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Review Article

Global Assessing Quality of Nutrition in Boarding Schools: A Review

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ABSTRACT

In general, results of studies show that the nutritional status of boarding schools is unsatisfactory. Since adolescence is one of the most critical periods of growth, nutrition plays important roles in personal, social and mental health of the adolescents. Furthermore, results of studies from this review show that the intake of calorie and nutrients in most boarding school students is inadequate, especially in less developed countries. Therefore, interventions such as allocating further food budgets, using fortified foods, participating charities in providing foods and other requirements and using essential supplements such as vitamin D, iron and calcium should be carried out for these school students.

Keywords: Nutrition, Boarding School, Food, Adolescent, Iran

Introduction

Human nutrition refers to the provision of essential nutrients necessary to support human life and health. Inadequate nutrition is a chronic problem caused by poor nutrition and poverty. Lack of appropriate nutrition results in decreased academic performances, lower grades and possibly lower student achievements as well as poor economies (1). Energy and nutrient intakes are important variables, especially during adolescence, indicating the fact that adolescence is a period of transition from childhood to adulthood. Therefore, energy needs and body compositions are important factors that should be addressed when drafting health and nutrition policies for adolescents (2). In schools, especially boarding schools, the food menu should ensure adequate intakes of macro and micronutrients. Food services of boarding schools play important roles in practical education of adolescents and can promote balanced and varied diet based on the recommendations (3). Results of studies in various countries show that energy intakes and micronutrients in boarding school students are less than requirements, which have led to protein-energy malnutrition and micronutrient deficiencies. In a study in two boarding schools for girls (12–17 years old) in South Africa, 51% of the girls showed anemia; of which, 24% showed iron deficiency anemia (4). A study on the nutritional status in Croatian boarding schools reported that intakes of micronutrients in girls and boys in the age group of 15–19 years were lower than the desired intakes (5). In comparative studies between boarding and non-boarding students, energy and calcium intakes in the two groups were insufficient (6). Results of a study in India demonstrated that protein-energy malnutrition was 8.9% and anemia was 46.7% in girls and 37.3% in boys (7). A study in five boarding schools in New Guinea on statuses of vitamin B1 in girls and boys showed that vitamin B1 deficiency was present in the two sexes from severe to marginal and this deficiency in Girls was more severe (8). Furthermore, studies have been carried out on nutritional statuses of public and private boarding schools. In one of these studies, it was shown that although the number of meals in private boarding schools was higher, consumption of essential foods such as fruits, milks, vegetables and meats were inadequate in private and public schools. It is noteworthy that prevalence of poor nutrition in private schools was higher (9). Due to the unfavorable results of the nutritional status in boarding schools and the lack of review articles in this area, this review was prepared to review studies published in the last 20 years and expressing their strengths and weaknesses as well as providing executive strategies to improve the nutritional status of boarding schools.

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Methods

The aim of this study was to investigate nutritional statuses of boarding schools. This review was prepared to analyze the existing studies in this field by searching scientific databases such as PubMed, Scopus and Google Scholar. Furthermore, the aim of the study was to review articles published between 2000 and August 2020, using the following key phrases in the titles of the articles: boarding school, boarding school and assessment, boarding school and survey, boarding school and nutrition, boarding school and intake, boarding school and nutritive, primary and secondary boarding schools, boarding schools and food security, and boarding schools and food. Thematic relevance of the studies was assessed by reviewing titles and abstracts of the articles. Only articles in English language were used in this review. Out of 60 articles, 20 articles were removed from the study due to the lack of thematic relevance, ten articles were removed due to their non-English language, five articles were removed due to the lack of access to their whole text and 13 articles were removed because of repetitiveness. In total, 12 articles were analyzed in this review (Fig. 1).

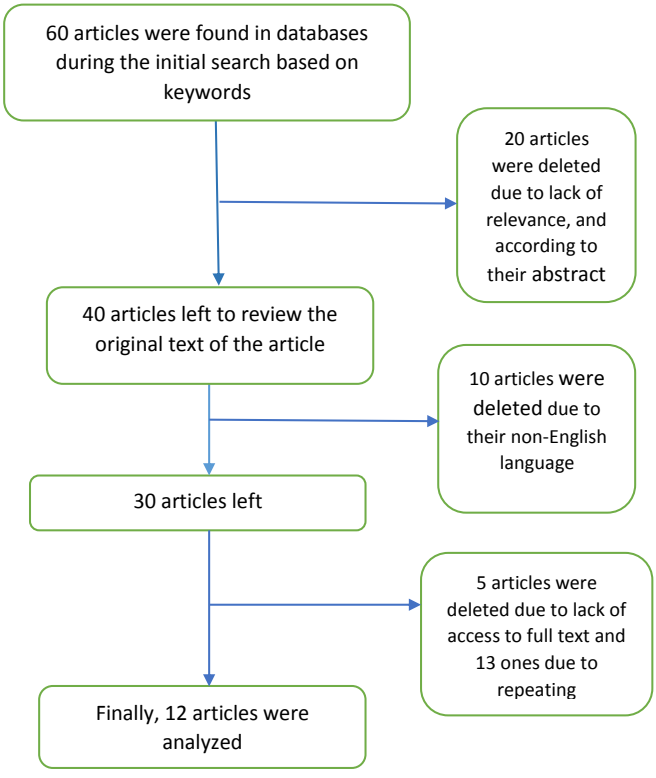

Figure 1. Flow chart showing the process of screening and selecting appropriate articles in this study

Results

The 12 studies were divided into three major groups based on their approaches. The first group included studies that assessed only the nutritional status of boarding schools. These studies included studies of Luo et al. (2007), Ogechi (2012), Ogechi et al. (2007), Kljusuric et al. (19997–1998), Gajdos et al (2001), Kljusuric (2004) and Nicholaus et al. (2019). The second group included studies that compared the nutritional status of boarding with usual schools, including studies of Chen et al. (2009), Dzifa et al. (2013), Bolajoko et al. (2014) and Ekanah et al. (2017). The third group, including only one study, was on attitudes of the catering principals or chefs of boarding schools by Serrem et al. (2019). Results are summarized in Table 1.

Results were analyzed based on whether the studies carried out in boarding schools or included comparisons between boarding and usual schools. First, studies carried out in boarding schools were analyzed. Results of Luo et al. study in a Chinese province in 2007 on 2014 students in ten boarding schools using a questionnaire on nutrition and energy consumption from various sources showed that nearly 16% of the students had one meal with pork, beef, mutton or chicken and only nearly 10% of them had at least one egg in their past three days. It is noteworthy that the major source of protein in schools was tofu made from soybeans; therefore, nearly 36% of those students consumed one or more meals with tofu in their past three days (10). A study of energy intake in 416 male and female students aged 11–18 years in six secondary schools by Ogechi (2012) in Nigeria reported that more than 80% of the energy at those schools were generated from carbohydrates. This study on food menus carried out within seven days showed that energy and fat consumptions by girls were less than those by boys, based on the recommended levels. Nutrient intakes were higher in boys but energy and fat intakes were lower in the two sexes, compared to the recommended values for their age groups. Similarly, protein intake was less than that of recommended values. However, the two sexes included high carbohydrate intakes, which were significantly higher in boys with that age range. It is noteworthy that the assessment of food menus revealed that the pattern of food consumption was not diverse in terms of food type and consumption frequency. The main dishes included garri, foofoo (*Manihot esculanta*), rice (*Oryza sativa*) and yam (*Dioscorea rotundata*) with stews or soups for lunch and dinner. Breakfast included bread and tea, bean pudding with popcorns and bean cakes with popcorns or beans. In two girl schools, breakfast included an egg twice a week. Lack of fruits in their menus was significant (2).

Table 1. Studies assessing nutritional statuses of boarding schools

Author(s)	Design	Country	sample size	Age/sex	Year	Evaluation	Result
Luo et al.(10)	randomized-stratified Sampling	China	2014	girl and boy/ 7-12 years	2007	questions on nutrition and energy intake	About 16 percent of students ate only one meal of pork, beef, mutton or chicken, and about 10 percent ate at least one meal of eggs in the past three days. It should be noted that the main source of protein received in these schools was tofu.
Ogechi (2)	cross sectional	Nigeria	416	girl and boy/ 11-18 years	2012	A 7-day course with food analysis of food menus	The energy and fat intake of girls was less than that recommended for boys. Nutrient intake in boys was higher than in girls and energy and fat intakes were lower than recommended for both sexes. Protein intake was lower than recommended, but both sexes consumed more carbohydrates. The pattern of food consumption was not different in terms of type of food and frequency of consumption and there was no fruit in the menus.
Ogechi et al.(11)	cross sectional	Nigeria	190	girl and boy/ 15-18 years	2007	Gathering nutritional information over 3 days (two normal days and one weekend)	Fat, carbohydrate, and energy intake were significantly higher in boys than girls, but protein intake was inadequate in both sexes, and malnutrition was reported to be higher among girls than boys.
Kljusuric et al.(12)	cross sectional	Croatia	1117	girl and boy/ 15-19 years	1997-1998	Within 7 days and by random sampling of each meal and completing a self-assessment questionnaire	Providing extra energy and fat to female students and too extra nutrients to both sexes was more than needed. In all schools, fat and protein intake was more than recommended, while carbohydrate intake was less than recommended. Regardless of gender, deficiencies of calcium, magnesium, phosphorus and zinc, and vitamins B1 and B6 were reported.
Kljusuric et al.(13)	cross sectional	Zagreb	1117	girl and boy/ 14-18 years	1997-2001	self-administrated food frequency questionnaire Meal analysis	Daily energy intake was higher than recommended. 15% of boys and 30% of girls received carbohydrates and fats that were not in accordance with the RDA, but protein intake was within the recommended range. The dietary calcium intake of girls was insufficient but boys were in accordance with the recommendations. According to the study, iron intake was so high that it was 50 percent higher in girls and 150 percent higher in boys than the RDA due to eating red meat with vegetables with high vitamin C content.
Kljusuric et al.(5)	cross sectional	Zagreb	1260	girl and boy/ 14-18 years	2004	A 7-day period using random sampling of three food items and self-assessment questionnaire and food frequency questionnaire were used.	The amount of energy from snacks was higher than that of 1997 survey, but the amount of vitamins and nutrients was less. Although in this study, the intake of protein, fat and carbohydrates was reported to be more than the recommended requirement, but in the 1997 study, the intake of fat and protein exceeded the recommended amounts, but the intake of carbohydrates was less than the recommended requirement. A significant percent of students consumed inadequate or any milk, fruits and vegetables.
Nicholaus et al.(14)	cross-sectional	Kilimanjaro	164	girl and boy/16-19 years	2019	24 hour recall and food frequency questionnaire	The average energy consumption of vitamin C, iron, calcium and zinc were 1392 kcal, 24.8 mg, 9.2 mg, 134.5 mg and 4.3 mg, respectively, which were less than the recommended daily requirements. Also, the average consumption of carbohydrates, fats and proteins were 471.9 grams, 73.7 grams and 80.7 grams, respectively, which were slightly more than the required daily recommendations in both sexes. In general, the boarding school diet is undiversified and inadequate in terms of key micronutrients such as iron, calcium, vitamin C and zinc.
Chen et al.(15)	cross-sectional	china	7600	girl and boy/7-12 years	2009	questionnaire personal information	Daily intake of iron in both types of schools was less than recommended, which had led to anemia in some students in those schools. Also, the low variety of diets and consumption of carbohydrate-rich foods compared to protein-rich foods was significant. There was also a significant difference in the overall diet pattern between day and night and just day students.

Author(s)	Design	Country	sample size	Age/sex	Year	Evaluation	Result
Bolajoko et al.(16)	cross-sectional	Nigeria	200	girl and boy/13-18 years	2014	24 hour recall	Protein and energy intake was 123% and 98% of RDA, respectively. There was no significant difference in energy intake between boarding and day school students. But vitamin B6, E, A, B9, C and calcium intake were 38%, 21%, 62%, 55%, 23% and 43% lower than RDA, respectively, while iron intake was 127% higher than RDA. However, there was no significant difference in the amount of energy consumption in boarding school students and their energy consumption was sufficient.
Intiful et al.(6)	cross-sectional	Accra	124	girl and boy/ 8-10 years	2013	24 hour recall	Total energy intake and nutrients such as calcium in students of both schools were insufficient. Due to the lack of fruits in boarding schools, the intake of vitamin C by boarding students was less than daily ones.
Ekanah et al.(1)	comparative cross sectional	Nigeria	326	girl / 10-15 years	2017	A semi-structured questionnaire	36% of usual students and 14% of day and night students ate beans at least twice a week, while 6% of usual students and 11% of day and night students ate beans more than 4 times a week. Also, more than half of usual school students and two-thirds of day and night school students were served fish, meat, or egg in all their meals. 55, 45 and 42 percent of usual students ate fruits twice a week, three times a week and daily, respectively, while 21%, 11%, and 9% of day and night students ate fruits twice a week, three times a week, and daily, respectively. Most day and night students emphasized that the meals offered in schools are not tasty, adequate and balanced.
Serrem et al.(17)	cross-sectional	Kenya	50 Catering Managers and Chefs	-----	2019	interview	Menus were simple, undiversified and repetitive, and contained 3 to 5 times more fiber than required and were deficient in nutrients such as carbohydrates, energy, vitamin A, folic acid, potassium, calcium, protein, and vitamin B1 - B12. Most boarding schools did not provide enough meals. The most vegetables (121 grams) were offered in city schools, while the least in private ones. Animal-source foods such as eggs, sausages, and beef were mostly offered at private schools' menus compared to other types of schools. Most of the offered foods were starchy. Milk was offered only at national schools. Private schools were most providing fruits, while the county schools' menu did not have fruits. Legumes were the main source of protein in all types of schools, except in private schools, which had more animal protein on their menu.

Results of this study were similar to those of another study by the same authors in 2007. The survey was carried out on 190 15–18 year-old male and female students in five secondary schools in Nigeria. Nutritional information was collected within three days (two normal and one weekend days) using two methods. In the first method, plate wastes were collected from the original weight of the food. In the second method, a representative sample of the food was collected and sent to the laboratory for proximate analysis using standard assay procedures. Results showed that fat, carbohydrate and energy intakes in boys were significantly higher than those in girls. However, protein intake in the two sexes was insufficient and malnutrition was reported in girls more than boys (11). However, results of other studies were in contrast to the results of the highlighted study. For example, in a study by Kljusuric et al. in Croatia (1997–1998) on 1117 15–19 year-old male and female students of boarding schools within seven days using random sampling of each meal, self-assessment questionnaires showed that supplies of energy and fat for female students and supplies of nutrients in the two sexes were too much. In all schools, fat and protein intakes were more while carbohydrate intake was less than the recommended values. Regardless of sex, deficiencies of calcium, magnesium, phosphorus, zinc and vitamins B1 and B6 were reported (12).

Another study by the same authors with a previous statistical population on students aged 14–18 years in 15 boarding schools in Zagreb analyzed meals of the students. The study demonstrated that the daily energy consumption was higher than the recommended values. Nearly 15.15% of boys and 30% of girls did not receive carbohydrates and fats according RDA. However, their protein intakes were in

the recommended range. Dietary calcium intake of girls was insufficient but that of boys was in the recommended range. Based on this study, iron intake was high since it was 50% higher than the RDA recommendations in girls and 150% higher than the RDA recommendations in boys due to eating red meats with vegetables with high contents of vitamin C (13). Kljusuric et al. (2004) carried out a study on 1,260 14–18 year-old male and female students in 17 boarding schools to compare changes in boarding school meals with the 1997 boarding school. In this study using a random sampling of three meals, a self-control questionnaire and a food frequency questionnaire within seven days, results showed that the quantity of energy from snacks increased but vitamins and nutrients decreased, compared to those of 1997 study. Moreover, nutrient supply was high within the two sexes in 1997 study. Although the intake of proteins, fats and carbohydrates were reported more than the recommended requirements in the recent study, but intakes of fats and proteins were more and intake of carbohydrates was less than the recommended values in 1997 study. Similar to 1997 study, a significant proportion of the students did not consume enough milks, fruits and vegetables or did not generally consume these foods (5).

Another study by Nicholaus et al. (2019) on 164 16–19 year-old students in 31 public and private secondary schools in Kilimanjaro using 24-h recall and food frequency questionnaire showed that the average quantity of the consumed energy, vitamin C, iron, calcium and zinc included 1392 kcal, 24.8 mg, 9.2 mg, 134.5 mg and 4.3 mg, respectively. These values were less than the recommended daily requirement values. The average consumptions of carbohydrates, fats and proteins included 471.9, 73.7 and 80.7 g, respectively, which were mildly higher than the required daily recommendations in the two sexes. In general, diets of the boarding schools were undiversified and inadequate in terms of key micronutrients such as iron, calcium, zinc and vitamin C. Grains, cereals, roots, tubers, bananas and legumes were frequently consumed more than seven times a week; predominantly, stiff maize porridge (ugali) and kidney beans were consumed more than seven times a week. Fruits and vegetables were rarely consumed. The most consumed fruit was banana. Red meat was consumed 1–2 times a week; however, fruit juices were rarely consumed (14). The second group of studies compared the nutritional status of boarding with day schools. One study belonged to Chen et al. Results of the study showed that the iron intake values from daily diets in the two school types were less than the recommended values, resulting in anemia in students of these schools. Furthermore, low varieties of diets and consumption of carbohydrate-rich foods were significant, compared to those of protein-rich foods. Significant differences were also reported in overall diet patterns between students from day and boarding schools. Red meats and vegetables were consumed only 1–2 times a week. However, juices were rarely consumed by the students (15). It is noteworthy that results of the study were similar to the results of a study by Bolajoko et al. (2014) on 200 students of boarding schools in a Nigerian city within four days. In this study using 24-h recall to assess food and nutrient intakes, results showed protein and energy intakes as 123 and 98% of the RDA recommended values, respectively. No significant differences were seen in energy intakes between the boarding and day-school students. However, intakes of vitamins B6, E, A, B9 and C and calcium included 38, 21, 62, 55, 23 and 43% lower than those of RDA recommended values, respectively. Moreover, iron intake was 127% higher than the RDA recommended value. However, no significant differences were seen between the energy consumptions in the studied schools as their energy consumptions were sufficient. Only vitamin C consumption was higher in daily students due to the fact that fruits were not served in boarding schools, while this vitamin plays important roles as an antioxidant in adolescent health (16). A study by Intiful et al. (2013) on 124 students aged 8–10 years in Accra, Ghana, compared nutritional statuses of day and night schools using 24-h recall questionnaires in terms of nutritional status and average intake. In general, nutrients were similar to the highlighted study. In fact, total energy and nutrient (e.g. calcium) intakes in students of the two schools were insufficient. Due to the lack of fruit consumption in boarding schools, intake of vitamin C by night students was less than that by daily students (6).

Another study by Ekanah et al. in Nigeria reported poor nutrition conditions in boarding schools. The study on 326 10–15 year-old students in the two school types using semi-structured questionnaires (self-administered) showed that 36% of usual students and 14% of boarding students consumed beans at least twice a week. Nearly half of usual school students and two-thirds of boarding school students were served with fish, meat or egg in all their meals. Nearly 55, 45 and 42% of usual students consumed fruits twice a week, thrice a week and daily, respectively, while 21, 11 and 9% of boarding students consumed fruits twice a week, thrice a week and daily, respectively. Most boarding students reported that meals offered in schools were not tasty, adequate and balanced. This resulted in student skip of certain meals, which affected their health. Hence, students of boarding schools were severely underweight, while but students of daily schools were overweight and obese (1). In contrast, study of Serrem et al. in the third category of studies was different from the other studies. The survey study was carried out from May to June 2019 through interviews with 50 catering principals and chefs of Kenyan night schools. The survey was carried

out in 50 selected boarding high schools classified by the Kenyan Ministry of Education, which were divided into national, extra county, county and private. Results of the interviews showed that the menus were simple, undiversified and repetitive, including 3–5 times more fiber than the required quantity. However, nutrients such as carbohydrates, energy, vitamin A, folic acid, potassium, calcium, proteins and vitamins B were insufficient. In general, it could be concluded that most boarding schools in the second grade did not provide enough foods. The study also reported that gitri (a mixture of corn and beans) was the main food of the city schools, while the food was less served in private schools. Results demonstrated the highest quantity of ogali porridge in national schools, the highest quantity of rice in private schools, the highest quantity of beans in city schools, the lowest quantity of beans in private schools, the highest quantity of vegetables (121 g) in city schools and the lowest quantity of vegetables in private schools. Breads and potatoes were served in all school types. Animal-source foods such as egg, sausage and beef were mostly on private school menus compared to other school types. Results showed that most of the provided foods were sources of starch with 64–68% of the total diets. Dairy (milk) was offered only in national schools. Private schools mainly provided fruits, while city school menus did not include fruits. Legumes were the major sources of proteins in all school types, except private schools, which offered further animal proteins in their menus. Vitamin A intake in private schools was significantly higher than that in other schools. The highest quantity of vitamin B1 (8.15 g) was in the city schools, which was more than the daily intake needs. Quantity of vitamin B12 was the highest (1.55 g) in private schools and the lowest in the city schools (0.7 g). Vitamin B6 and folic acid were significantly higher in private schools than other schools, while national schools included the highest quantities of calcium and magnesium (17).

Discussion

In general, results of studies on the nutritional status of boarding schools indicate that daily intakes of proteins and micronutrients by students are not enough. In school and puberty, where growth rate continues, nutritional deficiencies can include detrimental effects such as decreased growth rate, short stature and thinness and micronutrient deficiencies, especially iron, zinc and calcium, which are necessary for physical growth and learning. Studies have shown that iron deficiency during schools results in anemia and decreased growth rate as well as decreased learning and concentration and lack of academic achievement (18). One of the methods to prevent iron deficiency and its associated anemia in school and in puberty times is weekly food supplementation, which the effectiveness of this method has been shown in various studies (19). Zinc and iron include similar dietary sources; thus, deficiencies in animal proteins, especially meats, which usually occur in poor and low-income communities cause deficiencies of the two micronutrients. Numerous studies have shown associations between zinc and height growth as zinc deficiency has been suggested as one of the causes of nutritional short stature (20). One of the suggested solutions includes allocation of subsidies to animal protein sources for low-income groups. Governments can protect vulnerable people from various forms of malnutrition by increasing economic access to foods in a variety of ways, including food subsidies, livelihood assistance and foods for vulnerable groups, especially boarding school students. Of the important factors that significantly affect the nutritional status of boarding students, education and occupation of the parents, lack of taste in foods and lack of variety in meals can be addressed. It is recommended to include more foods, especially fruits, vegetables, legumes, milks and dairy products in daily diets of children to improve their nutritional status.

Another important step that is necessary to improve nutrition of boarding school students is to educate authorities involved in policy-making and planning to improve school nutrition. In general, it is noteworthy that improvement of the nutrition and food security at household, school and macro levels is a multi-sectoral issue, which needs participation and cooperation of various stakeholders. Producing and promoting vegetables gardens in schools and educating students to cultivate vegetables for using in school meals and teaching students how to make good use of available resources can be effective in improving nutritional status of the students. Furthermore, increasing budgets of nutrition in these schools, improving contents and monitoring types of foods, improving food tastes and providing enriched foods in menus (e.g. enriched pastas and breakfast cereals with micronutrients) are important methods to improve the nutritional status of boarding schools. Use of supplementation programs, including weekly supplementation of iron and zinc in some countries (including Iran with iron supplementation program), has shown its effectiveness in decreasing iron deficiency and its associated anemia (21). Moreover, developing school milk programs and distributing milks in boarding schools in deprived areas are other methods used in Iran and other countries such as New Zealand. These provide a proportion of the necessary energy, proteins and micronutrients of the students (22).

Suggestions: To prevent nutritional problems of the students in boarding schools, designing community-based interventions and multi-sectoral collaborations is one of the basic strategies. Moreover, comprehensive instructions for nutrition in boarding schools should be developed by the

education ministry of the countries and these instructions should be used with the supports of governments, school officials and other stakeholders. School officials should also be active in collecting donates, using this potential to improve food programs and student nutrition statuses at boarding schools and thereby improving their academic performance and health.

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