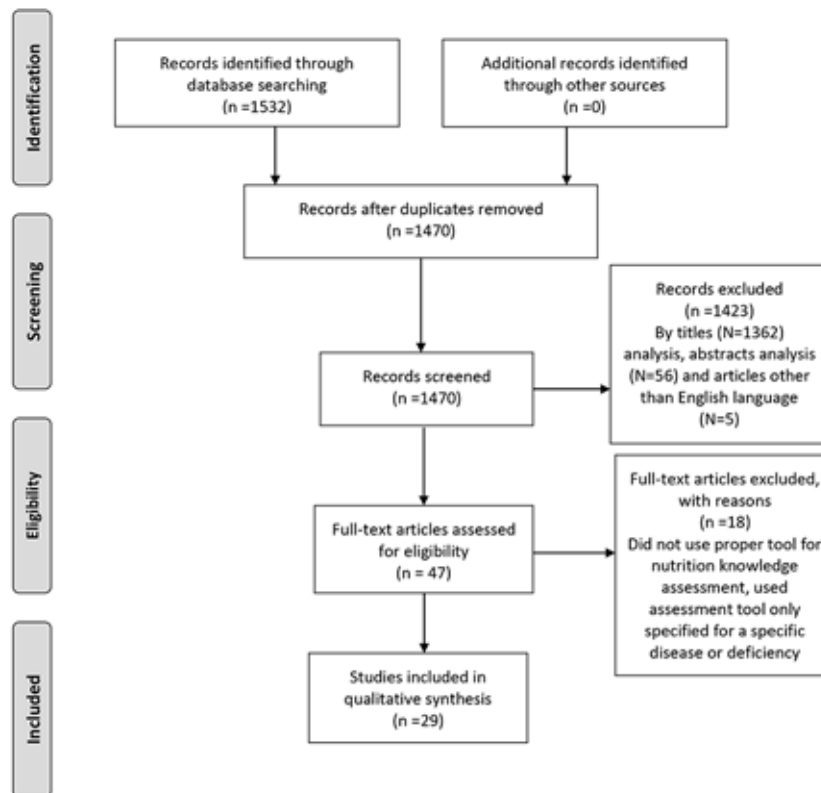


Figure 1. PRISMA Flow chart

Eligibility criteria included an assessment of nutrition knowledge in university students. The authors from the initial search reviewed titles and abstracts of the articles and determined the eligibility of the articles to the next step. The full text was downloaded for the articles which were initially screened and selected according to the inclusion criterion (PRISMA Figure 1 Flow chart).

#### Quality assessment

The authors used STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) standards for the quality assessment. Each article received a score range from 0 to 22 according to the earlier described STROBE scoring. Three categories were made according to the criterion by [13] Category A – study meets > 80% of the STROBE criteria; Category B – study meets 50-80% of the STROBE

criteria; and Category C – study meets less than 50% of the STROBE criteria.

#### Statistical analysis

Data were analyzed using IBM SPSS Statistics, Version 22.0 (IBM Corp, Armonk, NY, USA) and expressed as median and percentages. Prism 6.0 was used for illustrations. Non-parametric tests (Mann Whitney tests) were used for the comparison of the paper published before and after 2000, according to the STROBE points. A two-tail  $P < 0.05$  was considered significant.

#### Results

A total of 1470 articles were retrieved from the literature. Following the analysis and screening of

articles by titles, abstracts, and exclusion criteria, 29 studies were selected for this study, as presented in Figure 1. Seven studies were published before 2000.

#### *Study locations, sample size, and sampling techniques*

In total of 29 studies, nine studies were conducted in the US, 4 in the UK, 2 in China, 2 in Kuwait, and the rest in the other countries. The range of sample sizes varies from 63 to 1037. Overall, 20 studies didn't mention the sampling techniques, which include six studies published before 2000 out of 7 studies. Six studies used convenience sampling techniques, while the rest used other sampling methods.

#### *Targeted Population*

Most of the studies targeted the young population from universities. In the reviewed articles, four studies focused on clinical medicine students, two studies targeted nursing students, two studies targeted pharmacy students, and three studies were having participants from nutrition or dietetic and the rest of the studies target general students.

#### *Study design*

In the total reviewed article, 15 studies used a cross-sectional study design, four studies were validation studies about assessing and validating the nutrition knowledge assessment tool, and ten studies didn't mention the study design (Table 1). Any of the earlier published studies, i.e. before 2000, didn't mention the study design in the article.

#### *Nutrition assessment tools*

Out of 29 reviewed studies, the researcher in the eight studies specifically designed the nutrition assessment questionnaire by themselves, in which four studies validated their questionnaire while the other four didn't validate their assessment tool (Table 1). Most of the studies that designed their survey were published before 2000. The questionnaire was based on fundamental knowledge regarding nutrition, food

groups' knowledge, portion sizes, macronutrients, and micronutrients related knowledge, nutritional status, and disease management. The majority of the conducted studies (21 articles) followed earlier studies and adopted or followed their assessment tool as their assessment tool (Table 2). Many studies used the General nutrition knowledge questionnaire (GNKQ) [14] directly or in modified form according to their locality [15-20]. The GNKQ usually consists of four sections: expert recommendations of food group, nutrition-related knowledge, food choice, and diet-disease relationship.

#### *Contents of the articles*

The contents inside of most of the reviewed articles were mentioned. Some articles published before 2000 either have no [21-23] or not appropriate [24, 25] abstracts. The objectives of all cited articles were specific and appropriate. The majority of the article's introduction was having enough scientific evidence. Moreover, the included articles have a good methodology, results in interpretation and discussion. Some articles were lack of limitations [10, 16, 21, 23, 24, 26-33].

#### *Quality of articles*

The quality assessment of articles, according to the STROBE criterion, has been presented in Table 3. The range of strobe points was 5.5-17.13. The cross-section study design checklist was used in this study. According to the STROBE classification, seven studies (24.1 %) were found in category C while 22 studies (75.9 %) were found in Category B. No study was observed in category A. The median score for the paper published before 2000 was 12.7 while after 2000 was 12.8, with no significant difference (Figure 2).

## **Discussion**

In this review article, we qualitative assess nutrition knowledge, specifically in university students. Systematically, this article stated that the

**Table 2.** Nutritional assessment tools and main findings of the reviewed articles

<b>Authors</b>	<b>Nutrition assessment tool</b>	<b>Objectives</b>	<b>Main Results</b>
Phillips, M. G. 1971[21]	Recommended nutrients, food sources of nutrients and recommended food groups, Diet therapy for diseases including diet recommendation for it	Development of a test to measure nutrition knowledge	<ul style="list-style-type: none"> <li>Majority of the respondents were not familiar with the basic concepts of nutrition-related information</li> </ul>
Pietz et al. 1980 [24]	Normal and therapeutic nutrition, diet-related information, nutritional assessment	To investigate nutrition knowledge of 1st year and 4 <sup>th</sup> -year students	<ul style="list-style-type: none"> <li>68.6 % of respondents answered correctly about nutritional knowledge.</li> <li>The nutrition of First-year students was significantly higher than 4<sup>th</sup>-year students.</li> <li>There was no association between nutrition knowledge score and nutrition attitude score.</li> </ul>
Allard and Mongeon 1982 [26]	Naming food groups, and sources of vitamin C, calcium and iron	To test the strength of the associations between nutritional knowledge, attitude and behavior in the junior college students and to find out which model, if any, is supported by the pattern formed by the strongest relationship, and to see if the model thus selected applies equally to male and females	<ul style="list-style-type: none"> <li>Females had better nutritional knowledge than males.</li> <li>Younger ones have a low level of nutritional knowledge but physically fit than older ones.</li> <li>Overweight status was associated with an inadequate nutritional intake</li> <li>Good nutritional knowledge and favorable attitude toward nutrition were inter-related in junior college students</li> </ul>
Brett et al. 1986 [25]	Factual question regarding energy per macronutrient, kilojoules, daily intake of different nutrients, nutrition assessment,	To evaluate the nutritional knowledge of junior doctors and Clinical students	<ul style="list-style-type: none"> <li>50.8 % of the clinical students give correct answers to the factual questions based on nutritional knowledge, while this percentage for doctors was 58.5 %.</li> <li>50.0 % of the clinical students and 37 % of doctors didn't know about the responsibility of dieticians.</li> </ul>
Cotugna and Vickery, 1994 [22]	Knowledge about recommended daily servings, awareness of food pyramid, the nutritional quality of diet	To evaluate general Awareness of food groups, knowledge of serving size, and actual intake compared to the recommendation according to the food pyramid	<ul style="list-style-type: none"> <li>Forty-four percent of students did not know about the food pyramid.</li> <li>Knowledge about dairy and fruits was the greatest among the respondents.</li> <li>Only fruit was consumed according to the recommended intake by two-third of the respondents.</li> </ul>
Hamm et al. 1995 [23]	Food composition, blood cholesterol, recommendations question for a healthy life include cholesterol intake and ideal body weight	To examine the nutritional knowledge and attitudes of hotel and management students	<ul style="list-style-type: none"> <li>Respondents were having relatively poor knowledge regarding nutrition.</li> <li>They suggested classroom nutrition education in the study population</li> </ul>

(Continued)

Table 2. (Continued)

Hu et al. 1997 [39]	Nutritional functions of nutrients and disease management through nutrition	To find knowledge, attitude, and practices regarding nutrition in medical students	<ul style="list-style-type: none"> <li>• 60 % of respondents give the correct answer to general nutrition while 52 % of respondents had clinical nutrition knowledge.</li> <li>• The majority of students had positive attitude statements.</li> <li>• 30–60 % of students practiced nutrition-related behaviors</li> </ul>
Thomas et al. 2006 [40]	Dietary recommendations, exercise, and caloric expenditure, information regarding vitamins, minerals, carbohydrates, fats and cholesterol, protein and obesity	To evaluate nutrition knowledge of nursing, physical therapy, and fitness students	<ul style="list-style-type: none"> <li>• Fitness students had higher mean knowledge scores than nursing and physical therapy students.</li> <li>• Respondents who got nutrition education had higher scores.</li> <li>• Their findings suggest having a dietitian in the health care team for the provision of better nutrition services.</li> </ul>
Kolodinsky et al. 2007[41]	Importance of dietary guidelines, energy, fats, saturated and trans fats, maintaining weight, the importance of eating vegetables and fruits, fiber, added sugar	To investigate self-reported eating patterns of college students to identify whether following Dietary Guidelines for Americans and if their eating patterns are related to their knowledge of dietary guidance	<ul style="list-style-type: none"> <li>• The mean knowledge was <math>20.01 \pm 5.35</math> (range=10–35).</li> <li>• Higher knowledge of dietary guidance was found to be positively related to more healthy eating patterns among college students.</li> </ul>
Kresic et al. 2009 [15]	General nutrition knowledge questionnaire (GNKKQ)	To investigate the association of nutrition knowledge and dietary intake in Croatian university students.	<ul style="list-style-type: none"> <li>• Females, senior students, and students who cooked for themselves were having high nutrition knowledge.</li> <li>• Higher nutritional knowledge students were twelve times more likely to have their diet by the dietary recommendation than others.</li> </ul>
Jesse et al. 2010 [27]	Nutrient type, recovery, fluid, weight control and supplements adopted from another study	To investigate nutritional knowledge and factors determining this knowledge in university basketball and football players	<ul style="list-style-type: none"> <li>• The overall nutrition score of the female athlete was better than males.</li> <li>• The sports nutrition knowledge of athletes was inadequate, which lead to poor dietary behavior.</li> </ul>
El-Sabban and Badr 2011 [32]	General knowledge about nutrition, protein, carbohydrate, lipids, vitamins and minerals, water, and nutrition and diseases	To assess the nutrition knowledge about diseases of students and to evaluate some of the dietary habits in students	<ul style="list-style-type: none"> <li>• The overall nutrition knowledge of the students was fair.</li> <li>• The dietary habits, attitude, and interest in nutrition information were also fair.</li> </ul>
Shah et al. 2011 [33]	Diet advice questions as professionals to the patients or people, relevance and importance on diet advice, training, and experience of diet advice, Conflicting dietary messages	To assess nutritional knowledge of Dental, dietetic and nutrition students in comparison with national nutrition guidelines And to identify the conflicts in undergraduate training	<ul style="list-style-type: none"> <li>• Dietetic and nutrition students as compare follow national nutritional guidelines for their diet</li> <li>• Only one-third of the dental students' percept that their knowledge about patients' dietary management is sufficient.</li> </ul>

(Continued)



**Table 2.** (Continued)

<p>Alsaffar, A. A. 2012 [16]</p>	<p>General nutrition knowledge questionnaire (GNKQ) with modification</p>	<p>To validate the general nutrition questionnaire in Turkish university students</p>	<ul style="list-style-type: none"> <li>• Nutrition and dietetic students had significantly higher nutrition knowledge scores than engineering students.</li> <li>• The internal reliability of the questionnaire (Cronbach's <math>\alpha</math>) was 0.89. This questionnaire can be used as a tool for nutrition knowledge in Turkey.</li> </ul>
<p>Buxton and Davies 2013 [42]</p>	<p>Modifier version of nutrition knowledge question for nurses which include knowledge about nutrition and ability how to apply this knowledge in their career</p>	<p>To investigate the nutritional knowledge of a developing country</p>	<ul style="list-style-type: none"> <li>• 44.8% of nursing students in Ghana had below-average nutrition knowledge scores.</li> <li>• Nurses need more nutrition education in Ghana, which could be implemented in practical life.</li> </ul>
<p>Chepulis and Mearns 2015[30]</p>	<p>Information regarding food nutrients group, calories versus kilojoule, Glycemic index, BMI, and BMR.</p>	<p>To explore the nutritional knowledge of undergraduate students in New Zealand</p>	<ul style="list-style-type: none"> <li>• The overall nutritional knowledge scores were low.</li> <li>• Students who received nutrition teaching were having better knowledge than others (62.5 % VS 52.5 %)</li> </ul>
<p>Bernardes Spexoto et al. 2015 [31]</p>	<p>Brazilian Ministry of Health's Healthy Diet of the National Food and Nutrition Policy and the Nutrition Knowledge Scale</p>	<p>To evaluate the extent of healthy diet and nutrition knowledge of undergraduate pharmacy and biochemistry students and association with the variable of interest</p>	<ul style="list-style-type: none"> <li>• The majority of students had moderate nutritional knowledge (79.7 %), and 77.1 % paid attention to their diet.</li> <li>• The students from first-year who were not physically active were paid less attention to a healthy diet.</li> </ul>
<p>Yahia et al. 2016[43]</p>	<p>Diet and nutrition knowledge adopted from a previous study</p>	<p>To assess weight status, nutritional knowledge, physical activity, dietary beliefs and habits of college students</p>	<ul style="list-style-type: none"> <li>• Females, as compared to males, had good weight status.</li> <li>• Body composition parameters, including visceral fats and waist circumference of males, were higher than females.</li> <li>• 4 % of individuals had quite good nutritional knowledge. Student's dietary habits were satisfactory.</li> </ul>
<p>Yahia et al. 2016 [17]</p>	<p>General nutrition knowledge questionnaire (GNKQ)</p>	<p>To investigate the association of nutritional knowledge with lowering level of fats consumption in university students</p>	<ul style="list-style-type: none"> <li>• Female students had 5 points higher nutritional knowledge scores than male students.</li> <li>• Individuals who daily consumed more than 35 % of calories from fats or &gt;300 mg of cholesterol had lower nutrition knowledge scores.</li> <li>• Nutritional knowledge was independently negatively associated with saturated fats and cholesterol intake.</li> </ul>

(Continued)

Table 2. (Continued)

Zaborowicz et al. 2016 [10]	Questionnaire of Eating Behaviour (QEB)	To evaluate the selected dietary behavior taking into account gender and nutrition knowledge of university students	<ul style="list-style-type: none"> <li>• 40.2 % of males and 34.7 % of females were having satisfactory, while 34.7 % of females and 25.1 % of males had good nutrition knowledge scores.</li> <li>• Higher nutritional knowledge was associated with the number of students took vegetables and fruits as a snack instead of salty snacks.</li> <li>• Women were taking sweets, biscuits, nuts, and seeds as snacks while we're taking salty snacks, added salts to dishes, and added sugar to beverages.</li> <li>• Respondents with low nutritional knowledge often used snacks on salty snacks than fruits.</li> </ul>
Kliemann et al. [18]	General nutrition knowledge questionnaire (GNKQ)	To bring up-to-date, reliable and validate The General Nutritional Knowledge Questionnaire (GNKQ) with current recommendations	<ul style="list-style-type: none"> <li>• Nutritional scores of dietetic students were significantly higher than English students.</li> <li>• Revised General Nutritional Knowledge Questionnaire (GNKQ-R) scores were higher among younger and females as compared to older and males, respectively.</li> <li>• (GNKQ-R) is valid, reliable, consistent, and likely to be a useful tool for the assessment of nutrition knowledge in UK adults.</li> </ul>
Hargrove et al. [44]	Questions were based on general nutrition knowledge and specific interventions in obesity, cardiovascular, endocrine nutrition, and nutrients information. This tool is adapted from another study	To evaluate the nutritional knowledge and attitude of preclinical osteopathic medical students toward nutrition counseling in their future role as a physician	<ul style="list-style-type: none"> <li>• The average nutrition-related quiz score among all participants was 69.5 % below the school passing rate of 72.5 %.</li> <li>• The majority (55.1 %) felt comfortable with dietary recommendations to counsel patients.</li> <li>• Tiny (11.9 %) of the respondents were aware of dietary reference intake.</li> </ul>
Bottcher et al. 2017[19]	Derived tool from other published questionnaires and GNKQ, which include information regarding the Mediterranean diet adherence in the prevention of major chronic diseases.	To construct a survey tool relevant to the general population of the United States, integrating both nutrition knowledge and Mediterranean diet (MD) adherence questions from previously validated instruments, and to evaluate nutrition knowledge and MD adherence in a sample population in the southeast United States.	<ul style="list-style-type: none"> <li>• Total MD nutrition knowledge (MDNK) and MD Adherence Screener (MEDAS) scores were significantly higher in students with formal nutrition education and patrons of farmers' markets. The survey tool is a useful valid and reliable tool for assessing baseline nutrition knowledge of the Mediterranean diet to be used in the US population.</li> </ul>
Hanna et al. 2017 [20]	Modifiable form of General nutrition knowledge questionnaire (GNKQ)	To investigate physical activity, participation, nutrition knowledge and knowledge about public health messages regarding physical activity in university dance and dance performing sample students	<ul style="list-style-type: none"> <li>• Dance students had low general nutrition knowledge.</li> <li>• The physical activity level of dance students was varying i.e., low or exceeding the recommendations.</li> </ul>

(Continued)

**Table 2.** (Continued)

Abebe et al. 2017 [28]	Nutrition knowledge questions derived from core nutrition competencies	To evaluate the level of nutrition-sensitive agriculture competencies of Ethiopian graduating midlevel animal and plant sciences students and associated factors	<ul style="list-style-type: none"> <li>• 49 % of the graduates demonstrated mastery of nutrition competencies.</li> <li>• Federal and male respondents performed better.</li> <li>• Overall, students had low performance in nutrition competencies.</li> </ul>
El-Ahmady and WI-Wakeel 2017 [29]	Questions were based on basic nutrition knowledge and concepts	To evaluate the relationship between nutritional knowledge and awareness of Egyptian university students and their nutrition-related habits and health-related performance and indicators	<ul style="list-style-type: none"> <li>• Females had higher nutrition awareness knowledge and practices.</li> <li>• A positive correlation between nutritional literacy and health-related performance was reported.</li> <li>• Nutrition knowledge alone was not a stimulator for individuals to practice healthy habits.</li> </ul>
Erdenebileg et al. 2018 [45]	Nutrition knowledge, dietary attitude and habits questions	To compare body shape perception, nutrition knowledge, dietary attitude and habits, and health-related lifestyle between Korean and Mongolian college students	<ul style="list-style-type: none"> <li>• Korean students perceived themselves as fatter than Mongolian students.</li> <li>• Korean students had significantly higher nutrition scores, lower dietary attitudes, a high rate of skipping breakfast, a high frequency of alcohol mobile phone and exercise, than Mongolian students.</li> </ul>
Ul-Haq et al. 2018 [12]	Basic nutrition knowledge, attitude and practices questions	To compare knowledge, attitude, and practices (KAP), nutritional status and dietary intake between Chinese and international students	<ul style="list-style-type: none"> <li>• International students were having a high prevalence of overweight and obesity.</li> <li>• The nutritional KAP scores of Chinese students were significantly higher than international students.</li> <li>• The frequency of carbonated drinks and fast food was significantly higher in international students.</li> <li>• Nutritional KASP scores were found to be independently associated with BMI after the adjustment of confounders.</li> </ul>
Alkaed et al. 2018 [46]	Kuwait Adult Nutrition Knowledge Questionnaire (KANKO)	To construct a validated adult student's nutrition knowledge questionnaire in Kuwait	<ul style="list-style-type: none"> <li>• Nutrition and health-related students were having good overall nutrition scores as compared to non-health background major.</li> <li>• The test-retest reliability and internal consistency of the constructed questionnaire were moderate to high.</li> </ul>

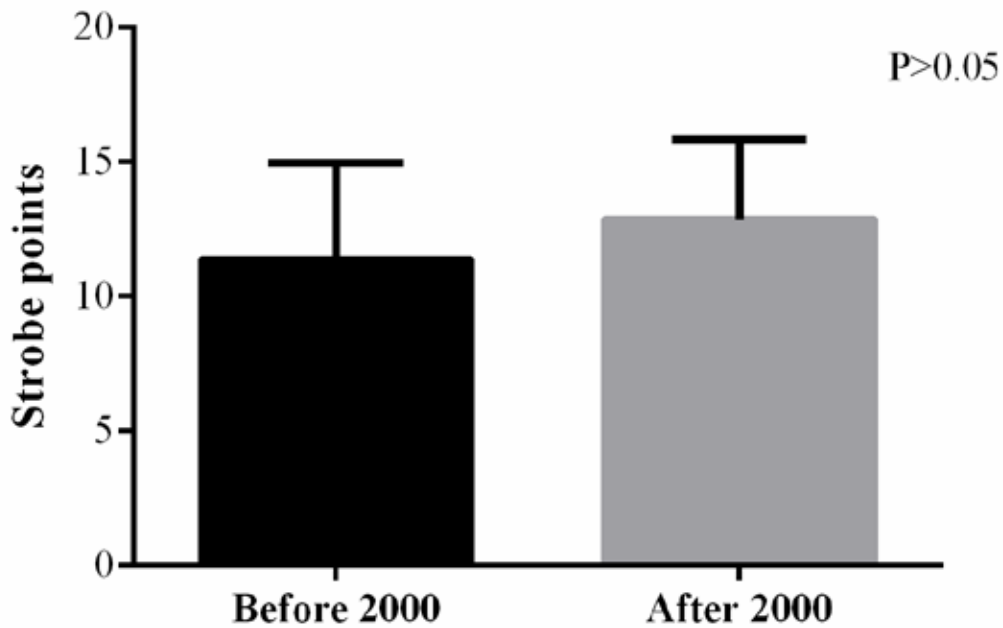
**Table 3.** Classification of articles according to STROBE criterion

References	STROBE points	Percentages	Categories
Phillips, M. G. 1971 [21]	12.2	55.5	B
Pietz et al. 1980 [24]	12.7	57.7	B
Allard and Mongeon 1982 [26]	15.23	69.2	B
Brett et al. 1986 [25]	5.5	25.0	C
Cotugna and Vickery, 1994 [22]	7.2	32.7	C
Hamm et al. 1995 [23]	12.7	57.7	B
Hu et al. 1997 [39]	13.9	63.2	B
Thomas et al. 2006 [40]	8.9	40.5	C
Kolodinsky et al. 2007[41]	14.43	65.6	B
Kresic et al. 2009 [15]	14.4	65.5	B
Jesseri et al. 2010 [27]	17.13	77.9	B
El-Sabban and Badr 2011 [32]	15.93	72.4	B
Shah et al. 2011 [33]	10.43	47.4	C
Alsaffar, A. A. 2012 [16]	10.73	48.8	C
Buxton and Davies 2013 [42]	15.43	70.1	B
Chepulis and Mearns 2015 [30]	9.03	41.0	B
Bernardes Spexoto et al. 2015 [31]	13.1	59.5	B
Yahia et al. 2016 [43]	15.43	70.1	B
Yahia et al. 2016 [17]	16.6	75.5	B
Zaborowicz et al. 2016 [10]	7.0	31.8	C
Kliemann et al. [18]	12.5	56.8	B
Hargrove et al. [44]	11.03	50.1	B
Bottcher et al. 2017 [19]	12.4	56.4	B
Hanna et al. [20]	12.03	54.7	B
Abebe et al. 2017 [28]	16.1	73.2	B
El-Ahmady and WI-Wakeel 2017 [29]	8.2	37.3	C
Erdenebileg et al. 2018 [45]	12.03	54.7	B
Ul Haq et al. 2018 [12]	16.1	73.2	B
Alkaed et al. 2018 [46]	13.73	62.4	B

nutritional knowledge in students was started in the era of the 1970s and still researchers are investigating the nutrition knowledge level of students around the globe.

Nutrition knowledge is necessary for the well-being of individuals. Nutritional knowledge might influence and improve nutritional status and can also lead to good dietary attitudes and practices [12]. Better practices and good quality of the diet can only be

attained by high nutrition knowledge [34]. As in literature, it has been showed that university students fail to reach dietary recommendation [35], which might be because of nutrition knowledge. Therefore, it is essential to measure nutritional knowledge in this population, as this population will practically build up the whole nation. This systematic article reviewed the literature and analyzed the contents and quality of the reported articles.



**Figure 2.** Comparison of STROBE scores between papers published before and after 2000. Seven studies before 2000 and 22 studies after 2000. Mann-Whitney test was used for comparison.

Enough sample size is the main representativeness of a study population and a component of external validity [36]. All the studies in this review stated their sample sizes, but very few studies reported the response rate. But the majority of the studies didn't mention the sampling techniques used in their studies. Some articles used convenience sampling techniques for selecting samples while other methods were non-probabilistic sampling technique [31], stratified sampling techniques [28], non-probability purposive sampling strategy [33] and systematic sampling [26].

In the reported articles in this review, most of the authors used just simple statistical tests as an analytical tool. Very few articles mentioned complex analysis like logistic regression, which can control confounding factors and find the original association of the nutritional knowledge with the outcome variables.

The nutrition assessment tools used in all studies varied from each other. Many studies used GNKQ as a standard questionnaire. The content in the assessment tools in other studies was different from other studies, which focused on basics nutrition to complex nutrition. There were many limitations in the reported

studies based on nutrition knowledge. Many studies were lack of the validation of the assessment instruments. As in literature, it has been shown that to have confidence in the results of an investigation; the researchers must assure that the assessment tool must both be reliable and validated [37]. In our results, we found many articles where the author didn't validate their instruments.

STROBE criterion has been strongly recommended to the researchers for the evaluation of the quality of observational study designs, i.e., case-control, cross-sectional and cohort study design [38]. The cross-sectional STROBE criterion was used for this study. In this study, we also reported validation studies and studies that didn't mention their study design. The included validation studies were cross-sectionally validated. The studies which did not mention their study design were also cross-sectionally investigated. Most of the articles (75.9 %) lied in the B category (50-80 % STROBE scores). We also found that there was no difference between the scores of articles published before and after 2000, which means that over the period most of the studies didn't focus on the quality of their

work. To do quality work, the researcher should follow the strobe criterion in observational studies.

This study was quite comprehensive, but having limitations as well. We used two searching engine, i.e., PubMed and Web of Sciences which maynot cover all the articles of our area of interest. It is also possible that during searching and handling, we might skipped some of the relevant articles.

### Conclusion

In conclusion, we found that majority of the studies regarding the assessment of nutritional knowledge in university students used validated tools. Their tools were different, and many of them used the GNKQ as a standard. All of them reported their sample size. Some were lack of sampling methods. The majority of studies had a clear methodology, results, and discussion. But some didn't indicate the limitation. In the future, we suggest that for a better quality of the study, the STROBE criterion should be followed strictly by the researchers.

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All authors reported no conflict of interest.

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**Correspondence:**

Department of Public Health & Nutrition, The University of Haripur, Khyber Pakhtunkhwa, Pakistan,  
Email: ijazbrt@outlook.com  
Suqing Wang, Department of Preventive Medicine, School of Health Sciences, Wuhan University Wuhan 430071, Hubei, China, Email: swang2099@whu.edu.cn