UNIVERSIDADE DE BRASÍLIA - UnB
FACULDADE DE CIÊNCIAS DA SAÚDE
DEPARTAMENTO DE NUTRIÇÃO
TRABALHO DE CONCLUSÃO DE CURSO

Nutritional interventions for adolescents using information and communication technologies (ICT): a systematic review

Aluna: *Giselle Rhaisa do Amaral e Melo*
Matrícula: *110012330*
Orientadora: *Maria Natacha Toral Bertolin*

Brasília - DF
2016

ABSTRACT

INTRODUCTION: Adolescence is considered a nutritional risk period associated with a high prevalence of inadequate dietetic habits, that if not treated, can lead to obesity and non-communicable diseases. Once the majority of adolescents in the USA have access to *Internet* and electronic devices, an interactive and low-cost way of promoting healthy nutrition behaviors is by using information and communication technologies (ICT) in interventional programs. Therefore, the **OBJECTIVE** of this systematic reviews is to identify the different technologies and likewise its main characteristics that have been used for nutritional interventions in adolescents as well as evaluate the quality and effectiveness of these studies. **METHODS:** This study followed PRISMA's guidelines and had its protocol published on PROSPERO (#CRD42016035882). Five databases (PubMed/MEDLINE, Scielo.ORG, Web of Science, PsycINFO, and Scopus) were searched to find articles written in English, Portuguese or Spanish describing nutritional interventions programs designed mainly for healthy adolescents that used ICT. MeSH terms representing ICT, nutrition, intervention, and adolescents had to be in the tittle or abstract. Randomized controlled trials, quasi-experimental, and observational studies, full papers, and original articles, published between January 2005 and January 2016 were included. Hand searches from reference lists were also performed. Study quality was assessed by the Effective Public Health Practice Project Quality Assessment Tool. Data was synthesized in a table. **RESULTS:** the search yielded 559 titles and abstracts. 44 studies went further analyses and 11 were included in this review. Participants were mostly recruited from school settings (10 of 11 studies), age varied from 9-17yo. 5 studies targeted specific populations. Study follow-up varied from 2 weeks to 2 years. 4 interventions were based on the Social Cognitive Theory. Interventions strategy included computer games, programs generating tailored feedback, text messages and interactive CD-ROM. 9 studies used computer-mediated ICT. 5 studies focused on multiple behaviors simultaneously. Participants were exposed to intervention once, daily, weekly or according to pre-determined number of lessons. 5 studies had significant outcomes. **CONCLUSION:** Nutritional interventions for adolescents using ICT shows to be more attractive. New technologies have emerged in the health care scenario. It is not simple to state the most effective interventions due to heterogeneity of studies. However, it can be suggested long-term interventions with more frequent exposure to technology resources that also have a theoretical component targeted to a single health behavior change.

KEYWORDS: Computer communication networks, Telecommunications, Adolescent, Review, Nutrition, Health Education, eHealth, Interventions.

INTRODUCTION

Adolescence is considered a nutritional risk period marked by psychological, physiological, and social changes. In this age group, the literature shows a prevalence of inadequate dietetic habits, such as high intake of sugary and processed foods, long spacing between meals, and low consumption of fruit and vegetables. The long-term effects of this consumption pattern can result in overweight issues as well as micronutrient deficiencies and non-communicable diseases (NCD), that if not treated, it can be track into adulthood [(1)].

Nutrition interventions are a cost effective way to promote health behaviors in order to reduce obesity and NCD in the teen population [(1)].

The internet and technology resources are increasingly growing among the population. Especially in adolescents, as reported by the Pew Research Center, in 2015, 92% of the American adolescents ages 13-17yo indicated to go online at least once a day. Furthermore, 88% and 87% mentioned to have access to a mobile phone and desktops, laptops or a computer daily, respectively [(2)].

A number of interventions, including those related to health promotion, have been delivered using Information and communication technologies (ICT), such as e-mails, websites, computer programs, smartphones, text messages, and games [(3)]. Thereby, the use of web-based resources in the health care scenario has allowed a more innovative and interactive way to promote behavior change, and ultimately improve positive health outcomes [(4)].

Consequently, this systematic review aimed to identify the different technologies that have been used for nutritional interventions in adolescents, likewise its main characteristics. An additional objective was to evaluate the quality and effectiveness of these studies.

METHODS

The fully protocol is available on PROSPERO Website (#CRD42016035882). The intervention followed the PRISMA's (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines [5].

Data sources and search strategy

Five databases (PubMed/MEDLINE, Scielo.ORG, Web of Science, PsycINFO, and Scopus) were searched in order to find articles written in English, Portuguese or Spanish, that promoted valuable information about nutrition education interventions that used ICT in adolescents. Several MeSH terms were applied to represent ICT, nutrition, intervention, and adolescents. *Table 1* represents the initial search designed for PubMed/MEDLINE. The search strategy was adapted to other databases.

Selection criteria

Only randomized controlled trials, quasi-experimental, and observational studies, full papers, and original articles, published between January 2005 and January 2016, were considered. The MeSH terms needed to be identify in the title or abstract. Description of the technology and/or intervention had to be available in the full papers. Participants were required to be healthy, but not necessarily eutrophic. Studies that included children above 8 years old or young adults could still be selected as long as they focused on adolescents (mean age between 10-19yo).

Selection process

The list of title and abstracts were downloaded and organized via the program *Mendeley*©. Duplicates were removed and the remaining studies were analyzed for eligibility by two reviewers (1R and 2R). The full articles selected were retrieved, subsequently. Disagreements

were resolved by discussion, in the presence of the Expert (E). Hand searches from reference lists of all included articles were performed.

Quality and risk of bias assessment

Study quality and risk of bias were assessed on study design, target population, confounders, data collection methods, dropouts, intervention integrity, and final analyses using the Effective Public Health Practice Project (EPHPP) Quality Assessment Tool, by 1R and independently. Based on final score, articles were considered weak, moderate or strong. Those considered weak were not removed, but the risk of bias of their evidence was highlighted. An expert (E) adjudicated unresolved discrepancies.

Data collection process and synthesis

Reviewers 1R and 2R developed a data collection form based on the Centre for Reviews and Dissemination guidance for undertaking reviews in health care [(6)]. Independently, they extracted the data on type of publication, country, financial sources, main purpose, study design, inclusion/exclusion criteria, recruitment procedures, unit of allocation, participant characteristics (age, gender, ethnicity, social economic status/education, weight status and comorbidities), intervention characteristics (type, frequency/duration of exposure and theoretical basis), and outcomes (follow-up, dropout rate, type of analysis, main and additional outcomes). Due to the lack of homogeneity of the included studies, a meta-analysis could not be performed. Data was then synthesized in a summarization table.

Table 1: *Search strategy designed for PubMed/MEDLINE*

DATABASE	**PubMed/MEDLINE**
DATE	**02/01/2016**

STRATEGY	#1 AND #2 AND #3 AND #4
#1	(adolescent OR adolescents OR adolescence OR teen OR teens OR teenager OR teenagers OR youth OR youths [MeSH Major Topic])
#2	telecommunications OR "electronic Mail" OR email OR E-mail OR telemedicine OR "mobile health" OR mhealth OR mhealths OR telehealth OR ehealth OR telephone OR telephones OR "cell phones" OR "cellular phone" OR "cellular phones" OR smartphone OR smartphones OR "smart phones" OR "mobile phone" OR "mobile phones" OR "text messaging" OR "texting" OR "short message service" OR "text messages" OR "text message" OR television OR "videodisc recording" OR videoconferencing OR videoconference OR videoconferences OR "webcast as topic" OR "streaming video as topic" OR "podcasts as topic" OR "podcasts as topics" OR "wireless technology" OR "wireless technologies" OR computer OR "digital computer" OR "digital computers" OR minicomputer OR "computer communication networks" OR "computer communication network" OR "distributed database" OR "distributed databases" OR "telecommunication networks" OR "telecommunication network" OR internet OR internets OR "world wide web"

	OR “twitter messaging” OR blogging OR blog OR blogs OR “social media” OR “social medium” OR “social mediums” OR “web 2.0” OR “local area networks” OR lan OR “satellite communications” OR “satellite communication” OR “satellite telecommunication” OR multimedia OR “handheld computer” OR “handheld computers” OR “pocket pc” OR “pocket pcs” OR “palmtop computer” OR “palmtop computers” OR “palm-top computer” OR “palm-top computers” OR “personal digital assistant” OR “pda computer” OR “pda computers” [MeSH Major Topic])
#3	(“intervention studies” OR “ intervention study” OR education OR workshops OR workshop OR “training program” OR “training programs” OR “educational activities” OR “health education” [MeSH Terms])
#4	(diet OR diets OR food OR “food consumption” OR “food habit” OR “food habits” OR "feeding behavior" OR "feeding behaviors" OR "feeding behaviour" OR "feeding behaviours" OR "dietary pattern" OR "dietary patterns" OR “diet pattern” OR “diet patterns” OR "eating pattern" OR "eating patterns" OR "dietary behavior" OR "dietary behaviors" OR "dietary behaviour" OR "dietary behaviours" OR "feeding pattern" OR

	"feeding patterns" OR "eating behavior" OR "eating behaviors" OR "eating behaviour" OR "eating behaviours" OR “nutritional status” OR “nutritional sciences” OR dietetics [MeSH Major Topic])

RESULTS

The search yielded 559 titles and abstracts. Once they were screened, 44 studies went under further analyses. Eleven studies fully met the inclusion criteria as well as one additional study that was found by hand searches from the reference lists. *Figure 1* describes in details the selection process of included studies. The quality assessment revealed three strong studies [9,10,12], five considered moderate [11,13,14,15,16], and also three rated as weak [7,8,17]. The studies which had a negative EPHPP tool’s evaluation were due to a non-representativeness of the sample and usage of a non-validated questionnaire.

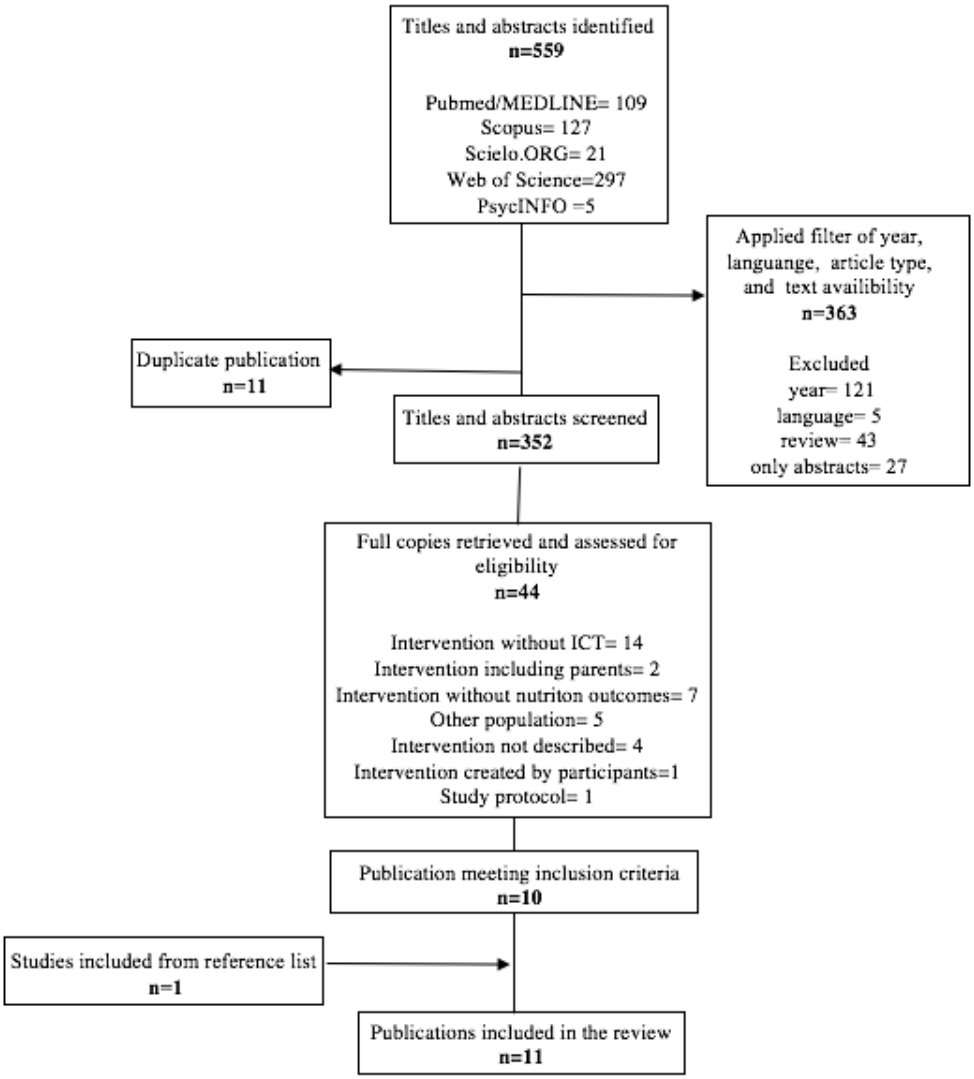

Figure 1: Completed selection process of included studies

Population

Participants were mostly recruited from school settings [7,8,9,10,11,12,13,14,16,17], with the exception of one study that recruited boy scout troops [15]. Age range varied from 9 to 17 years, with four studies focusing on 12 to 14 years old [8,9,10,11], four including older ones (15 to 17 years old) [12,13,16,17], and three had younger ones [7,14,15]. Five interventions targeted specific populations such as low-income groups, ethnic minorities, and minority females or males [11,13,14,15,17].

Study design

Sample sizes ranged from 87 to 1298 participants, and three studies had over 800 adolescents [9,12,13]. Of the eleven interventions, two were randomized controlled trials [8,11], five were cluster randomized controlled trials [10,12,14,16,17], and four used a quasi-experimental design [7,9,13,15].

Follow-up and study duration

The majority of studies had one follow-up after baseline assessment [7,8,10,11,13,14,17], but four had two follow-up measurements [9,12,15,16]. Study duration (last follow-up assessment) varied from 2 to 8 weeks [7,14,17], 3 to 4 months [8,10,12,13], 6 months and 1 to 2 years [9,11]. Seventy-five percent of studies that had a follow up over six months did not have results maintained later [9,15,16],

Theoretical basis

Four interventions used the Social Cognitive Theory as theoretical basis, either used it alone [11,15] or in a combination with the Theory of Reasoned Action [14] or the Theory of Planned Behavior [10]. Two studies based its interventions on principles from the Social learning theory, which supports the role of social and affective elements in behavior change, including the adoption of healthy behaviors [16,17].

Intervention strategies and variables measured

Four interventions included computer games [7,14,15,17], four were computer programs that generated tailored feedback/advice [9,12,13,16], two used text messages [8,11] and one used an interactive CD-ROM [10]. Altogether, nine of eleven studies used a computer-mediated intervention, either a program, website, game or an email tailored feedback [7,9,10,12,13,14,15,16,17]. Merely, two studies dealt with smartphone [8,11]; however, only one of them used exclusively this type of technology [11]. Six of the eleven interventions investigated dietary intakes of multiple food groups and nutrients simultaneously [9,12,13,14,16,17], whereas two focused only on

fruits and vegetables [8,15], and the remaining evaluated either just dietary fat intake [10], total calories per day [11] or nutritional knowledge [7]. Components such as physical activity [11,12,14], psychological variables [13] and psychosocial factors [14,15] were also incorporated or evaluated in some of the interventions.

Intervention duration and frequency of exposure

Duration and frequency of exposure to intervention varied widely. In two studies participants were exposed to intervention once [10,13], whereas other programs had daily [8] or weekly activities [7,11,14,15,17], and some did not have a specific time of exposure to intervention but established a number of lessons to be done within one to three months. [9,12,16].

Main outcomes

Five interventions had positive effects on diet that were statistically different from baseline measurements and/or comparison group [9,14,15,16,17]. *Ezendam et al. (2012)* found an increased intake of vegetables and a decrease in snack and sugar sweetened beverages after 4 months, but these findings were not maintained after 2 years. A lower sugar consumption was also shown by *Sharma et al. (2015)* and *Whittemore et al (2012)*, whose intervention also resulted in a decrease in junk food intake associated with an increase in vegetable and fruit consumption. *Thompson et al. (2009)* found that boy scout troops had significant increases in fruit juice consumption and home availability immediately after intervention, but this was not maintained later. *Bech-Larsen & Gronhoj (2013)* also found a significant increase in fruit and vegetable consumption, but only for students who had a low intake of these food groups at baseline. *Ress et al. (2010)* did not show statistically positive effects of the intervention for fruits and vegetables, but did show an increase of brown bread servings in the experimental group. *Yang et al. (2015)* who evaluated the effects of a team-based approach, showed significant positive improvements in dietary behaviors of most food groups (dairy, meats, fruits

and vegetables), as well as an increase in the consumption of fiber, calcium and vitamin C and B2, not only compared to baseline measurements, but also in comparison to the other experimental group who had a more individualized intervention rather than a group interaction. *Haerens et al. (2007)* did not detect effects of the intervention for its study whole sample, although a decrease in fat consumption was observed in girls from technical-vocational schools and in both girls and boys from general schools. *Maes et al. (2011)* reported an increase in fat intake over time in the control group; however, fat intake in the intervention group remained stable. Related to nutritional knowledge, *Banos et al. (2012)* found a significant increase for both groups, although a higher score was observed for the intervention students.

Table 2: Main characteristics of included studies

Study	***Objectives of the study***	***Study design***	***Participants characteristics***	***Intervention x Control***	***Variables measured***	***Duration, frequency of exposure and follow-up***	***Theoretical basis***	***Main results***
Baños et al., 2012 (7)	Efficacy for improving nutritional information and evaluate acceptability and playability of the games.	Quasi-experimental design	Number: 228 Age: 10-13 Gender: Boys and girls	**Intervention**: ETIOBEmates, educational website including games **Control**: Paper-pencil intervention	Nutritional knowledge	**Duration**: 2 weeks **Frequency**: "as much as they wanted" **Follow-up**: after 2 weeks	Not informed	Improved nutritional knowledge for both groups. Scores were greater in the intervention group.
Bech-Larsen & Grønhøj, 2013 (8)	Increase the comsumption of fruits and vegetables	Randomized controlled trial	Number: 256 Age: 12 Gender: Boys and girls	**Intervention**: SMS-based diary and feedback system plus nutrition education **Control**: Nutrition education only	Achievement of consumption goals for fruits and vegetables	**Duration**: 4 weeks **Frequency**: daily messages **Follow-up**: after 15 weeks	Not informed	Increased frequency of fruits and vegetables consumption only for those with a low pre-intervention intake.
Ezendam et al., 2012 (9)	Help prevent weight gain in girls by	Cluster randomized	Number: 883 Age: 12-13	**Intervention:** FATaintPHAT, web-	Consumption of SSB, snacks, fruits, and vegetables	**Duration**: 10 weeks	Theory of Planned Behavior	Higher vegetables intake and lower snack

	improving dietary behaviors and physical activity, and reducing sedentary behavior	controlled trial	Gender: Boys and girls	based computer programme -tailored intervention **Control**: No-intervention control group		**Frequency**: 8 lessons **Follow-up**: after 4 months and 2 years		and SSB consumption.
Haerens et al., 2007 (10)	Evaluate the acceptability, feasibility and effectiveness of a computer-tailored education program	Randomized controlled trial	Number: 333 Age: 12-14 Gender: Boys and girls	**Intervention**: Computer-tailored dietary fat intake intervention, provided as an interactive CD-ROM. **Control**: No-intervention control group	Dietary fat intake	**Duration**: 50 minutes **Frequency**: 1 session **Follow-up**: after 3 months	Social Cognitive theory, Theory of Planned behavior, and transtheoretical model	Decreased dietary fat intake in girls enrolled in technical-vocational schools; and those in general education who reported reading intervention messages.
Lubans et al., 2012 (11)	Evaluate the impact of a school-based obesity prevention program for girls	Cluster randomized controlled trial	Number: 357 Age: 12-14 Gender: Girls only	**Intervention**: NEAT Girls, multi-component school-based intervention program, including text messages, nutrition workshops, interactive seminars, handbooks, and sports sessions. **Control**: No-intervention control group	BMI, BF%, dietary intake (kcal/day)	**Duration**: 12 months **Frequency**: weekly messages **Follow-up**: after 12 months	Social Cognitive Theory	Body composition changes were higher in the intervention group, but not statistically significant.
Maes et al., 2011 (12)	Investigate the feasibility and impact of an Internet-based computer-tailored nutrition intervention	Quasi-experimental design	Number: 1298 Age: 12-17 Gender: Boys and girls	**Intervention**: Food-O-Meter, composed of a FFQ, food composition database, and a decision tree for generating individualis	Dietary intake of fiber, vitamin C, calcium, iron, fat and beverages	**Duration**: During school hours **Frequency**: 3 sessions **Follow-up**: after 1 and 3 months	Not informed	No significant changes in fat intake for the intervention group

				ed advice for improving dietary intake of target nutrients (fiber, vitamin C, calcium, iron and fat) **Control**: Generic standard advice in text format covering similar topics				
Rees et al., 2010 (13)	Evaluate the effectiveness of a computer-generated tailored intervention versus a generic leaflet to increase intakes of brown bread, wholegrain cereal, fruits and vegetables	Cluster randomized controlled trial	Number: 823 Age: 12-16 Gender: Girls only	**Intervention**: Computer-tailored intervention, based on individual's self-reported intake of target foods and psychological questionnaire **Control**: Generic leaflet based on National Guidelines (not tailored)	Dietary intakes of brown bread, wholegrain cereal, fruits and vegetables	**Frequency**: 1 session **Follow-up**: after 3 months	Theory of Planned Behavior, and The Transtheoretical Model	The tailored intervention leaflet had a significant effect on whole bread intake, but there were no significant effects for other foods.
Sharma et al., 2015 (14)	Evaluate the feasibility, acceptability, and effects of a computer game on dietary behaviors, physical activity behaviors, and psychosocial factors	Quasi-experimental design	Number: 107 Age: 9-11 Gender: Boys and girls from public schools	**Intervention**: Quest to Lava Mountain (QTLM), a game in which players must create an avatar and make it eat healthy and stay active; and complete a series of progressive	Dietary intake of fruits, vegetables, fiber, fat, and sugars.	**Duration**: 6 weeks **Frequency**: 90 minutes per week **Follow-up**: after 6 weeks	Social Cognitive Theory and the Theory of Reasoned Action	The intervention group had lower sugar consumption and improved nutrition and physical activity attitudes post intervention compared to the control group.

				gaming challenges. **Control**: No-intervention control group				
Thompson et al., 2009 (15)	Evaluate the effects of a Boy Scout Five-A-Day Badge program on fruit juice (FJ) and low-fat vegetable (LV) consumption	Cluster randomized controlled trial	Number: 473 Age: 10-14 Gender: Boys only	**Intervention**: Troop and internet (website) intervention to increase fruit juice (FJ) and low-fat vegetable (LV) consumption – online activities (knowledge games, web recipes, goal setting, problem solving) **Control**: Mirror-image intervention to increase physical activity	Fruit juice (FJ) and low-fat vegetable (LV) consumption	**Duration**: 9 weeks **Frequency**: 55 minutes per week **Follow-up**: after 9 weeks and 6 months	Social Cognitive Theory	Significant increases in FJ consumption, FJ home availability, and LV self-efficacy in the intervention group immediately following the intervention but were not maintained 6 months later.
Whittemore et al., 2012 (16)	Compare the effectiveness of two school-based internet obesity prevention programs	Cluster randomized controlled trial	Number: 604 Age: 14-16 Gender: Boys and girls	**Intervention**: Two experimental groups: (1) Health-e-Teen, program including lessons (nutrition, physical activity, metabolism and portion control), self-monitoring, health coaching, and social networking. (2)Health-e-Teen + coping skills training (addition of 4 lessons on	BMI; frequency of eating fruits and vegetables, breakfast, sugar drinks, fast food, junk food	**Frequency**: 8 or 12 lessons **Follow-up**: after 3 and 6 months	Social learning theory	Both groups significantly improved health behaviors including self-efficacy, healthy eating, fruit and vegetable intake, moderate and vigorous exercise, and stretching exercises; decreases in consumption of SSB and junk food, and decreased sedentary behavior.

				coping skills) **Control**: No-intervention control group				
Yang et al., 2015. (17)	Improve intake of food groups and nutritional elements using technology-enhanced game-based team learning	Quasi-experimental design	Number: 87 Age: 15-16 Gender: Girls only	**Intervention**: Two experimental groups (E1 and E2): E1, use of CDAS for self-monitoring and metacognitive strategies; E2, CDAS was also used as an online team-based competitive game **Control**: Traditional lecture-based instruction plus motivational elements (video clips related to healthy eating)	Dietary intake of food groups, macronutrients, and micronutrients	**Duration**: 8 weeks **Frequency**: 50 minutes per week **Follow-up**: after 8 weeks	Social-interdependence theory/ social learning	E2 improved dietary behaviors of most food groups (dairy, meats, proteins, vegetables and fruits), macronutrients (calories and fiber), and micronutrients (calcium, vitamin C and B2). Improvements were greater in E2 compared to the other two groups.

SSB, Sugar-sweetened beverages; FFQ, Food Frequency Questionnaire; BMI, Body Mass Index; CDAS, Cloud Diet Assessment System.

DISCUSSION

Eleven studies were systematically reviewed. All of them used an ICT-based intervention designed mainly for adolescents. This review is different from others for presenting studies that included all types of technology within the scope of nutrition, not focusing only on weight status or obesity. Besides, the main objective of this review is the intervention, particularly, the trends of ICT used for teens in the last 10 years; therefore, the description of its effectiveness is only a consequence. This fact can allow researchers to design innovative interventions so that the scientific community can experience a greater

understanding about those programs for youth, allowing a wide range of technology's efficiency to be tested.

The majority of studies recruited individuals from schools' facilities. According to *Hoelsher et al. (2002)*, this can be positive for providing a continuous contact with the participants, in addition to promoting a more cost effective way of research.

Only one of those studies whose population were minorities did not present at least one significant outcome in the intervention group compared to control group post-intervention. Ricci-Cabello et al. (2014) and Nierkens et al. (2013) concluded that educational programs targeted to minorities can be more effective; however, this fact can be easily influenced by the design, duration of intervention and follow up, as well as sample size. Extra research, including more homogeneous nutritional studies, need to further explored.

Both studies which exposed participants once or daily presented immediate significant results. Nonetheless, the long-term effects of the interventions were not maintained later in studies with a lower frequency of exposure. It can be seen continuous interventions are needed for outcomes be tracked into adulthood. These findings are consistent with *Norman et al. (2007)* and *Shaya et al. (2008)*.

Social Cognitive Theory was the predominant theoretical basis. Although all of the studies using this theoretical framework showed immediate post-intervention significant outcomes, it cannot be stated if it is a result of this particular theory. Health behavior change is complex and involves social, emotional and cognitive determinants that ultimately influence on how people adopt certain eating behaviors. These theories and models focus on understanding how such determinants influence health behaviors in order to guide future interventions. These theories tend to use different constructs and are often used in combination. It can be suggested that the use of more than one type of health behavior theory or model can

potentially be beneficial to promote healthy eating, because different elements are taking into consideration [20].

Related to intervention strategies, only one of them used a CD-ROM, showing new types of ICTs, for example games, are emerging in the health care scenario. In this systematic review, all interventions using games showed to be effective; this fact can be explained by the entertaining way of promoting educative learning so that is extremely appealing to the youth population [7]. The exclusively smartphone-based study had positive outcomes, but the quality assessed was rated as weak, showing a gap for future research. For the success of the intervention, it is crucial an identification of the type of technology most present in the routine of adolescents, once it can facilitate the availability of the information since the device is already a part of the adolescent's environment [7].

Most interventions reported being effective for promoting a variety of health benefits related to nutrition. It seems that studies targeting a single behavior, such as those focused on fruit and vegetable consumption, had better outcomes after the intervention. Although this evidence is questionable due to moderate and weak studies qualities as well as short duration of follow-up and small sample size, it is in accordance with *Norman et al. (2007)*.

This systematic review found a number of heterogeneous studies, making data difficult to be simply synthesized. For a better scientific insight, experimental studies need to be done isolating the ICT component, in a strong-evidence design. Based on *Whiteley et al. (2008),* a greater understanding only can be achieved once future research address randomization, representativeness of the population, and sufficient length of duration and follow-up of the intervention.

IMPLICATION AND CONTRIBUTIONS

The advantages of nutritional education programs for adolescents using technologies have been evidenced. This method of delivery information has the benefit of being interactive and

attractive to youth. Once new types of ICT are emerging, results of intervention studies are basically preliminary. Heterogeneity of studies makes it hard to state what kind of intervention is more effective; however, we can suggest that long-term interventions with more frequent exposure to technology resources that also have a theoretical component targeted to a single health behavior change can potentially improve nutrition behaviors.

FUNDING SOURCES AND CONFLICT OF INTERESTS

No funds were received for the development of this systematic review. All authors declare there is no conflict of interests.

REFERENCES

1. Hoelsher, D.M, Evans, A., Parcel, G.S., Kelder, S.H. (2002). Designing effective nutrition interventions for adolescents. American Dietetic Association , 102 (3), S52-S63 .
2. Lenhart, A. (2015). Retrieved from Pew Research Center's Teens Relationship Surveys, Sept. 25- Oct. 9, 2014 and Feb. 10- Mar.16, 2015: http://www.pewinternet.org/2015/04/09/a-majority-of-american-teens-report-access-to-a-computer-game-console-smartphone-and-a-tablet/
3. Webb, T., Joseph, J., Yardley, L., Michie, S. (2010). Using the Internet to Promote Health Behavior Change: A Systematic Review and Meta-analysis of the Impact of Theoretical Basis, Use of Behavior Change Techniques, and Mode of Delivery on Efficacy. J Med Internet Res;12(1):e4. DOI: 10.2196/jmir.1376.
4. Wantland, DJ, Portillo, CJ, Holzemer, WL, Slaughter, R, McGhee, EM. (2004). The Effectiveness of Web-Based vs. Non-Web-Based Interventions: A Meta-Analysis of Behavioral Change Outcomes. J Med Internet Res; 6(4):e40. DOI: 10.2196/jmir.6.4.e40.
5. Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group. (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement.
6. Centre for Reviews and Dissemination. (2008). CRD's guidance for undertaking reviews in health care.
7. Banos, RM, Cebolla, A., Oliver, E., Alcaniz, M. and Botella, C. (2012). Efficacy and acceptability of an Internet platform to improve the learning of nutritional knowledge in children: the ETIOBE mates. Health education research, Vol.28, no.2, pages 234–248.
8. Bech-Larsen, T. and Grønhøj, A. (2013). Promoting healthy eating to children: a text message (SMS) feedback approach. International Journal of Consumer Studies, 37, 250–256.
9. Ezendam NP, Brug J, Oenema A. (2012). Evaluation of the web-based computer-tailored FATaintPHAT intervention to promote energy balance among ad- olescents: Results from a school cluster randomized trial. Arch Pediatr Adolesc Med;166:248e55.

10. Haerens L, Deforche B, Maes L, et al. (2007). A computer-tailored dietary fat intake intervention for adolescents: Results of a randomized controlled trial. Ann Behav Med;34:253e62.

11. Lubans DR, Morgan FJ, Okely AD, Dewar D, Collins CE, Batterham M, Callister R, Plotnikoff RC. (2012). Preventing Obesity Among Adolescent Girls One-Year Outcomes of the Nutrition and Enjoyable Activity for Teen Girls (NEAT Girls) Cluster Randomized Controlled Trial. Arch Pediatr Adolesc Med;166(9):821-827. doi:10.1001/archpediatrics.2012.41.

12. Maes L, Cook TL, Ottovaere C, et al. (2011). Pilot evaluation of the HELENA (healthy lifestyle in Europe by nutrition in adolescence) food-O-meter, a computer- tailored nutrition advice for adolescents: A study in six European cities. Public Health Nutr;14:1292e302.

13. Rees G, Bakhshi S, Surujlal-Harry A, et al. Rees G, Bakhshi S, Surujlal-Harry A, et al. (2010). A computerised tailored intervention for increasing intakes of fruit, vegetables, brown bread and wholegrain cereals in adolescent girls. Public Health Nutr;13:1271e8.

14. Sharma SV, Shegog R, Chow J, et al. (2015). Effects of the *Quest to Lava Mountain* Computer Game on Dietary and Physical Activity Behaviors of Elementary School Children: A Pilot Group-Randomized Controlled Trial. J Acad Nutr Diet.;115:1260e71

15. Thompson D, Baranowski T, Baranowski J, et al. (2009). Boy Scout 5-a-Day Badge: Outcome results of a troop and Internet intervention. Prev Med. ;49:518e26.

16. Whittemore R, Jeon S, Grey M. (2013). An internet obesity prevention program for adolescents. J Adolesc Health;52:439e47.

17. Yang YC, Wang C, Tsai M, Wang J. (2015). Technology-enhanced game-based team learning for improving intake of food groups and nutritional elements. Computers & Education, 88, 143e159.

18. Ricci-Cabello I, et al. (2014). Characteristics and effectiveness of diabetes self-management educational programs targeted to racial/ethnic minority groups: a systematic review, meta-analysis and meta-regression. BMC Endocrine Disorders, 14, 60.

19. Nierkens V,et al. (2013). Effectiveness of Cultural Adaptations of Interventions Aimed at Smoking Cessation, Diet, and/or Physical Activity in Ethnic Minorities. A Systematic Review. PLOS ONE, v8, n 10.

20. Norman GJ, Zabinski MF, Adams MA, Rosenberg DE, Yaroch AL, Atienza AA. (2007). A Review of eHealth Interventions for Physical Activity and Dietary Behavior Change. Am J Prev Med;33. doi:10.1016/j.amepre.2007.05.007.

21. Shaya FT, Flores D, Gbarayor CM and Wang J. (2008). School-Based Obesity Interventions: A Literature Review. Journal of School Health, 78, 4, 189-196.

22. Ajie, WN and Chapman-Novakofski, KM. (2013). Impact of Computer-Mediated, Obesity-Related Nutrition Education Interventions for Adolescents: A Systematic Review. Journal of Adolescent Health, 54, 631-645.

23. Whiteley JA, Bailey BW, McInnis KJ. (2008). State of the art reviews: Using the internet to promote physical activity and healthy eating in youth. Am J Lifestyle Med;2:159e77.