



Review

Dietary practices and nutrient intake among adolescents: A general review

Thana' Y. ALjaraedah, Hamed R. Takruri, Reema F. Tayyem*

Department of Nutrition and Food Technology, Faculty of Agriculture, The University of Jordan, Amman, 11942, Jordan

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ABSTRACT

Adolescence is a vital and critical stage in the development of obesity as well as for increasing the risk of some metabolic and chronic diseases in maturity. Thus, pre-adulthood period could provide a chance to prepare for a healthful reproductive and productive life. Worldwide, malnutrition remains a pivotal nutritional problem for adolescents. Indeed, an increase in the global prevalence of obesity among adolescents has been reported in many surveys. Environment can exert a strong effect on people's food choices especially adolescents. In other words, if the food environment in school is healthy, this will encourage adolescents to develop healthy eating habits and make more healthy food choices. While, if the quality of marketed products for adolescents is unhealthy foods and beverages, this will affect their food and drink choices which may lead to many health complications in their later life. In this review the major dietary practices, eating patterns identified in adolescents and dietary intakes among this age have been discussed.

1. Introduction

Adolescence, a transition and intermediate interval between adulthood and childhood, is classified as one of the most rapid phases of development where specific developmental and health requirements should be met (Baltes et al., 1980). Globally, adolescents account up to 20% of the population (Ross et al., 2006). Adolescence may be classified based on social, psychological, and physical changes into three developmental stages including early adolescence occurs in age from ten to fourteen years old, mid adolescence aged from fifteen to seventeen years old and late adolescence occurs between seventeen to twenty one years old (Sullivan et al., 2010).

In fact, adolescence is a stage of rapid growth where up to 37% of total bone mass accumulated, 15–25% of adult height is achieved and 45% of skeletal growth takes place (Bingham et al., 1994; Williams et al., 2017). Moreover, this interval is characterized by physiological, psychological and social changes (Brener et al., 2003). Brain maturation and puberty have placed through adolescence and could lead to a new capacities and dietary behaviors. In addition, one of the key processes distinguishing adolescence is bone development. Considerable developmental processes imposes additional nutritional requirements in adolescence and these high requirements increase the risk for nutrients deficiencies (Spear et al., 2007). Therefore, healthy dietary choices and good eating patterns are essential to achieve proper development for adolescents.

2. Energy and nutrient requirements of adolescents

Total nutrients intake and energy needs during puberty exceed those at any other stage of life as a result of increasing skeletal mass, body fat and lean body mass. Unfortunately, there is a limited data about the optimal energy and nutrients intakes during adolescence. Most available data are extrapolated from adult or child nutritional requirements (Hammoud et al., 2008). The Dietary Reference Intakes (DRIs) give the best nutrient requirements estimation for adolescents (Otten et al., 2006). Adolescent's nutrient intakes in U.S. indicate that many of them consume inadequate amounts of minerals and vitamins; this trend is more common in females than in males. On average, adolescents utilize diets inadequate in minerals and vitamins including folate, vitamins A, C, B6, and E, iron, magnesium, zinc, phosphorus, and calcium (Hammoud et al., 2008). In addition, most of adolescents consume low amount of dietary fiber and higher amounts of total and saturated fats, sodium, cholesterol, and added sugar which exceed the recommendation (Hammoud et al., 2008).

Several factors influence the energy needs of adolescents including basal metabolic rate (BMR), activity level, and increased energy demand in order to support pubertal development. Basal metabolic rate is closely related to the amount of lean body mass of individuals. Indeed, adolescent males have greater increases in weight, height and lean body mass; therefore, they have higher caloric demand than females (Shomaker et al., 2010). Furthermore, adolescents who are physically more active with higher body muscle mass may need additional energy

* Corresponding author.

E-mail addresses: thanaana67@gmail.com (T.Y. ALjaraedah), htakruri@ju.edu.jo (H.R. Takruri), r.tayyem@ju.edu.jo (R.F. Tayyem).

List of abbreviations

%	Percentage
WHO	World Health Organization
DRI	Dietary Reference Intakes
BMR	Basal Metabolic Rate
Mg	Milligram
µg	Microgram

PUFA	Poly Unsaturated Fatty Acid
SFA	Saturated Fatty Acids
BMI	Body Mass Index
Kcal	Kilocalories
Kg	Kilogram
RE	Retinol Equivalent
Public Health England	PHE
Food Standards Agency	FSA

to meet their needs (Ridley et al., 2008).

Carbohydrate recommended intake among adolescents is 45–65% of daily energy needs or at least 130 g/day. Approximately, added sugars and sweeteners provide 21% of energy intake by adolescents (Petrie et al., 2004). Candy, Soft drinks, sweetened beverages and baked goods are the major source of added sweeteners in adolescent's diet. The DRIs set the recommended intake of dietary fiber for adolescent females at 26 g/day, for males < 14 years of age at 31 g/day, and for older adolescent males at 38 g/day. The low intake of vegetables and fruits in combination with less than one serving of whole grains per day among adolescents, are the main contributing factors that affect fiber intake among adolescents (O'Neil et al., 2014). The mean daily intakes of total energy, macronutrients, and micronutrients of Jordanian adolescents, the most of dietary intake values of macronutrient below dietary reference intake except protein and fat intake. Also most of dietary intake values of micronutrients intake below dietary reference intake except vitamin C in females, selenium, and sodium (Aljaraedah et al., 2019).

During adolescence, achieving calcium adequate intake is crucial to development and physical growth. About half of peak bone mass is formed, therefore, achieving calcium adequate intake is crucial in the formation of bone mass and in the reduction of the lifetime risk of osteoporosis and fractures. During puberty, males acquire more bone mass than females possibly due to hormonal influences. The DRI for calcium for 9-18 year-olds is 1300 mg/day. The national data suggest that many adolescents, most notably females, do not consume the DRI for calcium (Uenishi, 2018). Moreover, adolescents iron requirements are affected by several factors including the increase in blood volume, the rapid rate of linear growth, and the onset of menarche. Iron needs of an adolescent will be highest after menarche in females and during the adolescent growth spurt in males. Adequate dietary intakes of iron among 12–19-year-old youths are estimated to be 13.3 mg/day for females and 19.6 mg/day for males (Altschwager and Sonnevile, 2018). Folate is essential for RNA, DNA and protein synthesis. Thus, adolescents have increased demands of folate during puberty. Serum folate levels and red blood cells decrease during adolescence while sexual maturation proceeds, suggesting an increased folate demand during development. The DRI for folate among adolescents is 400 µg/day (Morris et al., 2005).

3. Major dietary behaviors and eating patterns identified in adolescents

Since dietary behaviors and eating habits are still developing in adolescents (Tayyem et al., 2014), it is important to help adolescents people to adopt healthy dietary behaviors and habits. Current dietary practices seen in adolescents may have several consequences on their health (Kubik et al., 2003). Strong evidence showed that many adolescents do not follow a diet meets their dietary guidelines. Study from UK National Diet and Nutrition Survey showed that only 7% of females and 10% of males aged 11–18 years met their vegetables and fruits recommendation. On the other hand, the consumption of saturated fat on average was greater than the recommended dietary reference intakes (Public Health England and Food Standards Agency, 2014). Eating habits of most adolescents consist of fast-food consumption, high intake of sweetened beverages and soda, inadequate intake of

vegetables, fruits and dairy products, low physical activity level. Therefore, there is a need to evaluate the dietary habits and lifestyle characteristics among adolescents (Rampersaud et al., 2005).

Increased consumption of pizza, French fries and fast food and reduced consumption of lean meats, whole grains, fruits, vegetables and fish were observed among adolescents (Ambrosini et al., 2012). This alteration in eating pattern leads to excessive consumption of added sugars, total saturated fatty acids, total fat, and trans fatty acids, combined with inadequate intake of micronutrient including calcium, potassium, zinc and vitamins A, C, D and folic acid (Appannah et al., 2015). The busy lifestyle of family usually leads in adolescents to depend on snack foods for basic nutrition and skipping meals especially breakfast (Duyff, 2012). Furthermore, in developing-countries, street foods which provide nutrient-dense traditional dishes are considered as major dietary contributors (Popkin et al., 2012).

4. Observed factors affecting dietary behaviors and eating patterns in adolescents

Adolescent eating patterns are established through a complex process involving internal and external factors such as food preferences and availability, body weight perception, and parental and peer influences (Azeredo et al., 2016). Adolescents are not a homogeneous group they have several variations in sex, age, socioeconomic status and cultures. Adolescents reported that school is one of the major determinants on adolescents' behaviors and attitudes to keep healthy weight (Power et al., 2010).

Due to the economic growth and urbanization, there was a significant change in nutritional habits and dietary patterns. Alteration in lifestyle to a more sedentary manner, utilization of high caloric density and processed foods and poor access to exercise parks and areas which contribute to lack of physical activity, were found in many Arab countries (Popkin, 2015). In this living situation, adolescents are affected the most, as they also strongly influenced by mass media and peer pressure for conformity. Food choices and purchases are increasingly made by the adolescents. Snacking, skipping meals and consuming of junk foods are common features of adolescents' diet in developed countries (Salvy et al., 2012).

Home and school environment, economic and unsuitable social environment, heavy marketing of unhealthy and energy dense foods are the most common factors related to weight gain. Furthermore, the search for identity, concern about appearance, peers pressure and media greatly affect adolescents eating habits, while the influence of the family starts to decrease (Delisle and World Health Organization, 2005).

There is a strong association between urbanization and changes in physical activity and dietary patterns. Westernization in the Arab countries happened during the past three decades increased the prevalence of obesity and overweight in the region. Physical inactivity and importing of processed high caloric density foods are found in many of the Arab countries. As reported by the ministry of health in Oman, there is rise in the metabolic disorders and nutritional deficiencies for the age group from fifteen to nineteen especially among females (Ng et al., 2014).

5. Macronutrient and micronutrient intake derived from school meals

In today's schools, students experience different types of eating options. Therefore, many studies conducted in order to assess macro and micro nutrients intake from the food eaten in the school. Bollella et al. (1999) determined the mean intake of protein, energy, fiber, total fat, saturated fat, cholesterol, percent energy from total and saturated fat, carbohydrate, iron, calcium, zinc, vitamins A, C, E, folate, B6 and B12, niacin, thiamin, riboflavin, sodium, and magnesium of preschool Head Start children away from school and at school. The result of this study indicated that children who spent half day at school consumed up to 25% of the daily recommendation for nutrients and energy, while children who spent all the day at school achieved only third of the daily recommended intakes. When intakes at home and school were combined, children intake exceeded dietary recommendations for vitamins, protein, and minerals. Energy intake remained less than 100% of the recommendation, while the intake of saturated fat, total fat, and cholesterol exceeded the recommendations (Bollella et al., 1999).

Another study was conducted to assess food and nutrient intake and eating during the school day in Finnish secondary-school pupils. The study result indicated that 28% of the boys and 40% of the girls showed eating fresh vegetables daily and fruit were 32% and 23%. The average intake of sucrose was greater and the average intakes of fiber, folate, iron, and vitamin D were lower than recommendations. School lunch provided around 20% of energy intake. Sugary drinks were the common sources of sucrose (Hoppu et al., 2010).

Another study was conducted to find the contribution of school meals to Swedish children's energy and nutrient intake during the week days and compare this to the reference values depending on the Nordic Nutrition Recommendations. The result of this study indicated that the mean intake from meals eaten in the school of energy, carbohydrates, polyunsaturated fatty acids, vitamins D and E, and dietary fiber, did not score the reference values while the intake of sodium and saturated fatty acids exceeded the reference values. Moreover, the students in the fifth grade did not score the reference values for potassium, folate, calcium, iron, magnesium, selenium, and zinc. In addition, dietary fiber, energy, PUFA, and vitamins E and D did not reach the references, whereas the intake of SFA and sodium exceeded reference values (Osowski et al., 2015).

Templeton et al. (2005) determined the effect of competitive foods on nutrient and energy intakes of adolescents participating in a school lunch program. Competitive foods are that foods and beverages other than meals reimbursed under programs authorized by the Richard B. Russell National School Lunch Act and the Child Nutrition Act of 1966 available for sale to students on the school campus during the school day. The results of this study indicated that adolescents in the sixth-grade eat energy and other nutrients in a level significantly lower than recommended levels except for iron; one third of adolescents purchasing school lunch as well as competitive food items. Moreover, adolescents who purchase competitive foods reduced their servings from school lunch and increased the waste from school lunch plate, resulting in lower intakes of energy (400 kcal vs 530) kcal for no competitive foods, calcium (300 mg vs 362 mg for no competitive foods), and vitamin A (77 retinol equivalents vs 113 retinol equivalents for no competitive foods) from the school lunch; and competitive foods supplied more than one third of total energy for the meal (Templeton et al., 2005).

6. Nutritional problems among adolescents

Worldwide, malnutrition is considered as a significant problem in adolescence. Obesity can be defined as the accumulation of excess body fat (Sharma and Padwal, 2010). Body mass index (BMI) is usually calculated as weight (kg)/height (m²). Centers for Disease Control and Prevention (CDC) growth charts of BMI-for-age defines obesity

as \geq 95th percentile, overweight as \geq 85th percentile and $<$ 95th percentile and underweight as $<$ 5th percentile (Kuczmarski, 2002). BMI is the most widely used index for obesity diagnosis (Selassie and Sinha, 2011). Several studies showed that obesity is a multifactorial disease including biological and non-biological factors. Non-biological factors include age, heredity, education, sex, socioeconomic level, eating habits, physical activity and psychological factors (Suleiman et al., 2009).

Globally, there is an increase in the prevalence of obesity among adolescents. In 2014, the World Health Organization's (WHO) global database showed that 1.9 billion adults were overweight; 600 million of them were diagnosed with obesity. (Wang et al., 2002; Williams et al., 2017). A rise in the prevalence of obesity in adolescents has been detected in many reports and surveys (Wang et al., 2002; Williams et al., 2017). Adolescence is a critical stage in the development of obesity and for starting risk factors for other chronic metabolic diseases in adulthood (Caballero, 2005).

Adolescents who are obese are likely to remain obese as adults (Gordon-Larsen et al., 2004). Musaiger et al. (2016) detected the prevalence of obesity and overweight between adolescents aged 15–18 years in 8 Arab countries. The results of this study indicated a high proportion of obesity and overweight in most countries. Adolescents in Kuwait have the highest proportion (24.8% and 23.4% for obese and overweight, respectively) followed by adolescents from Saudi Arabia (18.1% and 19.5%, for obese and overweight, respectively), then Iraqi adolescents (6.2% and 19.0% for obese and overweight, respectively) (Musaiger et al., 2016). In Jordan, the percentage of obesity and overweight among adolescents came after Libya and Iraq as Arab countries with middle income with 5.4% for obese and 17.0% for overweight (Musaiger et al., 2016). These increased trends in weight gain indicate that longer life spans among adolescent will be combined with rise in the incidence of other chronic diseases in adulthood (Wang et al., 2002). However, high-income countries including the Arab Gulf States and middle-income countries including Iran, Jordan, Egypt and Lebanon are scoring the same trend of the prevalence rate indicating the strong effect of the cultural factors not the economic factors in obesity development (Kilpi et al., 2014).

6.1. Adverse effect of poor diets on adolescents health

The alteration in eating pattern of adolescents leads to increased consumption of added sugars, fat, trans fats, saturated fat combined with inadequate consumption of micronutrient such as, iron, calcium, zinc, and potassium, as well as vitamins A, C, D and folic acid. Poor diet significantly contributes to several adverse health outcomes such as obesity, cardiovascular diseases, diabetes, hypertension and certain cancers (Appannah et al., 2015; Ishak et al., 2016). These diseases have their origin during adolescence and childhood, but the specific mechanism is poorly understood in adolescents.

In addition, the interactions between genetic predisposition, the environment and growth in adolescents and children have not yet been studied. Physical inactivity and inadequate dietary habits are the major preventable risk factors for the development and occurrence of non-communicable diseases. Reduction in the risk factor of non-communicable disease in adolescence and childhood may decrease morbidity and mortality in adulthood (Ishak et al., 2016).

7. School as an important determinant of dietary behaviors and practices

The environment can have a strong effect on people's food choices. The influence of the food environment in the school on adolescent diet is still little unclear in middle and low-income countries. Adolescents spend a long time of their day at school and have at least one meal a day there (Sallis and Glanz, 2009). Therefore, it is important to consider schools environment as a contributor in the development of eating habits, through nutritional education and food environment (Rovner

et al., 2011). Moreover, the food environment in school is healthy to encourage adolescents to develop healthy eating habits and make more healthy food choices, school is one of the main determinants of adolescents' dietary habits (Nathan et al., 2013).

According to the previous representative studies, 70–90% of adolescents aged 9–18 years visit the canteen of school daily (Haapalahti et al., 2003; Urho and Hasunen, 2004). Mostly, adolescents are unaware of consequences of unhealthy life style and dietary habits (Brener et al., 2003). Previous studies focused on the effect of changes to the school food environment showed that improvements on the school eating environment can give positive effects on the quality of adolescent's diet (Videon and Manning, 2003; Driessen et al., 2014). Moreover, schools can educate adolescents and increase their awareness of the importance of increasing the intake of vegetables and fruits, and decreasing the consumption of high-fat foods, soft drinks, and sweets (Story et al., 2002).

The school canteen is a very important and effective approach to enhance healthy food choices that can be made by the government (Måsse and De Niet, 2013; Nathan et al., 2013). Schools can affect food choice by influencing food availability, policy development, social norms and pricing (Kubik et al., 2003). Moreover, Schools can provide nutrition education programs that focus on increasing the intake of fruit and vegetables, and decreasing the consumption of soft drinks, high-fat-containing snacks, and sweets (Story et al., 2002). Therefore, policies to improve and enhance the nutritional quality of beverages and food presented and consumed in and around the school are needed (Story et al., 2002).

As a result, environmental cues, such as the mere presence of unhealthy food items, portion and packaging sizes, and tempting smells or displays of unhealthy food, will most probably have an impact on adolescents' eating behavior (Chandon and Wansink, 2012). In line with this, adolescents themselves also indicated that they are influenced by the presence of unhealthy food in the school canteens. Despite that, the majority of school canteens offers a large quantity of unhealthy products, and which contributes to the development of unhealthy eating habits in adolescent's people. When canteens offer healthy food in an attractive way by appealing presentation or putting it on display, this would increase healthy choices (Jones et al., 2014).

In addition, schools are increasingly considered as key settings for interventions related to healthy eating habits. Health promotion in schools worth's the effort, because it can contribute to healthier habits and behavior and greater academic achievements (Schwartz et al., 2010). A study conducted to examine the relationship between school food environments and children's BMI found that among elementary school children, offering dessert more than once per week and offering French fries and related potato products more than once per week were each related to significantly higher likelihood of obesity. Among middle school children, the availability of energy-dense foods was associated with a higher BMI z score (Ranjit et al., 2015).

However, the evidence concerning the influence of the school food environment and its surroundings on adolescents' food purchases, consumption and body weight was not consistent (Williams et al., 2017). Effects have been found to vary even between studies of the same food type, and between different school grades (Kubik et al., 2003; Cullen and Zakeri, 2004; Vericker, 2013).

7.1. Effect of School's surrounding environment on the eating patterns and dietary habits

Supermarkets can serve as one of the major food suppliers for adolescents. Even when school lunch is offered, adolescents still buy snacks from the supermarkets near to their schools, on their way to school or on the way back home from school (Cairns et al., 2013). In an observational study analyzing 833 intercept surveys in corner stores within walking distance of 10 schools, Borradaile et al. (2009) showed that urban elementary schoolchildren were most likely to purchase

energy-dense nutrient-poor products (chips, candy, sugar-sweetened drinks). General trend regarding the quality of marketed products for children as persistent exposure to unhealthy food and beverage products affect food and drink preferences leading children and adolescents to unhealthy food choices (Cairns et al., 2013; Harris et al., 2009).

7.2. Factors affecting food choices of adolescent students from school canteens

Food choices are determined by different individual and environmental variables. Three main variables affect food choices including perceived value including portion size and price, taste, and perceived nutrition. Foods differ along each of these factors. Individuals of lower socioeconomic status may give greater magnitude for perceived value, while those who are mainly focused on health may give greater importance for the nutritional fact and quality of foods. In general, people may be well-educated about healthful food choices and good eating habits, but they prefer to choose the cheaper and the taster food (Drewnowski et al., 2014).

A study was conducted to examine the influence of labeling, health concerns and nutrition information, availability, cost, taste, and peers on adolescents' food choices, in the school canteens and to determine if these factors differ by grade level, gender or adolescents' health and weight; and to give recommendations about the promotion of low-fat foods in the school canteens (Shannon et al., 2002). The results of this study showed that the factors associated with adolescents food choices when choosing foods from the school canteen were how much they can get foods from their money and the taste of the food they purchased (71.7%, 93.7% respectively). Females, and adolescents who concerned about their weight and health were more interested about reading labels and the nutrition facts of food item and availability of low-fat foods in the school canteen (Shannon et al., 2002).

Another study aimed to evaluate an environmental intervention used to increase sales of lower-fat foods in secondary school canteens. Twenty secondary schools were divided randomly into a control group or an environmental intervention. The intervention focused on increasing the availability of lower-fat foods and performed adolescent-based promotions. The results of this study showed that the increase in sales of lower-fat foods in year 1 (10% intervention vs –2.8% control, $P = 0.002$) and a higher percentage of sales of lower-fat foods in year 2 (33.6% intervention vs 22.1% control, $P = 0.041$) were observed. There were no significant changes in student self-reported food choices (French et al., 2004).

8. Conclusion

Adolescence is a crucial and critical stage in the development of obesity as well as for developing risk factors for some metabolic and chronic diseases in adulthood, Most of the adolescents are not aware of the long-term complications and consequences of their current eating patterns and unhealthy dietary habits and behaviors. In addition, adolescents usually do not receive attention in the governmental nutrition programs. In spite of knowing that adolescent health is tomorrow's adults and their health is crucial, the concern in adolescents' health is unsatisfactory.

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