

## Artículo de Revisión / Review Article

### Review of the strategies employed in the school setting for the teaching of human nutrition

### Revisión de las estrategias empleadas en el entorno escolar en la enseñanza de la nutrición humana

#### ABSTRACT

The main objective was to inquire about the strategies used in the school environment for the teaching of human nutrition. In addition, the existence of multidisciplinary proposals that can lead to significant learning, as well as the inclusion of the dimensions of attitude were verified. The methodological design consisted of a systematic review of studies published between 1999 and 2018, related to the theoretical reference and the type of didactic strategies that guide interventions in schoolchildren aimed at addressing the issue of human nutrition, as well as the possible difficulties that underlie them and the consequent influence on healthy lifestyles. The guidelines of EPPI-Centre were followed. In 45% of the articles reviewed an improvement was evident both in knowledge about nutrition and/or attitudes towards healthy lifestyle habits, as well as in the frequency of physical activity. Didactic proposals of diverse nature were evidenced, pointing to the protagonist role of children and adolescents and favoring their interaction through diverse strategies such as the use of ICTs (Information and Communication Technologies), games, cooperative learning and curricular integration. Nutrition education should be incorporated into school curriculum starting in early years with the active participation of teachers, family members and other community professionals. In the pedagogical and didactic approach to human nutrition, a holistic vision is necessary; this can be achieved through multidisciplinary teaching.

**Key Words:** Adolescents; Children; Health education; Nutrition; School.

#### RESUMEN

El objetivo principal fue indagar sobre las estrategias utilizadas en el ámbito escolar para la enseñanza de la nutrición humana. Además, verificar la existencia de propuestas multidisciplinarias que puedan conducir a aprendizajes significativos, así como la inclusión de la dimensión de las actitudes. El diseño metodológico consistió en una revisión sistemática de los estudios publicados entre 1999 y 2018, relacionados con los referentes teóricos y el tipo de estrategias didácticas que orientan las intervenciones en escolares dirigidas a abordar el tema de la nutrición

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humana, así como las posibles dificultades que subyacen a ellas y la influencia en estilos de vida saludables. En el 45% de las investigaciones se observó una mejoría tanto en los conocimientos sobre nutrición y/o actitudes hacia hábitos de vida saludables, como en la frecuencia de la actividad física. Se evidenciaron propuestas didácticas que señalan el papel protagónico de niños y adolescentes, favoreciendo su interacción a través de estrategias como el uso de las TIC, el juego, el aprendizaje cooperativo y la integración curricular. La educación nutricional debe incorporarse al currículo escolar desde los primeros años con la participación activa de maestros, familiares y otros profesionales de la comunidad. En el enfoque pedagógico y didáctico de la nutrición humana, es necesaria una visión

*holística; esto se puede lograr a través de una propuesta de enseñanza de carácter multidisciplinar.*

*Palabras clave: Adolescentes; Educación en salud; Escuela; Niños; Nutrición.*

## INTRODUCTION

In almost all countries, social and cultural factors have a major influence on what people eat, how they prepare their food, their food practices and the food they prefer<sup>1</sup>. While social and economic determinants play a decisive role in the quality of life and health status of communities, it is also true that access to information and knowledge can change behavior. This is why it is emphasized that guidelines, campaigns and educational practices play a fundamental role in making people aware of the best way to incorporate food into their lives and the need to be critical and objective consumers<sup>2</sup>.

The WHO defines health education as “the educational process aimed at equipping individuals and the community with the capacity to increase their control over the factors that influence their health”<sup>3</sup>. Within this perspective, there are strategies associated with the promotion of healthy nutrition habits, as a fundamental pillar that largely determines the quality of life of people in all age ranges, since the problems associated with the nutritional health of schoolchildren and the population in general each time are more frequent and diverse. The food and lifestyle behaviors of citizens are increasingly deteriorated and influenced by the pace of life and the media. The incidence of chronic diseases has been growing, so it is necessary to search for tools based on the three-dimensional concept of nutrition (biological, social and environmental aspects) to inform and provide populations with the knowledge necessary for the adoption of healthy lifestyles, an objective that will only be achieved through health education<sup>4</sup>. The nutritional situation is the expression not only of food balance, but also of the living conditions of the environment. While it is true that many old public health problems have been solved, it is important to note that the obesity epidemic has been increasing, especially among the most vulnerable and socioeconomically disadvantaged groups in both developed and developing countries<sup>5</sup>. There are different modalities of nutritional campaigns, which promote adequate nutrition for different populations (women during pregnancy, the period of lactation and the first years of life of the infant) while others focus on prevention and control strategies for the child, their families and the environment where children grow and develop. Despite these initiatives on the part of various types of entities, the coexistence of the two extremes of malnutrition (undernourishment and obesity) persist in different contexts at the global level<sup>6</sup>.

It is well known that a child or adolescent exposed to malnutrition conditions will be a vulnerable adult and prone to noncommunicable diseases (obesity, diabetes, osteoporosis, cancer), which is why malnutrition is considered a health priority in order to attend to the

nutritional needs and good dietary habits of children and adolescents belonging to all contexts. At the global level, there is evidence of health problems among this population group, derived from the lack of nutritional education in schools, as well as from inadequate nutrition in homes<sup>7</sup>. It is necessary to intervene at the school level, educating teachers, students and their families in healthy eating habits<sup>6</sup>. Nutrition education can take many forms, however, one of the most important elements is impacting knowledge about nutrition. It is precisely at this point where it becomes relevant to explore the approach to this subject in the school context, either from the implementation of academic courses or from extra-curricular initiatives. Nutrition is a fundamental subject that is taught in the subject of science and constitutes a concept that enables the articulation of various contents (energy transfer, chemical reactions, matter and organization of living systems, that is, it integrates energy, environment and health), as well as the need to influence the healthy lifestyle habits of students, as long as it is possible to transcend theoretical notions to practical questions. In this way, it would be consistent with the premise that “the main objective of science education should be to enable all individuals to informally take part in decisions and participate in actions that affect their personal well-being and the well-being of society and its environment”<sup>8</sup>.

In 2002, Hoelscher et al<sup>9</sup>, in 14 studies published between 1994 and 2000 about nutrition interventions aimed at the adolescent population, identified that the most prominent interventions were those in which teaching strategies were based on theory, focused on individual and environmental behaviors related to food and physical activity, as well as adequate time in terms of execution time. In 2016 Meiklejohn and collaborators<sup>10</sup> carried out a systematic review with the objective of updating the evidence on the impact of multi-strategy nutritional education interventions on the health of adolescents (ages 10-18) and their achievements in nutritional habits. It is important to mention that although the focus of the research included in that review was more aimed at detecting changes in the physical health of the adolescent population (mainly determined by the variation in anthropometric measures, monitoring of daily intake and frequency of physical activity), the fundamental role of nutritional education processes and strategies that result in observable and quantifiable changes is also recognized. In this regard, potentially significant interventions are those in which the following points are considered:

- Adoption of measures to modify the school environment in terms of access to healthy food and compliance with school eating policies.
- Requirement of an optimal and constant teacher training in current topics of nutrition.
- The need to involve families and the community in training activities.
- Integration of programs into existing curricula.

- The use of peer leaders and instructors.
- The incorporation of student self-assessments with personalized feedback.
- Use of innovative multimedia technology tools.
- Promotion of a physical activity component.

The rationale for this review stems from the fact that despite multiple efforts to improve the health of children and adolescents, the problems underlying states of malnutrition persist. For this reason, the various interventions and strategies that have been implemented at schooling levels corresponding to the last cycle of primary and secondary education were tracked, as well as the perceptions of experts and training and professional teachers, in relation to the themes and methodologies that, from school nutrition education, can favor the acquisition of adequate eating habits and healthy lifestyles. The main objective was to determine what type of treatment is given to the notion of nutrition and how holistic the approach to the subject is, verifying the existence of multidisciplinary proposals that can lead to significant learning, as well as the inclusion of the dimensions of attitude as a prerequisite for the adoption of behaviors in favor of health and welfare.

The goal was to update the evidence on the preponderant strategies used in the school environment for nutritional education programs, in order to design a next step, a novel proposal that is structured from a multidisciplinary approach and that stimulates the formation of good habits in students between the ages of 11 and 13.

## METHOD

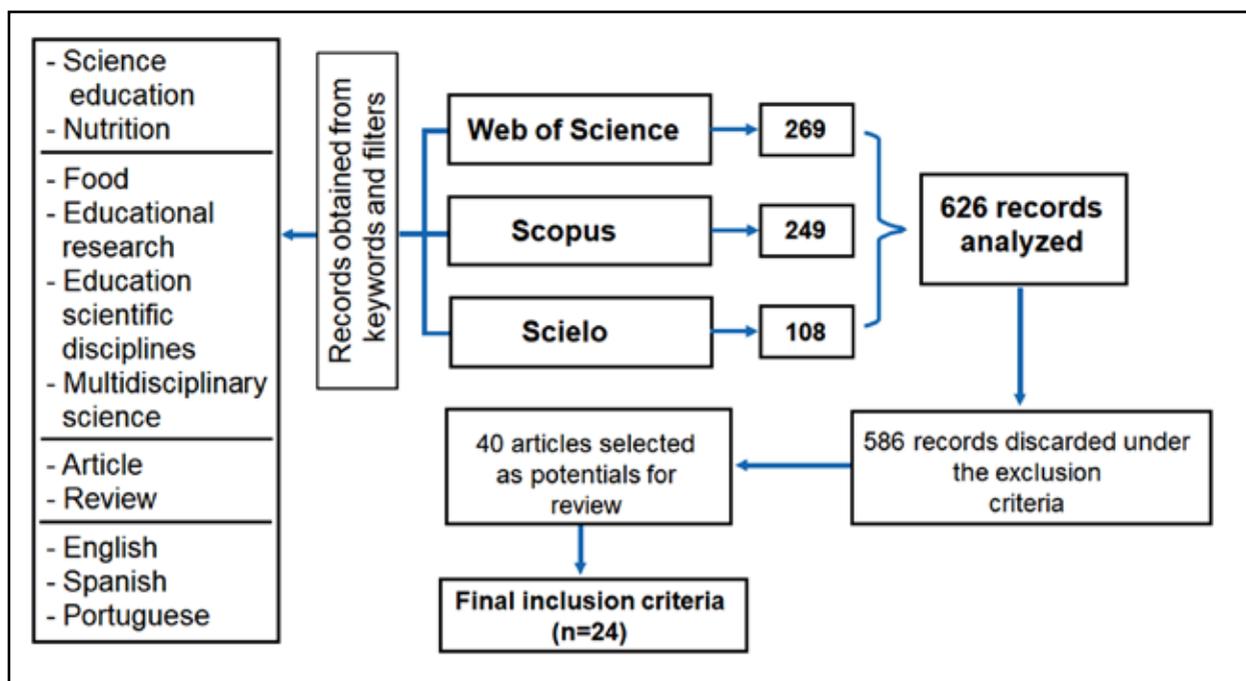
The Evidence for Policy and Practice Information and Coordinating Centre (EPPI-Centre) guidelines were followed. Accordingly, systematic reviews use explicit methods to identify what can be said reliably on the basis of such studies, then synthesize research results so that they can be accessible to all those involved in the decision-making process<sup>11</sup>. For its elaboration, the checklist proposed by Preferred Reporting Items for Systematic and Meta-Analyses, PRISMA<sup>12</sup>, was used to investigate and deepen the theoretical referent and the type of didactic strategies that guide interventions in schoolchildren aimed at addressing the issue of human nutrition. Possible difficulties that underlie interventions and the consequent influence on healthy lifestyles were also evaluated.

As a starting point for the revision initiated in the last trimester of 2018, the basic search of the main collection of the Web of Science (WOS) database was used, using the following key words: "Science Education", "Nutrition" and "Food", for a total of 2,211 records. After applying the filters for "Education Educational Research", "Education Scientific disciplines", "Multidisciplinary science", "Social science interdisciplinary" and selecting only articles in English, Spanish and Portuguese, 269 records published between 1999 and 2018 were obtained. SCOPUS was then searched for the same keywords, resulting in 4,510

documents. The filter for the disciplinary field was for the categories "Social Sciences", "Arts and Humanities" and "Multidisciplinary". The total for SCOPUS was 249 articles in English, Spanish and Portuguese, published in the previously established date range. The partial total of 518 was completed with 108 Spanish records from the SCIELO database using the keywords "Nutrition" and "Education". The selection of the databases was made according to their quality, recognition among the scientific community and coverage. Using SCIELO allowed access to research developed in Latin America that had not yet appeared in WOS or SCOPUS. The title, abstract and keywords of the 626 findings were read, in order to discard those that did not fit the purpose of this review. As an initial methodology for delimiting records, seven exclusion criteria were defined and categories were formed according to the content of the documents, which are listed below:

1. Curricular proposals aimed at university students belonging to programs related to the areas of health, food science and technology.
2. Works that included interventions with patients such as: medical treatments, clinical cases, diagnoses with anthropometric measures and follow-up of daily intake.
3. Non teaching programs in educational institutions, for example: nutritional assistance or public policies directed at the student population, such as prevention campaigns, management of school restaurants, health care or physical conditioning.
4. Influence of socio-demographic factors on the population's dietary habits and nutritional status, inequities in health and/or education and food insecurity.
5. Impact of teaching strategies on topics other than nutrition (e.g. biotechnology, microbiology and genetics) and other disciplines.
6. Records that do not approach the topic of interest, since the keywords appear, but are decontextualized.
7. Systematic reviews based on other criteria.

The adoption of these criteria was based on the possibility of including research that directly pointed to the objective of the review in terms of the population group, the type of methodologies used, the pedagogical approach and its scope. After the omission of 586 records, there were 40 articles selected as potentials for the review, which were read in their entirety. As a final inclusion criterion, those studies in which the following sections were clearly and coherently detected were considered: justification, theoretical references, objectives, characterization of the sample, description of the intervention, thematic axes, research methodology and results/conclusions. The articles were classified by two independent evaluators, who periodically validated the entire process of the present review, reaching an inter-evaluation ratio of 80%. The cases that did not coincide were decided by consensus. The final sample consisted of 24 articles as shown in figure 1.



**Figure 1:** Diagram for the identification, screening, selection and inclusion of the studies analyzed in the review.

## RESULTS

Following the application of the respective filters, exclusion criteria and sample selection as explained in the methods section, a table was drawn up summarizing the most relevant aspects of each of the 24 articles included in this review (a synthesis of the aspects covered in each article can be found in table 1)<sup>13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28,29,30,31,32,33,34,35,36</sup>.

It was found that most of the studies were carried out in the United States (n= 10)<sup>13,14,15,17,20,21,22,30,32,36</sup>, followed by Europe (n= 6)<sup>25,27,28,31,33,35</sup>, South America (n= 4)<sup>16,18,23,29</sup> and Asia (n= 4)<sup>19,24,26,34</sup>. National data from the United States showed that overweight and obesity rates were higher among children from low-income families, who were more likely to have behavioral risk factors for chronic diseases<sup>37</sup>. Most U.S. children do not meet recommended intakes and overeat high-calorie foods, a situation that is not absent in Latin American countries and on other continents. Hence, the interest in implementing health education strategies from school age onwards is a global objective.

The methodology used corresponded to qualitative research (n= 8)<sup>17,20,25,27,28,29,31,34</sup> and mixed methods (n= 16)<sup>13,14,15,18,19,21,22,23,24,26,30,32,33,35,36</sup>, which make it possible to take advantage of the strengths of both paradigms (qualitative and quantitative) to achieve a more complete understanding of the social and educational phenomena. With regard to the characterization of the sample, the

following distribution was found: students in the last years of primary education (n= 7)<sup>13,14,15,17,18,21,35</sup>, students of secondary education (n= 10)<sup>16,19,20,22,23,24,29,30,33,36</sup>, experts in health, education and related fields (n= 2)<sup>25,34</sup>, textbooks (n= 1)<sup>26</sup> and teachers in training or in practice (n= 4)<sup>27,28,31,32</sup>. It is important to specify that for preschool children and early education (age range not included in this review), a good number of studies have been reported, in which interaction with families is prioritized because, during early childhood, this is a key environment for children to learn and develop food preferences. As children grow and start school, teachers, peers, media and social leaders become more important<sup>38</sup>.

In interventions that directly addressed our population of interest, didactic proposals of a diverse nature were evidenced, pointing to the protagonist role of children and adolescents and favoring their interaction through diverse strategies such as the use of ICTs (n= 4)<sup>19,20,34,35</sup>, gaming (n= 3)<sup>18,19,23</sup>, cooperative learning (n= 2)<sup>19,36</sup>, curricular integration linking the topic of food with various subjects in the curriculum (n= 6)<sup>13,14,15,17,22,29</sup>, extracurricular programs (n= 1)<sup>21</sup> and optional courses (n= 1)<sup>30</sup>. Of these, all were carried out in the context of educational institutions, as a complement to formal planning established by grade. The sequences were applied by science or technology teachers with the support of teachers from other areas; in addition, total sequence time of between 2 days<sup>29</sup> and 18 weeks<sup>30</sup> were reported.

**Table 1.** Synthesis of the aspects covered in each article.

Author/Year	Aims and Objectives	Characterization of the sample	Methodology/ Description of the intervention	Findings *Indicates statistically significant difference between groups
CARRAWAY-STAGE ET AL, 2015 <sup>13</sup>	Evaluate the FMI (FoodMaster Intermediate) curriculum to determine if it positively impacts nutrition knowledge among fourth grade students.	34 fourth-grade courses in North Carolina and Ohio.  n= 473 students	Quasi-experimental design with a mixed approach. Nutrition knowledge was evaluated in the pre and post-test, from a questionnaire of 28 multiple-choice questions. A work proposal was designed consisting of ten chapters developed in 45-minute sessions covering the most relevant basic concepts of food and nutrition, each of which contained at least one practical experimental activity.	*Knowledge in science and nutrition was successfully integrated to achieve multiple academic standards.
HOVLAND ET AL, 2013 <sup>14</sup>	- Assess the science knowledge of fourth grade students associated with food topics. - To compare the achievements in science knowledge related to nutrition after the implementation of an integrated curriculum proposal.	34 fourth-grade courses in North Carolina and Ohio.  n= 580 students	Qualitative research supported by quantitative data. Pre and post-test, from a questionnaire of 13 multiple-choice questions, in relation to: Life sciences; Science from a personal and social perspective; Physical sciences; Science and Technology. The intervention included: - Selection of texts for reading comprehension. - Practical activities based on inquiry. - Challenges to try at home.	*The integrated curriculum based on food science increased the multidisciplinary knowledge of students.
CARRAWAY-STAGE ET AL, 2018 <sup>15</sup>	Present a secondary analysis of multiple regression of knowledge in nutrition, science, and mathematics of fourth grade students using the FMI curriculum.	34 fourth grade courses in North Carolina and Ohio.  n= 438 students	Qualitative research supported by quantitative data. The capacity of knowledge in science and mathematics (independent variables) to predict knowledge in nutrition was evaluated. Implementation of 24 lessons of knowledge in nutrition, science and mathematics jointly.	*The students' knowledge of nutrition was favored more by their knowledge of mathematics and science than by their previous notions of nutrition.
MÉNDIZ-ROJAS ET AL, 2017 <sup>16</sup>	Develop an abbreviated version of the scale of attitudes towards healthy eating.	n= 1238 students of second basic cycle of the city of Antofagasta (Chile).	Instrumental study. Application of the questionnaire in its first version (attitudinal statements from the model of attitudes, Likert type structure). Subsequently, the measuring instrument was refined.	The structure of the scale (attitudes and behaviors) responded to the need to maximize the capacity of the instrument to detect possible effects of interventions, as attitudes are more sensitive to effect than behavior.
BARTON ET AL, 2005 <sup>17</sup>	Report the findings of a qualitative study carried out to find out what children in conditions of high poverty think about food and the food system.	n= 24 fourth and fifth grade students residing in New York City.	Qualitative. Semi-structured interviews were carried out, the central axis of which was the question: What happens to food between the farm and the market? The exploratory questions sought to detect students' conceptions of processes related to the food system.	Although the students showed an understanding of the food process between farm and market, this was based more on home experiences and media information than on knowledge gained at school.
LIÉVANO Y LECLERCQ, 2013 <sup>18</sup>	Determine the effectiveness of board games developed as a strategy for the acquisition of basic knowledge in food and nutrition, personal hygiene and physical activity in school children.	n= 959 students from two public educational institutions in Bogotá-Colombia.	Controlled experimental study. Application of a pre- and post-intervention assessment on a scale from 0 to 100, based on a list of questions related to the origin and function of food. The intervention phase lasted approximately two months; each week one of the six games alluding to the topic was carried out.	*An increase in knowledge was achieved in the children who participated in the games, compared to those who did not; in addition, this knowledge lasted over time.

<p>YANG ET AL, 2015<sup>19</sup></p>	<p>Give answer to the following question: Will students who receive different teaching strategies show different levels of improvement in healthy eating?</p>	<p>n= 87 students in the tenth grade of a women's educational institution in northern Taiwan.</p>	<p>Quasi-experimental design. Students from all groups completed the CDAS (Cloud Dietary Assistance System), as pre-test and post-test. This served the function of monitoring daily intake throughout the intervention. It provides a metacognitive strategy that evaluates in a personalized way, if the type of feeding is being optimal in terms of calories, macro and micro nutrients.</p>	<p>*Cognition, metacognition and the socio-affective component, mediated by technology, result in effective behavioral changes associated with nutritional intake.</p>
<p>MATHESON AND ACHTERBERG, 2001<sup>20</sup></p>	<p>Describe the student-computer interactions, and the thinking process that takes place while children work in groups, in a computer-assisted nutrition education (CAI) program.</p>	<p>n= 32 sixth grade students from a rural school.</p>	<p>Observational methods were used to collect the information. The data analysis was done according to the methodology of Grounded Theory, comparing and contrasting the attitudes, reactions, responses and comments of the students. The computer-assisted "boat to land" program used nutrition as an integrating theme of the different skills of the main subjects.</p>	<p>Compared to the more homogeneous groups, those with students representing various styles of interaction (different ways of relating to each other) were more efficient in completing the CAI.</p>
<p>CARSON AND REIBOLDT, 2011<sup>21</sup></p>	<p>- Increase children's knowledge in:                  ✓Healthy eating                  ✓Physical activity.                   - Encourage healthy eating habits and physical activity in children and their parents.</p>	<p>n= 1810 students from six Southern California district schools.</p>	<p>Qualitative research supported by quantitative data. A pre-test and a post-test with 30 questions were applied to measure children's knowledge about healthy eating and physical activity. The project leaders implemented the eleven healthy eating sessions and the five physical activity sessions for 16 consecutive weeks.</p>	<p>*Health and well-being interventions, developed as extra-class programs, can have a positive impact on participants' knowledge and habits of healthy eating and physical activity.</p>
<p>CONTENTO ET AL, 2007<sup>22</sup></p>	<p>Evaluate a curriculum that focuses on providing students with a conceptual understanding of the role that biology and the environment play in personal behavior and health in order to help them cope with the current complex food system.</p>	<p>n= 278 seventh grade students from five schools in New York City.</p>	<p>Qualitative research supported by quantitative data. A 30 item instrument was designed to measure the level of sedentary/physical activity and the frequency of consumption of certain foods. The C3 curriculum ("Choice, Control and Change") consisted of 24 lessons applied by science teachers over a period of 8 weeks. Standards for biology and scientific inquiry were taken into account.</p>	<p>There were positive changes in participants' consumption of healthy foods, as well as decreases in non-recommended products.</p>
<p>FILADELFO AND GURIDI, 2014<sup>23</sup></p>	<p>Elaborate, implement and evaluate a didactic sequence for the teaching of food and nutrition topics.</p>	<p>Two groups of students from two schools, one public and one private, who were in the seventh year of basic education in Brazil.</p>	<p>Qualitative research supported by quantitative data. Application of pre- and post-test questionnaires, evaluation of the execution of the didactic sequence:                  ✓Food domino                  ✓Trail of feeding                  ✓Playful activity of reading and creation of labels with nutritional information.                  ✓Elaboration of a healthy menu.</p>	<p>*Most of the students improved their knowledge about the nutrients and other elements involved in the food and nutrition processes.</p>
<p>MAHAJAN AND CHUNAWALA, 1999<sup>24</sup></p>	<p>Analyze whether the scientific information on health presented in the biology texts is well understood by the students.</p>	<p>Tenth grade students (last year of school in India).                  n= between 36 and 212 depending on the stage of the research.</p>	<p>Qualitative research supported by quantitative data. Questionnaire of 32 multiple-choice questions, to investigate knowledge about different categories related to health.</p>	<p>There was little conceptualization of the nutritional, social and genetic aspects associated with health, in the case of the three groups. This seems to be related to the way in which these issues are addressed in textbooks and during classes.</p>

PÉREZ DE EULATE ET AL, 2015 <sup>25</sup>	To know the ideas and opinions of professionals belonging to health and educational institutions about the current problems and needs in the promotion of healthy eating and physical activity in high school students.	Creation of a heterogeneous panel of 21 experts belonging to the Human and Health Sciences.	The Delphi method was used to determine the degree of consensus among a diverse sample of professionals on the competencies that students in compulsory education should possess, in terms of nutrition and health.	The problems with the most valued items were: eating disorders and sedentary life, followed by malnutrition, overweight and obesity.
RAO ET AL, 2011 <sup>26</sup>	Analyze the nutrition and food security components of revised textbooks, in terms of presentation and quality.	n= 10 textbooks from grades one to ten, used by CBSE (Schools affiliated to the Central Commission of Secondary Education - India).	Mixed approach The following aspects were reviewed in each textbook: ✓ Chapters devoted entirely to nutrition and food security. ✓ Space dedicated to biology topics and in particular to nutrition and food issues.	The quantitative analysis of the contents showed that fewer sections are devoted to the biological component than to the physical and environmental sciences. In addition, chapters and illustrations referring to food security are scarce.
RIVADULLA-LÓPEZ ET AL, 2016 <sup>27</sup>	To present the ideas of the teachers in training regarding the selection of contents on human nutrition.	n = 142 students of the third year of Teaching in Primary Education at the University of La Coruña.	A qualitative study was carried out in which the analysis of concept maps elaborated by future teachers was carried out from different perspectives: - Concept/ purpose of nutrition - Systems involved in nutrition - Relationship between food and health - Relationship between food/nutrition and the environment.	Teachers tend to focus human nutrition on the individual (their decisions and repercussions on their well-being), without considering sustainable development, the maintenance of environmental resources and social welfare.
RIVADULLA-LÓPEZ ET AL, 2017 <sup>28</sup>	Know the key ideas that, in relation to human nutrition, teach and evaluate Portuguese and Spanish teachers of 5th and 6th grade of basic education.	Teachers from 10 schools in the northwest of Spain (8 women and 2 men) and 10 in the north of Portugal (9 women and 1 man). A total of 1332 activities and 227 evaluation issues were analyzed.	Qualitative study. For the analysis of the contributions of the teaching staff, a dossier was elaborated that contemplates the four main categories on human nutrition (N, concept and purpose of nutrition; S, systems that intervene in nutrition; A, relationship between food and health; M, relationship between food/nutrition and environment). Within each of them, subcategories were established, defining the corresponding units of meaning and teacher profiles.	The majority of Spanish teachers have a medium/high level of adequacy in the treatment of N, while the level of most Portuguese teachers is low. With respect to category A, the teaching staff of both groups reach a medium/high level in their treatment. For M, approximately half achieve a high level of treatment in their classrooms and the other half, low.
NÚÑEZ ET AL, 2007 <sup>29</sup>	To design a teaching strategy that allows students to identify needs and demands related to food and nutrition.	n=36 students in the ninth grade of a private school in the province of San Juan (Argentina).	Qualitative. Categories of analysis were defined from the productions of the students, derived from the problem situations that developed in the weekend camp, around: - Food and Nutrition - Energy content of food - Basal metabolic yield.	The analysis of the answers shows deficiencies in aspects related to food and nutrition. The strategy favored motivation by being able to use the contents in everyday life situations.
CRAWFORD WATSON ET AL, 2009 <sup>30</sup>	To evaluate the effectiveness of a nutritional education proposal in two family consumer science courses, in terms of knowledge and eating habits.	n=75 students in grades 9-12 at a school in North Texas. Intervened group: 45 students enrolled in one of two FCS nutrition-related courses.	Quasi-experimental design. A questionnaire (pre and post-test) was applied to collect basic information on each student, their knowledge about nutrition, attitudes about the subject and eating habits. Students in the intervention group completed 18 weeks of training with daily 50-minute sessions.	*Student interest in nutrition in the experimental group increased significantly after the intervention.
ALINA ANGHEL ET AL, 2017 <sup>31</sup>	Identify teachers' perceptions about the limits that arise when implementing some learning units in primary and secondary education.	n=64 teachers for primary and secondary levels, as well as their respective portfolios of activities.	Qualitative research - case studies. Review and analysis of portfolios of teaching activities pertaining to teaching about food and health risks, according to competencies for primary and secondary education.	Of the total of ten learning units, six were implemented by all teachers at both teaching levels. The teachers consider that the role of didactic resources is essential in the fulfillment of the objectives of the lessons of education for healthy eating.

BRENOWITZ AND TUTTLE, 2003 <sup>32</sup>	- Develop and validate a scale of self-efficacy in nutrition education (NTSES) - Research the time spent on nutrition education by primary school teachers.	n= 80 practicing elementary school teachers (Preschool to 5th grade) in the state of Maryland.	Qualitative with support of quantitative data. NTSES was an instrument composed of 20 Likert type items, whose response options were between very confident (score= 4) and not at all confident (= 0). The scale was oriented towards teachers' understanding of nutrition concepts, as well as the acquisition of the necessary skills to teach the concepts effectively.	67.5% of teachers taught at least one topic of nutrition during the school year; this percentage is lower than those reported in other studies. The evidence suggests that with this minimal intervention in nutrition education, it is not possible to generate an impact in the modification of dietary habits.
BULLEN AND BENTON, 2004 <sup>33</sup>	Inquire about: - How does age affect children's food categorization? - Can such information be used to improve nutrition education?	n= 222 students from two state schools in Swansea, United Kingdom.	Qualitative with support of quantitative data. The task consisted of: - Place foods in groups, taking into account which ones should go together. - Name each of the groups formed. - List the reasons why the foods in the photographs or cards were grouped in this way.	*37% of primary school students were unable to classify all of the photographs supplied. This difficulty decreases with age; 28% for children of 14 years and 16% for students of 16 years of age. The number of groups and the number of items included in each one, varies according to age.
CHOU ET AL, 2001 <sup>34</sup>	Create an integrated and interactive network of linked virtual worlds that can be used to support the health education curriculum (formal and informal).	1 specialist in computer-assisted training. 1 human interface designer. 1 specialist doctor. 1 3D graphic designer. 1 Developer of the VRML application.	A formative evaluation was conducted to examine the effectiveness of the system and the course. In addition, an interview with the experts was used. The name of the course was: "Travelling with our food"; users had to follow the path of the food as it passed through the digestive tract, from the mouth to the anus.	The test scores indicate that the students acquired basic knowledge of the digestive system from the course, especially from 2D and 3D graphics. Virtual reality is a viable alternative as a teaching tool for those concepts that require better visualization, as in the case of human body systems.
ERCAN, 2014 <sup>35</sup>	Identify changes in academic achievement and attitudes toward the science class of fifth grade students as a result of the use of multimedia materials designed to teach healthy nutrition.	n= 66 fifth grade students from a primary school in a province in Turkey.	Quasi-experimental design. A pre and post-test, a pilot test and the final proposal were applied. As a tool for data collection, an evaluation of academic achievements was implemented, to be answered online. The intervention lasted eight weeks, for a total of 32 class hours. The user's guide included theoretical bases on food and nutrition, consolidation activities and evaluation sections.	*The multimedia applications used in the subject of healthy nutrition, help students to become aware of current problems that may affect their health.
RANKINS ET AL, 2000 <sup>36</sup>	Evaluate the effectiveness of an innovative nutrition education curriculum, based on the change in knowledge, attitudes and practices on nutrition in students.	n = 341 students belonging to the "Food Science and Consumer" course at four schools in Florida.	Quasi-experimental design with a mixed approach. A survey with 106 multiple-choice questions was applied to measure the knowledge and attitudes of the students in relation to the objectives of the curriculum called "Live!" This consisted of five units, focused on building a knowledge base for the prevention of nutrition-related chronic diseases, as well as a component on culinary skills.	*The results of the students of the four schools varied in the response to the application of the curriculum called "Live!" but in all of them, there were significant improvements in one or more of the eight categories on nutrition attitudes and knowledge.

According to the synthesis of the 24 studies included in this review, it was found that five of them based their proposal on learning constructivist approaches (Vygotskian and Ausubelian principles)<sup>13,19,23,31,34</sup>, highlighting the role of one's own experience and previous notions in the process of knowledge elaboration. The importance of significant learning was made explicit in five of the studies<sup>23,27,29,33,35</sup>, three took into account the approaches of Vygotsky<sup>19,20,36</sup>, who considered educational processes as a product of social

interaction. Five of the interventions were based on the inquiry teaching methodology which helps children ask questions and develop a better understanding of topics of interest.

It is worth mentioning that 33% of papers<sup>16,19,22,25,30,32,35,36</sup> were interested not only in imparting knowledge about nutrition, but also in prioritizing the change in attitudes and behaviors as a measure of the real impact of the intervention. The design and evaluation of these proposals were based on the cognitive component of attitude, considered as a

psychological tendency expressed through the favorable or unfavorable evaluation made on something<sup>16</sup>. The theory of planned behavior was also taken as a basis, which states that the most immediate mediator of change in behavior is intention; which in turn is influenced by attitudes toward it<sup>22</sup>. It was possible to integrate the cognitive aspect, the metacognitive and the socio-affective factors, in the construction of a proposal oriented to the motivation for regulation in one's own habits, reflected in attitude changes<sup>19</sup>.

For this reason, in addition to the main and common thematic axes such as: food groups; food security; food hygiene and handling; types of nutrients; nutritional pyramid; food labelling; nutrient deficiency and diseases; relationship between diet/nutrition and the environment; and systems involved in nutrition, emphasis was placed on healthy eating habits and the relationship between well-being and food practices, such as adequate consumption of: fats and oils, vegetables, dairy products, fruits, meat and protein, grains, micro and macro nutrients<sup>19</sup>.

In relation to the results obtained, the comparison of the pre- and post-test scores showed statistically significant differences for the intervened groups in 11 of the studies<sup>13,14,15,18,19,21,23,30,33,34,36</sup>, reporting an improvement both in knowledge about nutrition<sup>13,21,23,33</sup> and/or in attitudes towards healthy lifestyle habits<sup>19,30,35,36</sup> and in the frequency of physical activity<sup>14,15,18</sup>. An important finding was the absence of longitudinal studies confirming the permanence of these changes over time. Long-term assessments are required to determine whether this knowledge is reflected in changes in attitudes and improved health conditions<sup>18</sup>.

Some of the components of interventions assessed as effective were: experimental practices<sup>13</sup>, learning by scientific inquiry<sup>14</sup>, implementation of science and mathematics lessons in an articulated way<sup>15</sup>, use of play<sup>18,19,23</sup>, activities mediated by technological resources<sup>19,35</sup>, routines of physical activity<sup>21</sup>, elective courses (optional subjects chosen according to the student's preferences) for curriculum immersed in nutritional education<sup>30</sup>, tasks of classification and categorization of food groups<sup>33</sup>, culinary skills workshops and academic debates<sup>36</sup>. An improvement was evidenced in the cognitive aspect related to knowledge about nutrition, mainly in those proposals based on curricular integration, the use of ICT and teaching through gaming. The strategies that took into account reflection and self-monitoring, as well as the development of critical thinking skills, also showed favorable results in terms of attitudes towards healthy eating and the modification of some habits and routines.

In these studies, the proposed methodology was assessed as pertinent and favorable, the formulated objectives were met, and improvements were detected in at least one of the cognitive or behavioral components evaluated. According to the reported data, there was a moderate increase in the consumption of healthy foods and in the frequency of physical activity<sup>21</sup>.

Students also showed some changes towards the belief in the advantages changes represent for health, making good

decisions regarding food choices<sup>22</sup>, recognizing that nutrient and calorie excess is detrimental to health. In addition, there was an adequate internalization of knowledge with respect to the reading and interpretation of nutritional labels<sup>23</sup>.

The students' conceptions and difficulties with regard to food properties and healthy lifestyles were investigated in this revision<sup>17,24,29</sup>. The lack of recognition of scientific principles underlying the biological dimension of health<sup>24</sup> was highlighted, with micronutrients being the topic that represented the greatest complexity<sup>13</sup>. The topic of active compounds in food aroused the interest of both teachers and students, who consider it important to relate the presence of certain chemical constituents (vitamins, dietary fiber, iron, antioxidants) with their impact on human health<sup>31</sup>. A conceptual obstacle was detected for students who are not aware of their energy demand or how to meet it<sup>29</sup>. Furthermore, they have the notion of a food as a product processed in a factory and offered in a market, not as a derivative of nature whose function is to satisfy a person's nutritional needs<sup>17</sup>. The lack of conceptualization of nutritional aspects associated with health seems to be related to the way in which these issues are addressed in textbooks and during classes<sup>24</sup>. Coupled with the above, the time invested in nutrition education in the classroom is insufficient to result in stable changes in the knowledge, attitudes and habits associated with food<sup>25</sup>.

### Discussion and implications

In all articles reviewed there was a clear and solid justification regarding the pertinence of implementing nutritional education strategies from school, based on the need to educate children and young people on healthy eating, in line with the WHO initiative, which seeks to promote nutritional programs in schools<sup>35</sup>. One of the most important elements is to impact knowledge about nutrition<sup>13</sup> through the joint work of health professionals and school principals with teachers, in accordance with the respective standards<sup>15</sup>. Although there are education programs in sciences oriented to nutritional well-being, it is rare that teaching is linked to a multidisciplinary approach<sup>14</sup>.

Macias and collaborators<sup>4</sup> start from the problem of considering nutrition as a purely biological aspect, which limits actions aimed at improving the nutritional situation of the current population. In the proposals of the studies included in the present revision, it was evident that the integration among different subjects and school projects, allows for significant learning, as well as the application of the knowledge in everyday life situations<sup>13,14,15,22,29</sup>. Human nutrition could be associated with the transfer of energy, chemical reactions, matter, and the organization of living systems, that is, the integration of energy, environment, and health<sup>15</sup>. It was also proposed that teaching of biology (as well as other disciplines), needs to be articulated with health topics in a meaningful way for students<sup>24</sup>, and that the combination of instructional activities and living-practices can promote significant improvements in dietary habits<sup>19</sup>.

Intervention in schools on the subject of nutrition is complex, since it does not form part of the curriculum and may represent an extra burden for educational institutions, which tend to be more concerned about the performance of students on standardized tests<sup>7</sup>. That is why their approach in the school setting is still very poor despite the different measures and policies that have emerged in this regard<sup>26</sup>.

When comparing the theoretical and methodological bases of nutrition education programs for healthy eating aimed at the school community, the analyzed studies start from the premise that traditional methodologies do not tend to be very effective when it comes to influencing changes in habits associated with quality of life and food. Thus, problems persist and are related to low academic performance, poor school coexistence and lack of self-esteem among the student population. Innovative models of food and nutrition education should be developed that consider existing knowledge and consumption habits of students, parents and teachers<sup>7</sup>.

Teacher training should have a greater impact on the analysis of the importance of human nutrition on the environment and on the very concept of nutrition<sup>27</sup>. Access to current training resources is required to facilitate didactic planning and improve learners' interest in developing healthy living skills through a balanced diet<sup>31</sup>. For this reason, emphasis is placed on the need for students to understand this vital function from a multidisciplinary perspective, in which the set of theoretical knowledge is articulated with significant and motivating work experiences, in order to have a favorable impact on the daily practices and lifestyles of the student population. Although there are several studies in the literature that report variations in diet quality in terms of daily intake and improvements in physical conditions based on anthropometric measures, these proposals are not necessarily immersed in the school curriculum and may present disadvantages such as the fact that sessions become very long after students have spent most of the day in school<sup>37</sup>.

Learning science implies being able to use scientific knowledge (of and about science) in everyday life situations –also called contexts– to make responsible decisions<sup>39</sup>. In spite of the arguments in favor of nutritional education programs with a view towards integration and interdisciplinarity, in this review we found that only 17% of the studies implemented a methodology consistent with this perspective, considering nutrition from its personal and social dimension<sup>13</sup>. Thus, nutrition was articulated within the subjects of biology, microbiology, chemistry and mathematics<sup>14,15</sup>. In the treatment of this concept, natural sciences, social sciences, technology, mathematics and language were also addressed together<sup>29</sup>.

Previous reviews have investigated the basic aspects that contribute to the effectiveness of nutritional care programs in schoolchildren<sup>9,10</sup>, among which the following stand out: convenient time and intensity, family participation, multi-component strategies, appropriate teaching methods, modification of the school environment (access to healthy

food, school feeding policies, school meals), teacher training opportunities, capacity to strengthen skills and influence attitudes. Bearing in mind that one of the key factors is teaching strategies based on the acquisition of knowledge about nutrition and its impact on healthy lifestyles, it is essential to investigate what types of methodologies have been taught in recent years in order to determine how relevant and motivating they are for the student population.

Returning to the aspects synthesized by Meiklejohn et al<sup>10</sup> we found coherence between these and the studies of the present review, in terms of: the need for teacher training<sup>27,28,31,32</sup>, the participation of the family environment<sup>21,36</sup>, the immersion of programs in existing curricula<sup>13,14,15,17,22,29</sup>, the advice of leaders and specialists<sup>25,34</sup>, the use of feedback strategies<sup>19,30</sup>, the use of ICTs<sup>19,20,34,35</sup> and the incorporation of physical activity practice<sup>14,15,18,21</sup>.

As a product of this systematic review, the relevance of including as a key point (in addition to curricular integration and multicomponent strategies), the holistic treatment of human nutrition from a multidisciplinary approach among the different areas of knowledge is validated. It also clarifies the need to introduce strategies and indicators that reflect attitudes towards healthy eating and the modification of habits in the medium and long term.

Nutrition education programs that articulate the multicomponent trend of extra-curricular campaigns with appropriate teaching strategies for schools can favor significant learning. This will contribute to promoting changes in attitudes towards healthy eating among children and adolescents, since, despite the initiatives and insistence of government policies, the percentages of malnutrition conditions and their respective consequences continue to show alarming figures in different contexts. It has been postulated that the more integral and sustained the educational interventions to promote patterns of self-care and healthy lifestyles from childhood are, the more positive and lasting the effects (WHO, 2004).

This perspective validates the appropriateness of using active learning methodologies that include several strategies such as those referenced in the studies included in this review that aim both at conceptual appropriation of nutrition topics and at determining whether this knowledge is reflected in changes in attitude and better health conditions in the intervened population. It is necessary to investigate the permanence of these habits in the medium and long term, in order to fulfill the fundamental role of the educational system in the scientific understanding of the different aspects of health on the part of students and in the promotion of healthy life practices in them<sup>24</sup>.

## CONCLUSIONS

The study of human nutrition has high educational value, focusing not only on the scientific aspect of anatomy and physiology, but also on the relationship with the environment and health<sup>27</sup>. In addition, some positive changes in students' attitudes towards food consumption habits can be detected,

bearing in mind that food is an excellent teaching tool because people have previous knowledge based on their own context<sup>14</sup>. This, in turn, can be reflected in the good health of young people and in the reduction of the problems associated with overweight and obesity<sup>30</sup>. It is important to emphasize that to be successful, nutritional education must be incorporated into the school curriculum with the active participation of teachers, family members and other community professionals.

In the pedagogical and didactic approach to human nutrition, a holistic vision seems to be necessary. This can be achieved through a multidisciplinary teaching proposal that provides nutritional education from various dimensions of knowledge and allows students to be consistent in applying information acquired to their daily lives. Since little research was found in this area for our age range, future research is needed to explore the impact of an integrated approach to nutrition education at different levels of schooling<sup>13</sup>.

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