Nutritional adequacy and fruit and vegetable intake in Portuguese adolescents: associations with parental educational level

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Todas as correções determinadas pelo júri, e só essas, foram efetuadas.

O Presidente do Júri,

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Abstract

Socioeconomic inequities in health and dietary habits have been emphasized in the past years and across all age groups. Recent literature suggests that those adolescents whose parents have high levels of education present more adequate dietary habits, with higher intake of plant based foods, that result in better nutritionally balanced dietary intake. Fruit and vegetable (F&V) consumption is one key element for a healthy diet, however its intake by young people has been shown to be below recommendations.

Parental educational level (EL) may influence adolescents' dietary habits in various ways, so it is one of the indicators used to evaluate adolescents' socioeconomic status, mainly that of the mother.

The aim of the present work is to evaluate the relationship between adolescents' diet nutritional adequacy (paper I) and their F&V intake (paper II) and parental EL. For that purpose, two original research papers were developed.

Sociodemographic, anthropometric and dietary variables were collected among adolescents aged 12 to 19 years from a Portuguese basic and secondary school. For paper I, the intake of 22 nutrients was analysed and comprised into a nutritional adequacy score (NAS), using the estimated average requirement cut-point method. For paper II, consumption of F&V was assessed in grams and number of portions and adequacy of intake was evaluated using the Portuguese recommendations. Statistical analysis was conducted through the application of logistic regression models for both papers. The influence of different confounders, as well as sex differences, were taken into account.

Paper I shows that adolescents' diets nutritional adequacy was low, being the average classification in the NAS of 58.05±9.02% for girls and 62.89±10.58% for boys. The highest percentages of inadequacy were found for Vitamin A, vitamin D, vitamin E, folate, calcium, magnesium and sodium. Results from this paper also suggest that nutritional adequacy may be positively associated with parental EL because adolescents with high-educated mothers seem to have higher chances of achieving nutritionally adequate diets.

Paper II demonstrates that F&V intake was low among adolescents, with no one achieving the Portuguese recommendations. Besides the high prevalence of inadequate intake, it seems that those individuals with both parents with high EL are more likely to consume more fruit. On the other hand only high mother EL seems to provide higher consumption of vegetables in comparison with low mother EL.

Results from both papers suggest that parental EL, mainly the mother's, positively influences both overall nutritional adequacy and F&V intake among Portuguese adolescents.

Keywords: Adolescents, nutritional adequacy, fruit and vegetable, socioeconomic status, parental educational level

Resumo

As desigualdades socioeconómicas na saúde e nos hábitos alimentares têm-se vindo a acentuar nos últimos anos e em todos os grupos etários. Literatura recente sugere que adolescentes cujos pais têm níveis de escolaridade (NE) mais elevados apresentam hábitos alimentares mais adequados, com um maior consumo de alimentos de origem vegetal, que resultam numa ingestão alimentar mais equilibrada nutricionalmente. O consumo de fruta e hortícolas é um elemento chave para uma alimentação saudável, contudo tem-se mostrado que o seu consumo em faixas etárias mais jovens está abaixo das recomendações.

O NE parental pode influenciar os hábitos alimentares de adolescentes de diferentes formas, sendo por isso um dos indicadores utilizados para avaliar o estatuto socioeconómico de adolescentes, principalmente o NE da mãe.

O objetivo do presente trabalho é avaliar a relação entre a adequação nutricional da alimentação de adolescentes (artigo I) e o seu consumo de fruta e hortícolas (artigo II) e o NE parental. Para isso, foram desenvolvidos dois artigos de investigação.

Dados sociodemográficos, antropométricos e alimentares foram recolhidos em adolescentes com idades entre 12 e 19 anos de uma escola básica e secundária de Portugal. Para o artigo I, a ingestão de 22 nutrientes foi analisada e reunida num score de adequação nutricional, usando como limite o método das necessidades médias estimadas. Para o artigo II, o consumo de fruta e hortícolas foi avaliados em gramas e número de porções e a adequação foi medida usando as recomendações portuguesas. A análise estatística foi conduzida através da aplicação de modelos de regressão linear para ambos os artigos. A influência de vários confundidores, bem como as diferenças entre sexos, foram consideradas.

O artigo I mostra que a adequação nutricional da alimentação de adolescentes foi baixa, tendo a classificação média no score de adequação nutricional sido de 58.05±9.02% para raparigas e 62.89±10.58% para rapazes. As percentagens mais elevadas de inadequação foram encontradas para a vitamina A, vitamina D, vitamina E, folato, cálcio, magnésio e sódio. Os resultados deste artigo sugerem ainda que a adequação nutricional pode estar positivamente associada ao NE parental, uma vez que adolescentes cujas mães têm elevado NE parecem ter mais probabilidade de atingir uma alimentação nutricionalmente mais adequada.

O artigo II demonstra que o consumo de fruta e hortícolas é baixo entre adolescentes, não tendo as recomendações portuguesas sido atingidas por nenhum indivíduo. Além da elevada prevalência de consumo inadequado, parece que indivíduos

com ambos os pais com elevado NE estão mais propensos a consumir uma maior quantidade de fruta. Por outro lado, apenas o NE materno parece promover um maior consumo de hortícolas, em comparação com baixo NE materno.

Os resultados de ambos os artigos sugerem que o NE parental, principalmente o da mãe, influencia positivamente tanto a adequação nutricional geral, como a ingestão de frutas e hortícolas entre adolescentes portugueses.

Palavras-chave: Adolescentes, adequação nutricional, fruta e hortícolas, estatuto socioeconómico, nível de escolaridade parental

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List of abbreviations

AMDR - Acceptable Macronutrient Distribution Ranges

BMI – Body Mass Index

CVD – Cardiovascular diseases

DRI - Dietary Reference Intake

EAR - Estimated Average Requirement

EFA – Essential Fatty Acids

EL – Educational Level

EPIC – European Prospective Investigation into Cancer

F&V – Fruit and vegetables

FA – Fatty Acids

FAS – Family Affluence Scale

GBD – Global Burden of Diseases

MVPA – Moderate to vigorous physical activity

NCD – Non-communicable diseases

NK – Nutritional knowledge

PA – Physical activity

PFW – Portuguese Food Wheel

PUFA – Polyunsaturated Fatty Acids

SES – Socioeconomic Status

T2DM – Type 2 Diabetes Mellitus

TEI – Total Energy Intake

WHO – World Health Organization

Introduction

Adolescence is a particularly vulnerable and sensitive period of human development as it is a life stage when major physical and psychological changes occur, being also a window of opportunity to the implementation of diet and physical activity habits that will subsist to adulthood.

Inadequate dietary habits and concomitant development of obesity and other chronic diseases are major problems nowadays, mainly because of the changes in lifestyle that have been occurring for the past years. This lifestyle changes are many times triggered by alterations in the environment that surround the individual. The influences of environmental factors in dietary behaviour are particularly notable during childhood and adolescence. Among these factors, family, social and economic influences deserve special mention.

Moreover, it has been shown that socioeconomic status (SES) is associated with the quality of children's and adolescents' diets, as well as with the development of obesity and other chronic diseases.

Parents' educational level (EL) is one of the three main predictors of SES and is also the most consistent one. It has been shown that more educated parents usually have children with better food habits and more adequate nutrient intake.

It is therefore important to understand the relationship between SES and family background and the adequacy of adolescents' diets. Being so, the major aim of the present study is to evaluate the association between parental EL and nutritional adequacy and fruit and vegetable consumption among adolescents. For that purpose, our secondary objectives are to (i) evaluate adolescents' food intake (ii) assess nutrient adequacy of adolescents' diets; (iii) study the results obtained according to parental EL.

Bibliographic research

Adolescence growth and development

The period of adolescence is broadly considered the one between the end of childhood and the beginning of adult life, however, an exact definition seems to be lacking between the scientific community because of the heterogeneity in the development process between different individuals (Lee, P.A., 1980). Being so, the World Health Organization (WHO) standardized for scientific purposes that adolescence is the life period between the ages of 10 and 19 years (Who, 2014).

During this life stage a series of physiological changes occur, particularly muscular and skeletal development and sexual maturity (Mesias, M. *et al.*, 2013; Rogol, A.D. *et al.*, 2002; Steinberg, L., 2005). The most important alterations during this development phase are the increase in growth rate, both in height and weight; the increase in the number and size of adipocytes (Alberga, A.S. *et al.*, 2012), with different body fat distribution for boys and girls (Pietrobelli, A. *et al.*, 2005); an increase in the percentage of fat free mass (Alberga, A.S. *et al.*, 2012); an increase in blood volume (Mesias, M. *et al.*, 2013); a high bone formation rate (Mesias, M. *et al.*, 2013); and other changes in body composition.

Besides the physical modifications adolescents also experience development at a psychological level. Puberty is a time of pronounced mental growth that includes the creation of a personal identity by building the individuals' own values, autonomy, independence and social importance (Steinberg, L., 2005). The social and peer relationships have a strong effect in the lifestyle and choices of adolescents, mainly because these individuals tend to build relationships with those with the same interests and behaviors (Valente, T.W. *et al.*, 2009), whom may exert positive or negative influences in the adolescents' health behavior and outcomes (Viner, R.M. *et al.*, 2012). The definition of economic interactions and the relationship with the socioeconomic environment are also initiated in this age period as adolescents are more autonomous and begin to spend more time outside the home environment, with increased access to different neighborhood services and to the resources, economic and others, that allow their use (Viner, R.M. *et al.*, 2012).

At this stage, individuals are able to make their own decisions, based on their knowledge and ability to recognize the effects that a specific behavior has in their future life (Tsang, S.K.M. *et al.*, 2012). However, social interactions are a major part in the decision making process as their influence might push someone towards healthy behaviors or attach that person to risk actions and attitudes (Steinberg, L., 2005; Viner,

R.M. *et al.*, 2012). The problem is that adolescents usually chose to be involved in unsafe activities, even though they are aware of the risks. This is the life stage when people acquire more risk habits and behaviors (Steinberg, L., 2007; Sweeting, H. and West, P., 2005).

All these modifications at social, emotional and physical levels, as well as the new interactions adolescents' experience make this life stage a unique window of opportunity for health promotion, but also a critical point for the existence of various health risks.

Dietary habits and of other lifestyle variables acquired during childhood and adolescence will track into adulthood. This way, the implementation of heathy eating and physical activity practices during these life stages is of major importance, not only to prevent immediate negative health outcomes, but also to prevent the decay of diet quality and the development of diseases later in life (Sawyer, S.M. *et al.*, 2012).

Social inequalities and nutritional intake

Obesity and some chronic diseases have strongly been associated with the social position and economic power (Drewnowski, A., 2009; Loring, B. and Robertson, A., 2014), fact that alights the inequities observed in health distribution. An inverse association between an individual's SES and the risk to develop obesity and other chronic diseases was found (Drewnowski, A., 2009; Loring, B. and Robertson, A., 2014), so poorer individuals are usually fatter and sicker than the more advantaged ones. The problem is that this inequities are widening, with the high SES individuals becoming healthier and the ones from lower strata becoming more obese (Loring, B. and Robertson, A., 2014).

Portugal has been facing an economic and political crisis in the past years that considerably affects people's purchasing power and, consequently, the amount of money they have available for the different expenses, mainly for food. It is then understandable that people would try to limit day-to-day expenses in order to have money available to all their activities. This way, the amount of money people will be willing to spend on food would decrease and individuals would look for the most affordable items. It has been proven that low-nutrient, energy-dense foods and beverages are associated with a lower cost and that healthier foods and behaviors are more expensive (Drewnowski, A., 2009).

Diet cost is very difficult to be correctly measured and, depending on the way this issue is approached, different findings are obtained. For instance, in a cost per edible weight or portion size point of view, fruits and vegetables tend to be cheaper than inadequate foods (Carlson, A. and Frazão, E., 2012). On the other hand, if a price per calorie approach is used, than it is more likely that less healthy foods, high in sugar and

fat, are more affordable (Carlson, A. and Frazão, E., 2012; Darmon, N. *et al.*, 2004; Drewnowski, A. *et al.*, 2004). Besides the cost of foods, taste and preferences have great importance in the decision making process for people from lower SES backgrounds, as they will be more willing to spend their money on palatable foods (Drewnowski, A. *et al.*, 2004).

However, a healthy diet is still seen as more expensive than less adequate options (Darmon, N. and Drewnowski, A., 2008) and being food price a recognized determinant of food choice, not only for adults but also for children and adolescents (Engler-Stringer, R. *et al.*, 2014), individuals will tend to choose unhealthy food items that, besides being more palatable are more financially accessible.

Obesity and health inequities are also linked to education. Usually, more advantaged people are also more educated and thus better able to access, interpret and apply health information. Education and knowledge of health and nutrition are tools to healthier choices and stand out because they keep to be effective even when other constraints exist (Parmenter, K. *et al.*, 2000). This means, for instance, that even if there is a lack of financial resources to engage in healthy habits or a lower availability of healthy food options, people with better education will still have the information to make the best possible choice under the given circumstances.

Being so, education and nutritional knowledge (NK) may actually be in the base of the observed growing inequalities in health and nutrition (Parmenter, K. *et al.*, 2000). This happens because there is an increasing in health information, constantly updated, available do people but, unfortunately, only those with access to the right tools, ie those with more education, will be able to assimilate and use that information, which leaves out all other individuals, with lower educational background, that will not be able to understand the information provided, neither to use it for improving their own and their families' health status (Parmenter, K. *et al.*, 2000).

Nutritional intake in adolescents

All the changes that occur during adolescence require satisfactory nutrition, both in terms of energy and nutrients (Mesias, M. *et al.*, 2011), so that adequate growth and development can be assured. It has become of general knowledge among the scientific community that inadequate nutrition in adolescent, mainly through excessive intake of energy, total and saturated fats, cholesterol, sugars and salt, may be on the base of the development of chronic diseases such as obesity, hypertension, cardiovascular diseases (CVD), diabetes and even cancer (Who, 2003) later in life.

Adequate energy intake during childhood and adolescence is crucial to guarantee a healthy development. An excess in energy intake may conduct to a positive energy balance and cause excess weight and consequent obesity. On the other hand, intake of energy below the needed amount may cause growing delays and weight loss (Who, 2001a). Energy intake is guaranteed through the intake of macronutrients, namely proteins, carbohydrates and fats, each of which have different contributes. Proteins and carbohydrates contribute with 4 Kcal per gram, while fats adds 9 Kcal per gram. Having this in mind, it is recommended that for adolescents aged 4 to 18 years energy intake should be distributed as follows: 45%-65% of carbohydrates, 10%-30% of proteins and 25%-35% of fats (Otten, J.J. *et al.*, 2006).

Proteins are an important nutrient for the building of muscle mass, so an intake below recommendations may cause delays in growth and development in this life stage, as well as loss of lean body mass and alterations in body composition (Who, 2002).

As for carbohydrates, they are a group of energetic nutrients, so they are essential to guarantee energy input. Fibre is one of the most important carbohydrates for adequate bowl function and the prevention of chronic diseases such as obesity and diabetes in adults, however their role in children and adolescents' health is not so well documented (Kranz, S. *et al.*, 2012). Even so, a review has shown that fibre intake in childhood and adolescence seems to contribute to the improvement of conditions such as constipation, obesity and diabetes (Kranz, S. *et al.*, 2012). Sugars constitute another group of carbohydrates that should also be considered when addressing adolescents' health. In fact, WHO has recognized that excess intake of free sugars is positively associated with increased body weight and with the development of dental caries, in children and adolescents. Being so, this organization suggests that, for both children and adults, free sugars' intake should be limited to 10% of total energy intake (Who, 2015).

The group of dietary fats is also important for children and adolescents. First, it is crucial that intake of saturated and trans fatty acids (FA) stays below the limit established as these nutrients tend to favour the development of CVD (Fao, 2010). On the other hand, dietary fats facilitate the absorption of lipid-soluble vitamins and are rich in essential fatty acids (EFA), namely omega-3 and omega-6 polyunsaturated FA, that are essential for adequate growth and development as our organism is not able to produce them (Fao, 2010). Increasing importance has been attributed to the role of EFA in childhood development, namely in the development of the central nervous system, as they are a vital part of membrane construction and their participation in generating and transmitting electrical impulses has also been established (Fao, 2010; Sinn, N. *et al.*, 2010; Uauy, R. and Dangour, A.D., 2009). Moreover they present anti-inflammatory, anti-thrombotic and

vasodilator properties, being involved in the prevention of CVD (Fao, 2010; Sinn, N. *et al.*, 2010; Uauy, R. and Dangour, A.D., 2009). Their role in growth and well-being is diverse and in some cases not well defined yet, so further studies are needed to clarify their action in disease prevention and health promotion. Even so, EFA, mainly omega-3, have been associated to the preventions and treatment of several mental illnesses, both in adults and children (Sinn, N. *et al.*, 2010; Uauy, R. and Dangour, A.D., 2009).

As for micronutrient needs, they usually are higher during adolescence for adequate growth and development. Iron needs are increased during adolescence due to the higher needs of haemoglobin needed to the expansion of blood volume and myoglobin needed to the growing of muscular mass. Also, if iron needs are not suppressed risk of developing anaemia is increased (Mesias, M. *et al.*, 2013). Iron needs are more elevated among adolescent girls than in boys because of blood loss during their menstruation (Who, 2001b). In this view, adequate copper intake is also important due to its role in iron absorption, release and incorporation in haemoglobin (Collins, J.F. and Klevay, L.M., 2011).

Along with growing muscle mass also the development of bone mass and of the endocrine system occurs during adolescence, fact that increases the needs of calcium (Mesias, M. *et al.*, 2011; Who, 2001b) and vitamin D (Misra, M. *et al.*, 2008; Who, 2001b) in this life stage. Magnesium is also linked to bone formation so its adequate intake must also be assured (Zofkova, I. *et al.*, 2013). Besides, low serum magnesium levels also seem to be related to the development of insulin resistance in obese children (Celik, N. *et al.*, 2011).

Zinc is known for its role in growth and sexual maturity, due to its participation in cell division and protein synthesis processes, fact that increases its needs during adolescence (Who, 2001b). Moreover, its deficiency has also been associated to respiratory infections, stunting, diarrhea and dermatitis (Who, 2001b; Willoughby, J.L. and Bowen, C.N., 2014).

Adequate folic acid intake is also important during adolescence, not only because it is involved in the formation of lean body mass, but also because girls enter reproductive age during adolescence and folic acid is crucial to the prevention of neural tube defects in the fetus (Dean, S.V. *et al.*, 2014; Who, 2001b).

Sodium is a micronutrient that deserves special consideration as its intake must be below the defined upper limit. Reduced sodium intake is associated with decreased systolic and diastolic blood pressure, which may prevent the development of diseases such as stroke and fatal coronary heart disease (Who, 2012a).

Moreover, attention must also be addressed to other micronutrients such as vitamin K, fluorine, manganese (Zofkova, I. *et al.*, 2013) and potassium (Who, 2003) as their deficiency is also a threat to overall health, particularly cardiovascular (Who, 2003) and bone (Mesias, M. *et al.*, 2011; Zofkova, I. *et al.*, 2013) health.

Being so, nutritional adequacy of adolescents' diets is an issue of worry. A recent study, the first to include data from several European countries (Greece, Germany, Belgium, France, Hungary, Italy, Sweden, Austria and Spain), has assessed nutritional intakes of adolescents aged 12.5 to 17.5 years (Diethelm, K. *et al.*, 2014). It was shown that the most concerning nutrients were polyunsaturated fatty acids (PUFA), vitamin D, folate, calcium, iodine and fluorine because of low intake, and protein, saturated FA, sodium and chloride for excessive consumption. Intakes of energy, fiber, vitamin D, folate, iron, vitamin A, saturated FA and sucrose are of concern in Finnish adolescents (Hoppu, U. *et al.*, 2010), whilst for Germany adolescents there is a need to focus on the intake of folate, iron and calcium (Libuda, L. *et al.*, 2009). Canadian children and adolescents showed intakes below recommendations for calcium, magnesium, vitamin and vitamin D (Barr, S.I. *et al.*, 2014).

To the best of our knowledge there are no Portuguese studies specifically describing the nutritional adequacy of adolescents' diets. Even so, a study showed that Portuguese children consume higher amounts of total fat and protein and lower of carbohydrates and polyunsaturated FA than it is recommended. Moreover, these individuals also present a high degree of inadequacy for folate, vitamin E, molybdenum, calcium and fiber intake and a lower inadequacy degree of vitamins B1, B2, B6, B12, PP and A, magnesium, phosphorus, zinc, iodine, selenium and iron intakes (Valente, H. *et al.*, 2010). Although this study was performed in children, it is also an alert to adolescents' nutritional intake as the quality of the diet tends to decline from childhood to adolescence (Demory-Luce, D. *et al.*, 2004).

Despite adolescents being considered healthy individuals, it's of major importance to promote healthy lifestyles as most of the consequences of poor nutrition and lack of physical activity, as well as other risk behaviors, tend to occur later in life. People, and specially adolescents, base their choices more on its immediate consequences, mainly social, rather than on the long term outcomes, that usually relate to health (Steinberg, L., 2005; Who, 2003). It has been widely spread that not only health problems but also habits acquired during adolescence tend to track into adulthood, making it harder to prevent disease and to engage in healthier lifestyles than it would be sooner in life (Lee, H. *et al.*, 2013; Who, 2003).

Fruit and vegetable intake in adolescents

It is known that healthy dietary behaviours are, along with adequate levels of physical activity, a key element for a healthy lifestyle and for the prevention of malnutrition and non-communicable diseases (NCD). Moreover, adequate fruit and vegetable (F&V) consumption is considered one of the most important modifiable factors for the prevention of NCD (Who, 2003), particularly CVD and certain types of cancer (Rodgers, A. *et al.*, 2002). The Portuguese Directorate-General of Health, based on data from the Global Burden of Diseases (GBD), has identified inadequate dietary habits as the fact that most contributes to the total years of healthy life lost by the Portuguese population. On the top of the list of these habits we find diets poor in fruit, high in sodium, and poor in vegetables, in descending order (Bordalo, A. *et al.*, 2015).

The importance of F&V intake for a healthy life has been widely studied and reviewed and its role in a balanced and nutritious diet is well defended (Boeing, H. *et al.*, 2012; Who, 2003). The beneficial effects in overall health are supported by its high content in vitamins, minerals, fiber and other dietary components such as antioxidants, sulfur-containing compounds and phytochemicals (Kushi, L.H. *et al.*, 2012; Van Duyn, M.A. and Pivonka, E., 2000). F&V role in the prevention of chronic diseases has been explored but the effects vary, so an individual analysis is important.

In what concerns to CVD, the relationship with F&V intake is strong. In fact, evidence regarding the association between high F&V intake and lower risk of developing coronary heart disease, hypertension and stroke was classified as convincing (Boeing, H. *et al.*, 2012). Two recent meta-analysis have strengthen the association between high F&V intake and lower risk of mortality from all causes and CVD (Wang, X. *et al.*, 2014; Zhan, J. *et al.*, 2015). The protective effect of F&V consumption is limited to 5 servings per day (a serving equals 77 g for vegetables and 80 g for fruit), after which the risk does not reduce further (Wang, X. *et al.*, 2014). The mechanism by which the protective effects might act are various and are linked to the high content of antioxidant compounds and polyphenols present in F&V that prevent blood lipids' oxidation (Agudo, A. *et al.*, 2007; Asplund, K., 2002), the small decrease in blood pressure that may be provided by the intake of F&V (John, J.H. *et al.*, 2002) and its content in magnesium and potassium that contribute to prevent mortality from CVD (Hunt, B.D. and Cappuccio, F.P., 2014; Kolte, D. *et al.*, 2014; Zhan, J. *et al.*, 2015).

The relationship between F&V consumption and cancer risk is the most controversial association, although it is widely studied, maybe because effects of F&V intake vary with different types of cancer (Wang, X. *et al.*, 2014; Zhan, J. *et al.*, 2015). Overall, it seems that there is probable evidence that F&V intake may reduce cancer risk

(Boeing, H. *et al.*, 2012), but this is a weak association (Boffetta, P. *et al.*, 2010), however a recent meta-analysis has shown no association between consumption of this type of foods and cancer development (Wang, X. *et al.*, 2014). A recent report from the European Prospective Investigation into Cancer and Nutrition (EPIC) studies noted that there is a significant, although small, association between high intake of F&V and lower risk of mouth, pharynx, larynx, esophageal and lung (just in current smokers) cancers (Bradbury, K.E. *et al.*, 2014).

The effects of F&V in reduction of type 2 diabetes mellitus (T2DM) risk seems to be differential between the two food groups. In fact, a recent review that analyzed a total of 9 studies on F&V consumption and T2DM found a significant inverse association with T2DM only for the intake of green leafy vegetables and root vegetables and not for fruit and other types of vegetables (Wu, Y. *et al.*, 2015). The same is shown in an older meta-analysis (Cooper, A.J. *et al.*, 2012). A direct relation between F&V consumption and incidence of T2DM hasn't however been found (Boeing, H. *et al.*, 2012; Wu, Y. *et al.*, 2015). The mechanisms by which beneficial effects occur are not well established and still need further investigation, however, it was suggested that it might be related to the fact that F&V may lower the likelihood of weight gain (Alinia, S. *et al.*, 2009; Boeing, H. *et al.*, 2012), to the high magnesium content of GLV (Schulze, M.B. *et al.*, 2007) which may improve glucose metabolism or to the upgrading of overall diet quality (Fulton, S.L. *et al.*, 2014).

The role of F&V in body weight is not so deeply understood. It seems that F&V intake may provide a light decrease in body weight or a reduction in weight gain (Alinia, S. *et al.*, 2009; Mytton, O.T. *et al.*, 2014). It seems to exist possible evidence that F&V intake may contribute to weight maintenance (Boeing, H. *et al.*, 2012), however to increase these food's intake *per se* doesn't seem to stimulate weight loss (Boeing, H. *et al.*, 2012; Mytton, O.T. *et al.*, 2014). The mechanisms behind are still not established but may be linked to a reduction in energy intake (Alinia, S. *et al.*, 2009), however even this is not certain (Mytton, O.T. *et al.*, 2014), or an improvement in overall diet profile such as increase in micronutrient and fiber intake and decrease in fat intake (Fulton, S.L. *et al.*, 2014). Studies addressing the effect of F&V consumption in body weight in children and adolescents are lacking (Boeing, H. *et al.*, 2012).

Having in mind all the cited beneficial effects, several recommendations and campaigns have been developed in order to promote F&V intake. WHO recommends the intake of at least 400g of fruits and vegetables, together, in order to promote good health. As for the Portuguese references, the Portuguese food guide (the Portuguese Food Wheel (PFW)) divides F&V in two different groups in order to emphasize the need to

include both in a balanced diet, not only because of their different nutritional value but also because of their different use in meals. This guide recommends the intake of 3 to 5 portions of each group daily. A portion of fruit equals 160g of raw fresh fruits and a portion of vegetables is represented by 140g of cooked vegetables. According to the PFW recommendations, adolescent girls should achieve 4 portions and male adolescents should consume 5 portions of each of these food groups (Rodrigues, S.S. *et al.*, 2006).

The concern with the intake of F&V increases when we look to the prevalence of adequate intake among younger individuals. Studies conducted in European countries (Diethelm, K. *et al.*, 2012; Lynch, C. *et al.*, 2014), one of which included information of 11-year-old Portuguese children's diets (Lynch, C. *et al.*, 2014), showed that F&V intake in young populations is below recommended values. The first study compared European adolescents' F&V intake with recommendations described in the Dietary Guidelines for Americans 2005 (Thompson, T.G. and Veneman, A.M., 2005) and showed that only 35% of the boys achieved the recommendations for F&V while girls presented a prevalence of adequate intake of 40% for vegetables and 50% for fruit intake (Diethelm, K. *et al.*, 2012). A more recent study drawn similar conclusions with only 53,3% of children consuming fruit on a daily basis and a merely 23,5% achieving the recommended daily intake of 400g of F&V (Lynch, C. *et al.*, 2014). In Portugal, in 2010, prevalence of daily fruit consumption among adolescents was around 40% to 50% and of vegetables was about 20% to 30% (Vereecken, C. *et al.*, 2015).

F&V consumption also seems to differ between males and females. In Portugal, girls appear to have higher intakes of fruits and lower of vegetables comparing to boys (Lynch, C. *et al.*, 2014), still in other European countries girls showed higher intakes of both fruits and vegetables than their male counterparts (Diethelm, K. *et al.*, 2012; Nilsen, S.M. *et al.*, 2010; Vereecken, C. *et al.*, 2015).

Besides the low prevalence of adequate intake of F&V, a decline in the consumption of these food groups seem to occur from early to middle and from middle to late adolescence (Larson, N.I. *et al.*, 2007; Vereecken, C. *et al.*, 2015), fact that increases the importance that should be given to this age group. As if it were not enough, in past years a decrease in fruit consumption and a maintenance of the amount of vegetables consumed among Portuguese adolescents was shown (Vereecken, C. *et al.*, 2015).

Food choice determinants

The process behind food choice is complex and multifactorial, and it is influenced by a variety of factors from the biologically determined ones to those set by social or environmental elements. Figure 1 specifies the different dimensions of food choice.

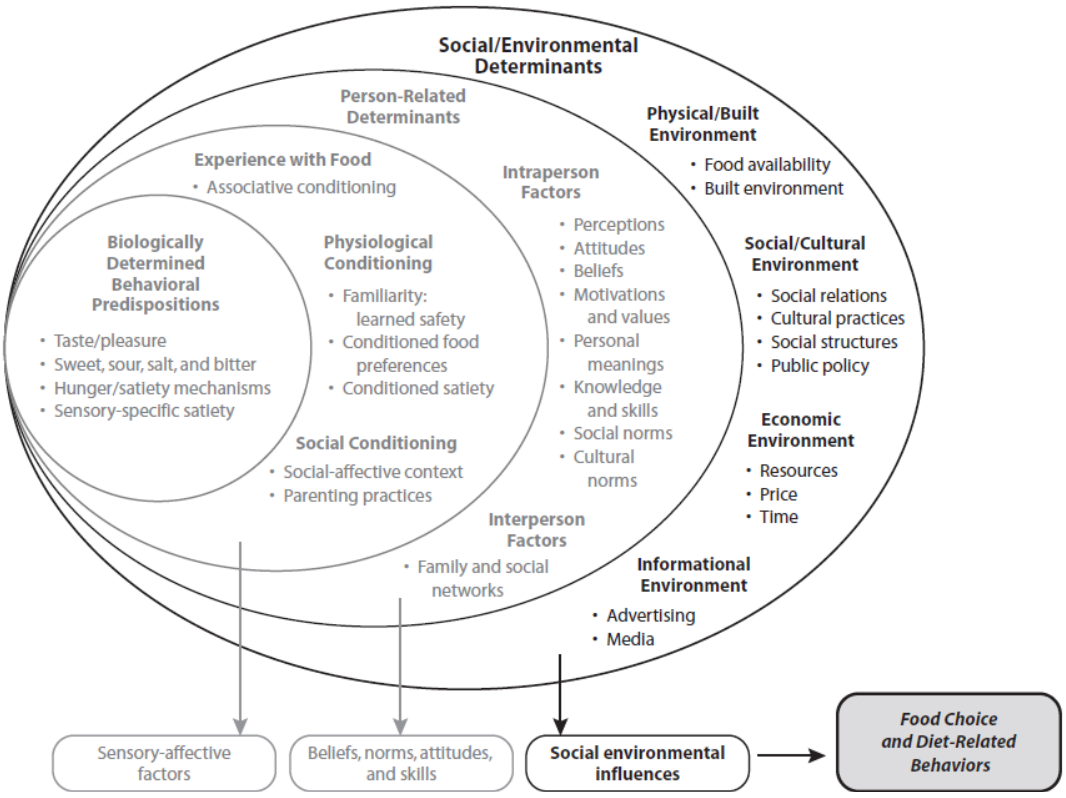

Figure 1 – The determinants of food choice. In: Contento, I. R. (2011). Nutrition education: linking research, theory, and practice (2nd ed.). Sudbury, Mass. Jones and Bartlett

Beginning with the most basic of the determinants, the biologically determined behavioral predispositions relates to the innate capacities of an individual to deal with food: the preference for sweet and salty foods and the rejection of sour or bitter ones; the mechanisms that control hunger and satiety; and the sensory experience food provides. This means that when it comes to choose something to eat or drink we will naturally follow our likes and dislikes first (Contento, I.R., 2007; Contento, I.R., 2008).

On the next level we find the sensory-affective factors, meaning the ones related to feelings and emotions towards food, the ability to learn to like something and the familiarity it acquires in our diet. After these, come the personal factors, both intra-personal, the ones defined by an individual's beliefs, attitudes, knowledge, skills and social norms; as well as inter-personal, which involve family, friends and other social relationship networks. In the last level arise the environmental factors that, even being the ones most distant from the individual itself, are possibly the ones that most influence exert in food choice nowadays. These factors are the food availability and accessibility; social, environmental and cultural practices; material resources; economic environment; and food

marketing practices. Usually, these determinants will help or hinder a person to follow their beliefs and knowledge (Contento, I.R., 2007; Contento, I.R., 2008).

Being so, our food choices are influenced, not only by our preferences, beliefs and knowledge, but also, and in a great extent, by other people, mainly our family, peers, neighborhood, school and the government. The economic environment, here represented mainly through family's SES, may also affect food choices and dietary habits, as nowadays knowledge of nutrition recommendations acquired through educational years and economic power will be reflected in the types of food items a family will incentive their children to prefer.

Socioeconomic status

According to the American Psychological Association, SES "is commonly conceptualized as the social standing or class of an individual or group. It is often measured as a combination of education, income and occupation" (Apa, 2015). A panel of experts that set recommendations to the United States Center for Education Statistics defined SES as "one's access to financial, social, cultural, and human capital resources" (Cowan, C.D. *et al.*, 2012).

It was early established that SES was a combination of three main predictors: education, occupation and income (Berkman, L.F. and Macintyre, S., 1997; Liberatos, P. *et al.*, 1988). However, it should be noticed that each of these three indicators influence health outcomes in a unique way and should not, therefore, be seen as interchangeable variables (Turrell, G. *et al.*, 2003). Turrel and colleagues reviewed the applications of each of these indicators to the nutritional background and noted that education relates to one's capacity to understand nutritional messages and food labels; occupation relates to cultures and norms developed by a specific professional group as well as with relationships established between coworkers; and income relates to the availability of material and economic resources that will facilitate or hinder one's access to healthy food items (Turrell, G. *et al.*, 2003).

The measurement of SES in children and adolescents has also been studied. The National Centre for Vocational Education Research from the Australian Government developed a document with some technical considerations on the subject (Lim, P. and Gemici, S., 2011). As children and adolescent still depend on family and do not have economic and financial independence, parental background characteristics should be considered when measuring a young individual's SES (Lim, P. and Gemici, S., 2011), for

example the parental occupation, parental education and family income (Cowan, C.D. *et al.*, 2012; Currie, C.E. *et al.*, 1997; Lim, P. and Gemici, S., 2011).

Parental occupational status may be assessed through the International Standard Classification of Occupations (Ilo, 2004) and the International Socio-Economic Index of Occupational Status (Ganzeboom, H.B.G. *et al.*, 1992). It's also important to define which parent's occupation will be used. It is possible to use the father's occupation only, considering that the male figure in the household is more engaged in the labor force; the highest status of occupation available, having in mind that the person with the highest occupational status contributes the most to the family's SES; or to use the father's occupational status and, when missing, the mother's, helping to reduce missing values (Lim, P. and Gemici, S., 2011). The Australian Government suggests the use of the third option (Lim, P. and Gemici, S., 2011).

Parental EL may be classified as the length of formal education or according to national or international classification systems, for example using the International Standard Classification of Education (Unesco, 2012). Apart to the way education is assessed, it is crucial to establish which parent's education attainment will be measured. Three approaches have been presented: to focus only on mother's education, as mothers usually are the ones more engaged in the child's rearing; to focus on the higher level of education in the family, as this individual may be the one to exert more influence in the family's SES; or to focus on mother's education and, if missing, the father's EL, having in mind that children are able to identify the EL of at least one of the parents (Lim, P. and Gemici, S., 2011). The Australian Government suggests the use of the third option (Lim, P. and Gemici, S., 2011).

The family income may be directly asked to the individual or through indirect questions about family's possessions and house conditions (Cowan, C.D. *et al.*, 2012). Although this is routinely used as a SES predictor as it directly represents the access to economic resources, if applied in a direct form, it is a sensitive and difficult question to be asked. Besides, children and adolescents usually do not know accurately or do not know at all their parent's income (Lim, P. and Gemici, S., 2011), a situation that may cause biased information or missing values. Usually family income is presented per capita, so that is possible to know the amount of money available for each member of the family (Cowan, C.D. *et al.*, 2012).

Other measures of the SES may be applied both at the individual level, such as the School Lunch Program participation and the family's possessions; or at the population's level using the neighborhood SES, the school SES or national data from the

CENSUS (Cowan, C.D. *et al.*, 2012). The problem with the population-based measures is that they do not accurately represent the individual's SES (Lim, P. and Gemici, S., 2011).

The measurement of SES should be a composite of the three main SES indicators, so that the different influences can be accounted for. There are some validated scales that allow the researcher to measure SES of an individual. One example is the Kuppuswamy's Socio-Economic Status Scale, developed in 1976. This scale uses the education and occupation of the head of the household and the family income as SES predictors. Moreover, due to the continuous modifications in world's economy, this scale is periodically updated (Gururaj and Maheshwaran, 2014).

The Family Affluence Scale (FAS) (Currie, C.E. *et al.*, 1997), besides the father's occupational status, takes into consideration questions that involve the ownership of goods and services that are somewhat related with the economic resources available in the family. This scale, developed to be applied to children and adolescents, asks the number of telephones in the household, the number of cars in the family, if the individual has a own unshared bedroom and the amount of money spent weekly (Currie, C.E. *et al.*, 1997). Updated versions of this scale have been recently used to assess young people's SES (Currie, C. *et al.*, 2008; Fismen, A.S. *et al.*, 2014).

Another method to evaluate the effect of SES through more than one indicator is the use of adjusted models (Galobardes, B. *et al.*, 2001; Sweeting, H. and West, P., 2005; Turrell, G. *et al.*, 2003; Zarnowiecki, D. *et al.*, 2014), in which usually a regression model is applied to simultaneously adjust all variables in study, namely education, occupation and income, or others the researcher finds useful.

There is also the possibility of constructing a new scale adapted to the study's purpose and variables. Some studies used their own SES composite which were developed specifically for those studies (Coombs, N. *et al.*, 2013; Nicholson, J.M. *et al.*, 2012; Parrott, M.D. *et al.*, 2013; Weyers, S. *et al.*, 2010).

It is important to wisely choose the indicators to use, always having in mind that all of them exert different effects in the variables in study. The use of a single indicator is not recommended as it can introduce bias in the study's results, mainly by underestimating the influence of SES (Turrell, G. *et al.*, 2003). However, constraints in data availability may limit researchers' access to the three SES indicators described above. In these cases, there should be used as much indicators as the ones that are at the researcher's disposal, so the different effects of each indicator can be accounted for and bias reduced (Turrell, G. *et al.*, 2003). Even so, no less importance should be given to the evaluation of the effects of each indicator separately in dietary outcomes, as they contribute to SES in diverse and not interchangeable ways.

The importance of parental educational level

Parental EL has been described as the strongest and most consistent variable to predict SES, mainly the mother's education (Zarnowiecki, D. *et al.*, 2014). It has been shown that a higher EL is consistently associated with better NK (Hendrie, G.A. *et al.*, 2008; Parmenter, K. *et al.*, 2000) and with better capacities in accessing, interpreting and applying health information (Ball, K. and Crawford, D., 2006; Parmenter, K. *et al.*, 2000). Furthermore, in a Portuguese study the mother's education, and not the father's, presented a relationship with dietary outcomes (Moreira, P. *et al.*, 2010).

This may be in the base of the greater healthy eating support (Ball, K. *et al.*, 2009) and importance attributed to nutrition and health when making food choices (Zarnowiecki, D. *et al.*, 2012) found in families with more educated mothers. On the other hand, less educated parents, besides privileging food price at the expense of its effects in health when purchasing food (Ball, K. and Crawford, D., 2006; Parmenter, K. *et al.*, 2000), don't always see the need and importance to give their children information on healthy eating (Zarnowiecki, D. *et al.*, 2012).

People with higher levels of education tend to have better NK and be better equipped with tools that allow them to understand and share the information they receive (Hendrie, G.A. *et al.*, 2008; Parmenter, K. *et al.*, 2000). Moreover, more educated adults usually have healthier dietary habits (Ball, K. and Crawford, D., 2006; Moreira, P.A. and Padrao, P.D., 2004), which makes them better role models to their children. The fact that well educated parents have good NK allows them, not only to make the best choices for themselves, this way having higher chances of following a good quality diet, but also to include their children in those healthful choices as well as to improve the quality of foods available at home.

Socioeconomic status and nutritional and dietary intake

The relationship between SES and diet quality and dietary habits has been studied by various authors. Low SES seems to be related with poorer dietary habits and less healthy behaviors (Ambrosini, G.L. *et al.*, 2009; Beghin, L. *et al.*, 2014; Bere, E. *et al.*, 2008; Craig, L.C. *et al.*, 2010; Golley, R.K. *et al.*, 2011; Nilsen, S.M. *et al.*, 2010; Stephens, L.D. *et al.*, 2011; Zarnowiecki, D. *et al.*, 2014). Children and adolescents whose mothers have low EL seem to have a more inadequate dietary intake (Ambrosini, G.L. *et al.*, 2009; Aranceta, J. *et al.*, 2003; Nilsen, S.M. *et al.*, 2010; Rasmussen, M. *et al.*, 2006;

Sweeting, H. and West, P., 2005). Moreover, it was shown that both lower education and lower occupational status were associated with bad dietary habits (Galobardes, B. *et al.*, 2001), as the more educated are more aware of the recommended healthy dietary behaviors (Hulshof, K.F. *et al.*, 2003).

Low maternal education has been associated to a greater intake of non-core foods, like sugar sweetened beverages, and with a lower intake of vegetables, as well as with a higher probability of engaging in unhealthy behaviours (Zarnowiecki, D. *et al.*, 2014). Moreover, adolescents who reported to follow a healthy eating pattern were more likely to have mothers with greater education, in contrast with their counterparts, whom had less healthy eating patterns and whose mothers were likely to be younger and less educated (Northstone, K. *et al.*, 2014). This highlights the contribution of mother's EL to the quality of their children's diets (Attorp, A. *et al.*, 2014).

Several studies have assessed the association between parental EL and dietary patterns followed by their children (Ambrosini, G.L. *et al.*, 2009; Grosso, G. *et al.*, 2013; Moreira, P. *et al.*, 2010; Northstone, K. *et al.*, 2014). Adolescents who follow healthier dietary patterns, that usually include foods from plant origin such as F&V, seem to have parents with high levels of education, mainly their mothers (Ambrosini, G.L. *et al.*, 2009; Moreira, P. *et al.*, 2010; Northstone, K. *et al.*, 2014). A study in Italy has also shown that adherence to the Mediterranean Diet pattern, that is known by a high intake of F&V, was higher in adolescents from high SES backgrounds (high parental occupational status and EL) (Grosso, G. *et al.*, 2013).

Intake of F&V as an individual food group also seems to be influenced by parental SES. Generally, adolescents whose parents have high levels of education reported eating more F&V than those whose parents do not have such high levels of education (Araujo, J. *et al.*, 2011; Bere, E. *et al.*, 2008; Lehto, E. *et al.*, 2015; Nilsen, S.M. *et al.*, 2010; Rasmussen, M. *et al.*, 2006), being these associations more pronounced for mother EL (Nilsen, S.M. *et al.*, 2010; Rasmussen, M. *et al.*, 2006). Other studies suggest that associations between parental EL and fruit intake are similar for boys and girls but when vegetable intake is considered, it seems that relationships of these foods' intake and parental EL are stronger for boys (Cameron, A.J. *et al.*, 2012; Finger, J.D. *et al.*, 2015).

Most of the studies in this field of research emphasis the relationship between SES and the consumption of specific food groups, leaving the association between SES and the intake or status of specific nutrients behind (Iglesia, I. *et al.*, 2014; Novakovic, R. *et al.*, 2014).

Studies relating SES and macronutrient intake are scarce and outdated (Van Der Horst, K. *et al.*, 2007). Nevertheless, lower EL of the head of the family was associated

with higher intakes of energy, protein, sodium and cholesterol, whilst higher household income was related to lower intakes of the same nutrients, except for cholesterol (Mazur, R.E. *et al.*, 2003). Another study found that intakes of trans FA, saturated FA, monounsaturated FA and cholesterol were negatively associated to EL; and higher intakes of carbohydrates, protein and fibre were related to higher EL (Xie, B. *et al.*, 2003). However, these associations are not consistent as Tur et al. didn't find any significant relations between the mother's level of education and the intake of carbohydrates (total, mono-, di- and polysaccharides and dietary fibre), protein (total and from animal and vegetable origin) and fat (total, saturated, monounsaturated and polyunsaturated fat and cholesterol) (Tur, J.A. *et al.*, 2004).

In terms of micronutrient intake more studies that focus on the relationship of SES and the intake of micronutrients are needed, particularly in Europe. Even so, parental EL was the most studied SES indicator, followed by household income (Novakovic, R. *et al.*, 2014).

A study in adolescents reported a reduction of about 40% in the risk of poor nutritional intake when the individual belonged to the higher social class (Serra-Majem, L. *et al.*, 2002). Moreover, a British study found that household income and social class were associated with lower intakes of most vitamins and minerals, particularly in boys (Smithers, G. *et al.*, 2000).

The intake of calcium and vitamin D is correlated with family income and EL (Martini, L.A. *et al.*, 2013; Xie, B. *et al.*, 2003), with a higher intake of these nutrients being found among individuals with higher levels of education (Matthys, C. *et al.*, 2006) and whose mothers have better EL (Cribb, V.L. *et al.*, 2011; Navia, B. *et al.*, 2003). The association between calcium intake and maternal EL seems to be stronger for girls (Tur, J.A. *et al.*, 2004).

The intake of folate is associated with both maternal and paternal EL (Iglesia, I. *et al.*, 2014; Xie, B. *et al.*, 2003) with lower intakes being found among children (Navia, B. *et al.*, 2003) and adolescents (Cribb, V.L. *et al.*, 2011) with mothers with low EL.

The intake of vitamin B12 was also related to the maternal education and occupation in females and with parental education in males (Iglesia, I. *et al.*, 2014). However, results seem to vary according to age as it was found that in children higher intakes of this vitamin were associated with lower EL from the mothers (Navia, B. *et al.*, 2003) and in adolescents higher intakes were related to better mother's EL (Cribb, V.L. *et al.*, 2011).

When it comes to the intake of vitamin C, iron, selenium and zinc it was shown that the higher the mother's EL, the more adequate was the intake of these nutrients (Cribb,

V.L. *et al.*, 2011; Mazur, R.E. *et al.*, 2003; Navia, B. *et al.*, 2003). For adolescent girls, higher intakes of magnesium, phosphorus and iron were associated with higher maternal EL (Tur, J.A. *et al.*, 2004). Higher maternal EL was also associated to higher intakes of sodium in adolescent boys and girls (Tur, J.A. *et al.*, 2004).

Being so, children and adolescents from low SES backgrounds seem to be a special group in what concerns to the improvement of eating habits, as it is important to act in this age group and prevent the decay of diet quality into adulthood (Lien, N. *et al.*, 2001).

Given the exposed, it is absolutely crucial to understand the relationship between the socioeconomic background and dietary outcomes in order to design intervention programs that will be well addressed and effective in this specific population.

Purposes and structure

As discussed in the theoretical background, it is widely accepted that SES, particularly parental EL, is a relevant determinant of food choice and, consequently, of the amount and type of nutrients an individual ingests. Being so, it is crucial to understand the relationships between parental EL and the adolescents' food and nutrient intake. This is the main objective of this work, which is being studied in two research papers:

Paper I: Parental educational level and nutritional adequacy in Portuguese adolescents

Paper II: Parental educational level and fruit and vegetable intake in Portuguese adolescents

General methodology

Project characterization

The project "Afina-te!" is an intervention program in adolescents to promote physical fitness, physical activity and nutritional knowledge.

This project comprises the measurement of physical activity using accelerometers, the estimation of cardio-respiratory fitness and the evaluation of nutritional knowledge and practices through the application of various questionnaires. This is an experimental study that uses both school and internet based actions to promote healthy behaviors related to physical activity and nutrition. Students, parents, teachers and school departments are involved in curricular and extracurricular activities. The sample for the study consists of 1000 adolescents aged between 12 and 19 years from the District of Porto.

The main aims of this project are (i) the validation of the Nutritional Knowledge Quiz for young people; (ii) to explore the associations between cardio-respiratory fitness, physical activity and food knowledge; (iii) to evaluate the effects of an intervention program based at school and on the internet, involving the promotion of physical activity and healthy nutrition behaviors; and (iv) to study adolescents' nutritional and dietary intake, as well as possible associations with sociodemographic and lifestyle variables.

The project has several researchers working, namely research fellows, PhD students, post-doctoral students and college professors. I'm a research fellow of this project and my function relates to the data collection in the schools, codification and interpretation of nutrition-related questionnaires, writing of scientific papers and elaboration of presentations for the scientific community, in congresses, for instance, and for the participants in the project.

Population

The data to this study belongs to a sub-sample of the project and was collected in a basic and secondary school from the north of Portugal in the 2012/2013 school year. There were evaluated a total of 302 students (160 girls) aged between 12 and 19 years old from the 7th to the 12th grade of education, a sub sample selected from the participants in the project Afina-te!. Their weight ranged from 34,5 kg to 109,0 kg, their height varied between 1,45 m and 1,85 m and their body mass index (BMI) ranged from 15,31 kg/m^2 to 40,53 kg/m^2, with 71,5% of the students having a normal weight, 25,8% being overweight and 2,6% obese, according to the classification of Cole (Cole, T.J. and Lobstein, T., 2012).

Questionnaires

The project Afina-te! Used numerous questionnaires during data collection, however to fulfill the purposes of this dissertation only the Questionnaire of Physical Activity Knowledge, that provided the necessary sociodemographic information, and the Food Diary were used.

Ethical questions

Ethical considerations were taken into account as the project “Afina-te!” was approved by the Research Centre in Physical Activity, Health and Leisure Scientific Committee, all parents from participating students signed a written informed consent, schools directors gave their ethical approval and adolescents were allowed to refuse to participate. Moreover, the guidelines defined in the Declaration of Helsinki were followed.

Original research

The two original research papers that form part of the present dissertation will be presented in this chapter.

Paper I

Parental educational level and nutritional adequacy in Portuguese adolescents

Raquel Esteves; Pedro Moreira; Vera Ferro-Lebres; José Ribeiro

Submitted

Abstract

Objective: The aim of the present study is to evaluate the relationship between adolescents' nutritional adequacy and parental EL.

Design: Sociodemographic, anthropometric and dietary information were collected. The intake of 22 nutrients was evaluated and a nutritional adequacy score was constructed. Evaluation of nutritional adequacy was conducted using the estimated average requirement cut-point method. Sex differences were taken into account, as well as the influence of possible confounders. A logistic regression model was applied for statistical analysis, through SPSS.

Setting: Basic and secondary school from the north of Portugal

Subjects: The sample of the present study included 302 adolescents aged 12 to 19 years

Results: Nutritional adequacy of the adolescents' diets was low, with girls being classified with 58.05±9.02% in the nutritional adequacy score and boys with 62.89±10.58%. Vitamin A, vitamin D, vitamin E, folate, calcium, magnesium and sodium were the nutrients with the higher percentages of inadequate intake. Analyzing the relationship of nutritional adequacy and parental EL, we note that adolescents whose mothers have high EL are more likely to have adequate nutritional intake than those whose mothers have low EL, independently of age group. Father EL appears not to be related to overall nutritional adequacy.

Conclusions: These results could provide directions for the design and implementation of nutrition education interventions and policies.

Keywords

Nutritional adequacy; Adolescents; Parental educational level; Socioeconomic status; Nutritional adequacy score

Introduction

Adolescence is a life period, between the ages of 10 and 19 years [1], which leads to a series of physiological and psychological changes. Moreover, social relationships, the influence of peers [2] and socio-economic interactions [3] gain importance in this life stage and adolescents become capable of making their own decisions [4].

All biological modifications will affect the adolescents' needs of energy and nutrients [5], which need to be satisfied in order to assure an adequate development. Unhealthy food habits lead to inadequate nutrition, that may be related to future health problems such as obesity and associated chronic diseases [6].

The adequacy of adolescents' diets was previously studied in foreign populations. It was shown that intakes of total fat and carbohydrates are usually within recommendations, while the intake of saturated fatty acids (FA) is far above recommendations [7, 8]. For protein intake both excessive [7] and adequate [8] intakes have been described. The intake of micronutrients such as polyunsaturated fatty acids (PUFA), vitamin D, folate, calcium, iodine, fluorine, iron and sodium seem to be inadequate among adolescents [7-9]. Other studies showed that calcium, vitamin D, vitamin K, zinc, copper, fluorine, manganese, magnesium, iron [10] and potassium [6] intakes should be taken into account as they exert prominent roles in adolescents' health [5, 6, 10]. To the best of our knowledge there are no Portuguese studies addressing nutritional adequacy of adolescents' diets.

Family's socioeconomic status (SES) seems to be negatively associated with the development of overweight and obesity [11, 12], as well as with dietary habits of adolescents [13, 14].

Adolescents' SES is usually measured through three main predictors of family's socioeconomic background: education, occupation and income [15-17], which should not be seen as interchangeable but studied individually and as a composite [18]. Parental educational level (EL) is the strongest and most consistent predictor of family's SES [13] as more educated individuals usually have better nutritional knowledge, being better equipped with intellectual tools to positively influence their children [19, 20], and have healthier dietary habits [21, 22].

Parental EL has been associated to adolescents' nutrient intake, although the number of studies in this field is scarce. It was found that lower EL of the head of the family relates to higher intakes of energy, protein, sodium and cholesterol [23]. Moreover, higher EL was associated to lower intakes of trans fatty acids, saturated fat, monounsaturated fatty acids and cholesterol and to higher intakes of carbohydrates, protein and fibre [24]. On the other hand, studies exist that contradict these findings, with no associations established between mother's EL and intake of carbohydrates, protein and fat [25].

Higher intakes of calcium and vitamin D [24, 26-28], folate [24, 27, 29], vitamin B12 [27], vitamin C, iron, selenium and zinc [23, 27, 28] and sodium [25] were related with higher parental EL. In adolescent girls, higher maternal EL was associated to higher intakes of magnesium, phosphorus and iron [25].

The association of family's SES and adolescents' diet quality measured through an index or score was also conducted. In fact, family's SES seems to be positively related to adolescents' diet quality [14, 30].

Being so, adolescents from low SES backgrounds, mainly those with low-educated parents, seem to be a group in need of special attention in what concerns to dietary habits that provide adequate intakes of nutrients.

It is our objective to study the association of family's SES, through parental EL, and nutritional adequacy in Portuguese adolescents. For this purpose, the evaluation of nutrient intake and family's social background is undoubtedly important.

Methodology

A total of 302 students (160 girls) aged between 12 and 19 years old from the 7th to the 12th grade of education, a convenience sample from a secondary school from the north of Portugal participating in the project Afina-te!, were evaluated. Age categories were applied consistent to the definition of early (12 to 14 years) and late (15 to 19 years) adolescence [31].

Socioeconomic data was obtained through a self-applied questionnaire that comprised fields such as age, sex, school grade, parents' EL and monthly family income. Parental EL was classified as the number of completed years of education: low EL (up to the 9th grade); medium EL (from the 10^{th} to the 12^{th} grade); and high EL (above the 12^{th} grade/university education). This approach has already been used in Portuguese populations [32, 33].

Anthropometric assessment was carried out with a SECA portable stadiometer (0,1 cm precision) to evaluate height and a TANITA BC-545 body composition analyser (100g precision) to measure weight. Anthropometric procedures were in line with guidelines of the World Health Organization (WHO) for the use and interpretation of anthropometry [34]. These data was then used to asses body mass index (BMI) [weight (kg) divided by the height (m) squared], which was categorized according to Cole's classification (31).

Nutritional data was obtained through the application of 3 days food diaries (2 weekdays and 1 weekend day) in which individuals were asked to report everything they would eat and drink on those days, as detailed as possible. Food was quantified in household measures, units, weight or individual portions, without the help of any quantifying instrument. Food data was converted into

nutrients according to the Portuguese Food Composition Table [35] and labels of specific foods when unavailable in the composition table.

To assess the nutritional adequacy, a score comprising 22 nutrients (proteins, carbohydrates, simple sugars, total fat, saturated fat, linoleic acid, vitamin A, vitamin C, vitamin E, thiamin, riboflavin, niacin, vitamin B6, folate, vitamin B12, iron, magnesium, phosphorus, zinc, vitamin D, calcium and sodium) was calculated. Micronutrients' (except sodium) adequacy was established for intakes above the Estimated Average Requirement (EAR) [36-38], while for macronutrients (except saturated FA) the intake was considered adequate if it was within the Acceptable Macronutrient Distribution Ranges (AMDR) described in the Dietary Reference Intake (DRI) document [37]. For saturated fat an intake below the one defined by the American Heart Association [39] was considered adequate while sodium intake should be below the tolerable upper intake level [37] to be acceptable. The proportion of intakes that don't respect this cut-points was examined to estimate the prevalence of inadequacy [40].

The nutritional adequacy score (NAS) was then calculated: each nutrient with adequate intake scored one point and those with inadequate intakes scored 0 points. The sum of all the nutrients allowed a maximum score of 22 points (if all the nutrients' intake was adequate) and a minimum of 0 points (if none of the nutrients reach an adequate intake). High nutritional adequacy was defined for NAS above the median value, which was separately calculated for girls and boys. Goldberg cut-off method [41] adapted by Black [42] was used to identify misreporters. Only those individuals who have adequately reported their energy intake were included in the analysis.

Physical activity (PA) level was measured through the use of Actigraph GT3X accelerometers for 7 consecutive days, according to published procedures [43]. Both parents and adolescents were informed about accelerometer use and the equipment started being used immediately. Students should wear the accelerometer, with an elastic band in the waist line and on their non-dominant side, from the time they woke up in the morning until bed time, except for water activities. Equipment was collected at the 8th day. Data was analyzed through Actilife (version 6.9, Actigraph, Florida) and was considered valid when a minimum of 8h/day of usage was recorded. Outcome data was measured in min/day and classified according to intensity in sedentary, light, moderate and vigorous activity [44]. Moderate to vigorous physical activity (MVPA) resulted from the sum of moderate and vigorous activities. The WHO recommends a minimum of 60 minutes of MVPA per day [45].

Statistical analysis was carried out using SPSS 21.0 and a logistic regression model was applied, with the NAS set as the dependent variable and sociodemographic characteristics (sex, age group, BMI, MVPA compliance, father EL and mother EL) set as independent. Those independent variables that presented an association with the NAS in the crude model were involved in the adjusted

models. The groups used as the reference of sociodemographic variables were those of lowest classification. Total energy intake (TEI) was also considered a confounder in the adjusted models. Statistical significance was set for *p* values below 0.05.

Results

From the initial sample of 302 students, only 179 (100 girls) reported their energy intake adequately, so these were the ones used in the present analysis.

Medium weight was 55.90±9.85 kg, individuals had an average height of 162.90±8.97 cm and BMI of 20.98±2.78 kg/m^2. Translating to percentages, 82.1% of the evaluated adolescents were normal weighted and 17.9% were overweight or obese. Distributions of sociodemographic variables by sex may be consulted in table 1.

Analyzing SES characterization it is possible to notice that, in what concerns to mother EL, 45.5% of the individuals had mothers with high EL, 30.1% had low-educated mothers and 24.4% had mothers with medium EL. The majority of the students had low-educated fathers (41.8%), 34.5% had fathers with high levels of education and 23.7% had fathers classified with medium EL.

The distribution of the NAS classifications in each sex according to sociodemographic variables is described in table 2. Mean adequacy score of the entire sample was 60.18±10.01% [minimum 31.82% (7 nutrients) and maximum 86.36% (19 nutrients)], while girls reached 58.05±9.02% and boys 62.89±10.58%, being these results significantly different (p=0.004). The highest score was found for boys whose mothers have high EL, with an average of 14 adequate nutrients among the total 22; and the lowest score was achieved by girls with low-educated mothers, with an average of 12 adequate nutrients.

Confronting nutrient intake with dietary recommendations it is possible to see that there are very low rates of nutrient adequacy in the studied sample (table 3). For macronutrients, total and saturated fat presented high percentages of intakes above the defined recommendations while protein, carbohydrates and simple sugars had the majority of students with adequate intakes. Most of the students didn't meet the recommendations for linoleic acid because of deficient intake. There were no significant differences in macronutrient adequacy between boys and girls.

Analyzing the results for micronutrient adequacy it is noticeable that more than 40% of the individuals didn't meet the dietary recommendations of vitamin A, vitamin D, vitamin E, folate, calcium, magnesium and sodium, while thiamin, riboflavin, niacin, vitamin B6, vitamin B12, iron and zinc presented relatively low rates of inadequacy. Statistical significant differences between the

effects of gender in nutrient adequacy were found for vitamin E, folate, calcium, magnesium and phosphorus with girls having lower adequacy rates than their male counterparts.

The relationship between several variables and the nutritional adequacy of adolescents' diets was evaluated through logistic regression models. Results are presented in table 4.

The crude model was implemented for each variable individually, presenting the results of their association with nutritional adequacy not accounting for the effect of possible confounders. Analyzing these data it is possible to notice that age group, MVPA compliance and mother EL seem to influence the probability of achieving higher nutritional adequacy. In this group, young and less active adolescents have higher chances of achieving a higher nutritional adequacy (p=0.005 and p=0.004, respectively). Moreover, students with high educated mothers are about 3 times more likely to have high adequate nutrient intake (p=0.002).

The first regression model applied included only age group and mother EL, which were the variables with significant influence in the NAS, besides MVPA compliance. This model was also adjusted for TEI. Results from model 1 show that both age group and mother EL remain significant (p<0.001 and p=0.008, respectively) and have trends similar to those shown in the crude model. TEI also proved to have significant effects in the model (p<0.001, data not shown).

PA was not included in the first model because only a very small subsample of the studied group completed the accelerometer use (64 out of 179 individuals) and the small sample size may bias results. Even though, we applied a second regression model that included this variable.

Being so, regression model 2 included age group, MVPA and mother EL and was adjusted to TEI. Age group and MVPA continue to have significant effects and similar trends (both with p=0.001). Mother EL loses significance (p for trend=0.546) and trends are inversed, with adolescents with mothers with medium EL having higher odds of an adequate nutrient intake than do the ones with high educated mothers. TEI also persist being significant in the model (p=0.039, data not shown).

Discussion

It seems to exist a relation between parental EL, mainly the mother's, and adequacy of adolescents' diets.

As it was expected by literature review [7-9], NAS and individual nutrients' percentages of adequacy were generally low. Even if results from our NAS are difficult to compare due to its methodological exclusivity, studying and comparing adequacy of specific nutrients gives us some understandings of the quality of these adolescents' diets.

In what concerns to macronutrients, the intake of total and saturated fat was much above de recommended values; protein, carbohydrates and simple sugars are within recommended intake; and

linoleic acid is far below the adequate intake. These results are in line with those of other Portuguese study in what respects to total fat and linoleic acid intake [46]. A recent study in European countries has shown similar results for saturated FA, carbohydrates and PUFA, however their individuals presented intakes of protein twice as high as the recommended value established [7]. A Finnish study also showed excessive intakes of saturated FA and adequate intakes of carbohydrates and protein among adolescents [8].

Fats provide 9 Kcal per gram [37], so an excessive intake may substantially increase TEI and conduct to a positive energy balance and consequent obesity. Besides, excessive intake of saturated FA promotes the development of CVD [47], while low intakes of essential FA such as the linoleic acid may compromise adequate growth and development [47].

Directing attention to micronutrients, this specific sample presents high inadequacy rates for vitamin A, vitamin D, vitamin E, folate, calcium, magnesium and sodium. Other Portuguese study also showed high rates of inadequacy for folate, vitamin E and calcium but low rates of inadequacy for vitamin A and magnesium in children [46]. These differences in results may be explained by the fact that nutritional adequacy of the diet tends to decrease with age [48]. In line with the same work, our results also show low inadequacy rates for vitamin B1, vitamin B2, niacin, vitamin B6, vitamin B12, iron and zinc [46]; this study didn't specify vitamin D and sodium intake.

Foreign studies also showed high inadequacy rates for vitamin A [49, 50], vitamin D [7, 8, 49, 50], vitamin E [49], folate [7-9, 49], calcium [49, 50] and magnesium [49, 50] for both sexes. Besides, it has been suggested that sodium intake is much above the recommendations in adolescents [7, 51-53].

Calcium and vitamin D intakes are of particular worry in this sample. Their low intake may hamper bone formation and healing and compromise the adequate development of the endocrine system [5, 54, 55]. Magnesium intake is also low, fact that may also relate to bone illnesses [10] and insulin resistance in obese children [56]. Folate intake is also low, mainly among girls, who should guarantee adequate folic acid intake during reproductive age in order to prevent malformations in the fetus [54, 57]. As for vitamin A, its low intake may compromise the adequate functioning of the visual, immune and reproductive systems, as well as interfere with growth and development [54]. Vitamin E deficiency may be related to damages in the cell caused by oxidative process that occur mainly against PUFA, proteins and DNA, which may conduct to muscular and neurological pathologies [54]. Excessive intakes of sodium are related to increase systolic and diastolic blood pressure, which may progress to serious diseases later on such as stroke and fatal coronary heart disease [58].

Even if an individual's intake of a specific nutrient is not within the recommended limits, it does not indicate the presence of a deficiency, however it could mean a possible deficiency that will be as greater the more distant are the ingested and the recommended values [59].

In the present study, girls had significantly lower classifications in the NAS and higher rates of inadequacy for vitamin E, folate, calcium, magnesium and phosphorus than boys, what has already been shown in Portuguese children [46].

According to the results obtained in the present study, maternal EL seems to be related to the adequacy of adolescents' diets, independently from age group and TEI but not from MVPA compliance.

Analyzing adolescents' dietary intake as a whole it seems that there is a relationship between overall nutritional adequacy of the diet and the mother EL, but not the father's. These results corroborate others presented in various studies, even if some have methodological differences [14, 30, 60-62].

When different nutrients intake was evaluated individually, it was found a positive influence of mother EL in the intakes of folate [27], vitamin C [23, 27, 28] and sodium [24]. Moreover, other authors have confirmed the relation between mother EL and folate [63] and magnesium [24] intake in adolescent girls and sodium intake in adolescent boys [24].

According to the studies mentioned above, it seems that mother EL is much more related to a better quality of the diet than the father EL, even if it has already been shown that a slight relationship with the latter might exist [64]. It is understandable that the relationship between maternal education and adequacy of the diet of their children is much solid than it is for paternal education, as mothers tend to spend more time with them [65] and are more engaged in household care, food purchase and its home availability [66], cooking and transmitting nutrition information to their children [67].

Manios *et al* [68] also studied the relationship between parental EL and their children's dietary intake, however they didn't evaluate results separately for mother and father EL. Even so, these authors found that the inadequacy rates of vitamin A, vitamin B2, vitamin B6, vitamin C, calcium and iron intakes were higher in children whose parents had lower EL.

Student's age also seems to negatively influence NAS, independently of mother EL and level of PA. In fact, it was already shown by other authors that diet quality tends to decline with age, with younger children having a more adequate nutritional intake [48, 69]. This might happen because in younger ages individuals are more susceptible to parental control and influence than in older adolescence, period during which peers and friends gain importance. In fact, the contact with people external to the household and socio-economic involvement is less accentuated in children than in adolescents [3].

As for the compliance with PA recommendations, adolescents who fulfilled recommendations of more than 60 min of MVPA per day were more likely to have an inadequate diet. This goes against what has been shown in the literature as generally, studies show that individuals with healthier dietary patterns are usually more active than those with less adequate food intake [70-73], however, this may not always be true [74].

This is, in fact, an unexpected result that may be explained, in our view, by the very small sample size with accelerometer use that may have bias results. Other approach to explain this variation is through the compensatory health beliefs model that defends the belief that engaging in healthy behaviors may compensate for unhealthy options people have made [75]. Being so, people may think that if they exercise they can indulge with unhealthy but palatable foods. In fact, a study has shown that young adults admitted to engage in PA in order to compensate for unhealthy food consumption [76].

This study presents some important strengths. The study topic is not well documented in the Portuguese literature, so the work adds some new and important information for health and education professionals and politicians. Moreover, the dietary intake measurement tool used allows for a detailed information on intake throughout the week, as it involves three days. The dietary information was adjusted for possible confounders, which strengthens the results, and adequate energy intake report and intra-individual variability were considered.

Even so, some limitations may be listed. First of all, this is a cross-sectional study and, as such, does not allow the inference of causality between variables. Self-reported food intake may introduce some bias to the dietary information collected, even when misreporting is considered. The measure used for the evaluation of SES, even being the most consistent and strong indicator, is not the ideal approach, as family income and parental occupation should also be taken into account for a complete SES composite measure. However, data unavailability didn't allow the optimization of SES evaluation, and underestimation of total SES effect may have occurred [77]. Even if family income was part of the questionnaire applied, the number of people in the household was not asked, so monthly income could not be adjusted, being this the reason why we discarded its application. The low number of individuals that completed accelerometer use may have negatively influence results. Further studies with bigger sample sizes are needed to verify the relations described.

Conclusions

In conclusion, this study suggests that higher maternal EL is related to better nutritional adequacy in Portuguese adolescents, independently of adolescents' age group but not PA level. This data must be considered when developing future intervention programs for individuals with a lower SES background. Deepen the existing knowledge about the relationship between SES and diet quality of Portuguese children and adolescents as well as the influence of other lifestyle variables should be a priority in future studies.

Table 1 – Sociodemographic characteristics by sex

		Girls (n=100)	Boys (n=79)	*p*
Age group	12-14 y	38 (38,0%)	27 (34,2%)	0,597
	15-19 y	62 (62,0%)	52 (65,8%)	
BMI	normal weight	82 (82,0%)	65 (82,3%)	0,961
	overweight/obesity	18 (18,0%)	14 (17,7%)	
MVPA	< 60 min/day	25 (78,1%)	12 (37,5%)	0,001*
	> 60 min/day	7 (21,9%)	20 (62,5%)	
Father EL	low	43 (43,4%)	31 (39,7%)	0,040*
	medium	29 (29,3%)	13 (16,7%)	
	high	27 (27,3%)	34 (43,6%)	
Mother EL	low	31 (31,3%)	22 (28,6%)	0,127
	medium	29 (29,3%)	14 (18,2%)	
	high	39 (39,4%)	41 (53,2%)	

BMI, Body Mass Index | MVPA, Moderate to Vigorous Physical Activity | EL, Educational Level | p values for qui-square test | *statistical significant differences

Table 2 - Distribution of nutritional adequacy score classifications by sex according to sociodemographic variables

Nutritional Adequacy Score (%)		Girls									Boys								
		Mean	SD	P50	MIN	MAX	P5	P25	P75	P95	Mean	SD	P50	MIN	MAX	P5	P25	P75	P95
Total		58,05	9,02	56,82	31,82	81,82	45,45	52,27	63,64	75,00	62,89	10,58	59,1	45,45	86,36	45,45	54,55	72,73	81,82
Age group	12-14 y	62,20	8,72	63,64	45,45	81,82	45,45	54,55	68,18	77,27	63,64	10,99	59,09	45,45	86,36	45,45	59,09	72,73	81,82
	15-19 y	55,50	8,28	54,55	31,82	81,82	40,91	50,00	59,09	68,18	62,50	10,45	59,09	45,45	81,82	50,00	54,55	70,45	81,82
BMI	normal weight	58,48	9,11	59,09	31,82	81,82	45,45	54,55	63,64	77,27	63,29	10,82	59,09	45,45	86,36	50,00	54,55	72,73	81,82
	overweight/obesity	56,06	8,54	54,55	40,91	72,73	40,91	50,00	63,64	72,73	61,04	9,55	59,09	45,45	77,27	45,45	54,55	68,18	77,27
MVPA	< 60 min/day	61,09	7,08	63,64	50,00	77,27	50,00	54,55	63,64	72,73	68,56	10,70	68,18	50,00	81,82	50,00	61,36	77,27	81,82
	> 60 min/day	61,09	12,82	59,09	50,00	81,82	50,00	50,00	77,27	81,82	58,86	10,98	56,82	45,45	86,36	47,73	50,00	59,09	84,09
Father EL	low	56,55	8,89	54,55	31,82	77,27	40,91	50,00	63,64	72,73	64,52	10,97	59,09	50,00	86,36	50,00	54,55	72,73	81,82
	medium	58,31	8,06	59,09	45,45	81,82	50,00	50,00	63,64	68,18	59,09	9,46	59,09	45,45	77,27	45,45	50,00	63,64	77,27
	high	60,27	10,13	59,09	40,91	81,82	45,45	54,55	68,18	77,27	63,24	10,46	63,64	45,45	81,82	45,45	59,09	68,18	81,82
Mother EL	low	56,16	8,34	54,55	40,91	77,27	45,45	50,00	59,09	77,27	59,50	9,40	56,82	45,45	81,82	50,00	54,55	68,18	77,27
	medium	57,05	9,76	54,55	31,82	81,82	40,91	50,00	63,64	72,73	61,36	8,87	59,09	50,00	77,27	50,00	54,55	68,18	77,27
	high	60,49	8,67	59,09	40,91	81,82	45,45	54,55	68,18	77,27	65,19	11,16	63,64	45,45	86,36	45,45	59,09	77,27	81,82

BMI, Body Mass Index | MVPA, Moderate to Vigorous Physical Activity | EL, Educational Level | SD, standard deviation | P, percentile | MIN, Minimum | MAX, Maximum

Table 3 – Percentages of adequacy of the 22 nutrients comprised in the Nutritional Adequacy Score

		Girls	Boys	*p*
Protein	Below	0,0%	0,0%	
	Adequate	100,0%	100,0%	-
	Above	0,0%	0,0%	
Carbohydrates	Below	34,0%	32,9%	
	Adequate	66,0%	67,1%	0,878
	Above	0,0%	0,0%	
Simple sugars	Below	88,0%	94,9%	0,106
	Above	12,0%	5,1%	
Total fat	Below	1,0%	2,5%	
	Adequate	42,0%	54,4%	0,154
	Above	57,0%	43,0%	
Saturated fat	Below	0,0%	0,0%	-
	Above	100,0%	100,0%	
Linoleic acid	Below	84,0%	86,1%	
	Adequate	16,0%	13,9%	0,700
	Above	0,0%	0,0%	
VIT A	Inadequate	43,0%	53,2%	0,176
	Adequate	57,0%	46,8%	
VIT C	Inadequate	39,0%	32,9%	0,400
	Adequate	61,0%	67,1%	
VIT D	Inadequate	97,0%	94,9%	0,479
	Adequate	3,0%	5,1%	
VIT E	Inadequate	83,0%	60,8%	0,001
	Adequate	17,0%	39,2%	
Thiamine	Inadequate	2,0%	1,3%	0,704
	Adequate	98,0%	98,7%	
Riboflavin	Inadequate	0,0%	0,0%	-
	Adequate	100,0%	100,0%	
Niacin	Inadequate	1,00%	0,00%	0,373
	Adequate	99,00%	100,00%	
VIT B6	Inadequate	2,0%	0,0%	0,206
	Adequate	98,0%	100,0%	
Folate	Inadequate	85,0%	67,1%	0,005
	Adequate	15,0%	32,9%	
VIT B12	Inadequate	2,0%	0,0%	0,206
	Adequate	98,0%	100,0%	
Calcium	Inadequate	92,0%	81,0%	0,029
	Adequate	8,0%	19,0%	
Iron	Inadequate	4,0%	0,0%	0,072
	Adequate	96,0%	100,0%	
Magnesium	Inadequate	69,0%	51,9%	0,020
	Adequate	31,0%	48,1%	
Phosphorus	Inadequate	17,0%	3,8%	0,005
	Adequate	83,0%	96,2%	
Zinc	Inadequate	5,0%	2,5%	0,398
	Adequate	95,0%	97,5%	
Sodium	Inadequate	97,0%	100,0%	0,121
	Adequate	3,0%	0,0%	

VIT, Vitamin | p values for qui-square test between groups

Table 4 - Variables associated with high nutritional adequacy

		N (% total)	Nutritional adequacy score		P^*	Crude			Model 1			Model 2		
			<P50	≥P50		OR	95% CI	$p^\dagger$	OR	95% CI	$p^\dagger$	OR	95% CI	$p^\dagger$
Sex	Girls	100 (55,9%)	50 (54,9%)	50 (56,8%)	0,801	1,000								
	Boys	79 (44,1%)	41 (45,1%)	38 (43,2%)		0,927	0,514-1,672	0,801						
Age group	12 - 14 y	65 (36,3%)	24 (26,4%)	41 (46,6%)	0,005‡	1,000			1,000			1,000		
	15 - 19 y	114 (63,7%)	67 (73,6%)	47 (53,4%)		0,411‡	0,219-0,769	0,005	0,229‡	0,108-0,485	<0,001	0,077‡	0,016-0,367	0,001
BMI	Normal weight	147 (82,1%)	72 (79,1%)	75 (85,2%)	0,286	1,000								
	Overweight/obesity	32 (17,9%)	19 (20,9%)	13 (14,8%)		0,657	0,302-1,427	0,288						
MVPA	< 60 min/day	37 (20,7%)	12 (38,7%)	25 (75,8%)	0,003‡	1						1		
	≥ 60 min/day	27 (15,1%)	19 (61,3%)	8 (24,2%)		0,202‡	0,069-0,592	0,004				0,088‡	0,020-0,383	0,001
Father EL	Low	74 (41,3%)	39 (43,8%)	35 (39,8%)	0,699	1,000								
	Medium	42 (23,5%)	22 (24,7%)	20 (22,7%)		1,013	0,475-2,162	0,973						
	High	61 (34,1%)	28 (31,5%)	33 (37,5%)		1,313	0,666-2,591	0,432						
p for trend								0,468						
Mother EL	Low	53 (29,6%)	35 (39,3%)	18 (20,7%)	0,008‡	1,000			1,000			1,000		
	Medium	43 (24,0%)	23 (25,8%)	20 (23,0%)		1,691	0,740-3,862	0,213	1,766	0,705-4,422	0,225	2,430	0,353-16,724	0,367
	High	80 (44,7%)	31 (34,8%)	49 (56,3%)		3,073‡	1,489-6,345	0,002	3,006‡	1,340-6,744	0,008	1,655	0,349-7,851	0,526
p for trend								0,002			0,008			0,546

Model 1, includes age group and mother EL, adjusted for total energy intake (continuous) | Model 2, includes age group, MVPA and mother EL, adjusted for total energy intake (continuous) | P, percentile | CI, Confidence Interval | OR, Odds ratio | BMI, Body Mass Index | MVPA, Moderate to Vigorous Physical Activity | EL, Educational Level | * p values for qui-square test | † p values for logistic regression analysis | ‡Statistical significant differences

References

1. WHO. Adolescent health: World Health Organization; 2014 [27.11.2014]. Available from: http://www.who.int/topics/adolescent_health/en/.

2. Valente TW, Fujimoto K, Chou CP, *et al.* Adolescent affiliations and adiposity: a social network analysis of friendships and obesity. The Journal of adolescent health : official publication of the Society for Adolescent Medicine. 2009;45(2):202-4.

3. Viner RM, Ozer EM, Denny S, *et al.* Adolescence and the social determinants of health. The Lancet. 2012;379(9826):1641-52.

4. Tsang SKM, Hui EKP, Law BCM. Positive Identity as a Positive Youth Development Construct: A Conceptual Review. The Scientific World Journal. 2012;2012:8.

5. Mesias M, Seiquer I, Navarro MP. Calcium nutrition in adolescence. Critical reviews in food science and nutrition. 2011;51(3):195-209.

6. Diet, nutrition and the prevention of chronic diseases. Geneva, Switzerland: 2003.

7. Diethelm K, Huybrechts I, Moreno L, *et al.* Nutrient intake of European adolescents: results of the HELENA (Healthy Lifestyle in Europe by Nutrition in Adolescence) Study. Public health nutrition. 2014;17(3):486-97.

8. Hoppu U, Lehtisalo J, Tapanainen H, *et al.* Dietary habits and nutrient intake of Finnish adolescents. Public health nutrition. 2010;13(6a):965-72.

9. Libuda L, Alexy U, Buyken AE, *et al.* Consumption of sugar-sweetened beverages and its association with nutrient intakes and diet quality in German children and adolescents. The British journal of nutrition. 2009;101(10):1549-57.

10. Zofkova I, Nemcikova P, Matucha P. Trace elements and bone health. Clinical chemistry and laboratory medicine : CCLM / FESCC. 2013;51(8):1555-61.

11. Jeannot E, Mahler P, Elia N, *et al.* Sociodemographic and Economic Determinants of Overweight and Obesity for Public-school Children in Geneva State, Switzerland: A Cross-sectional Study. International journal of preventive medicine. 2015;6:39.

12. Lord S, Manlhiot C, Tyrrell PN, *et al.* Lower socioeconomic status, adiposity and negative health behaviours in youth: a cross-sectional observational study. BMJ open. 2015;5(5):e008291.

13. Zarnowiecki D, Ball K, Parletta N, *et al.* Describing socioeconomic gradients in children's diets - does the socioeconomic indicator used matter? International Journal of Behavioral Nutrition and Physical Activity. 2014;11:12.

14. Beghin L, Dauchet L, De Vriendt T, *et al.* Influence of parental socio-economic status on diet quality of European adolescents: results from the HELENA study. The British journal of nutrition. 2014;111(7):1303-12.

15. Berkman LF, Macintyre S. The measurement of social class in health studies: old measures and new formulations. IARC scientific publications. 1997(138):51-64.

16. Liberatos P, Link BG, Kelsey JL. The measurement of social class in epidemiology. Epidemiologic reviews. 1988;10:87-121.

17. Lim P, Gemici S. Measuring the socioeconomic status of Australian youth. In: Research NCfVE, editor. Australia: National Centre for Vocational Education Research; 2011.

18. Turrell G, Hewitt B, Patterson C, *et al.* Measuring socio-economic position in dietary research: is choice of socio-economic indicator important? Public health nutrition. 2003;6(2):191-200.

19. Parmenter K, Waller J, Wardle J. Demographic variation in nutrition knowledge in England. Health education research. 2000;15(2):163-74.

20. Hendrie GA, Coveney J, Cox D. Exploring nutrition knowledge and the demographic variation in knowledge levels in an Australian community sample. Public health nutrition. 2008;11(12):1365-71.

21. Ball K, Crawford D. Socio-economic factors in obesity: a case of slim chance in a fat world? Asia Pacific journal of clinical nutrition. 2006;15 Suppl:15-20.

22. Moreira PA, Padrao PD. Educational and economic determinants of food intake in Portuguese adults: a cross-sectional survey. BMC public health. 2004;4:58.

23. Mazur RE, Marquis GS, Jensen HH. Diet and food insufficiency among Hispanic youths: acculturation and socioeconomic factors in the third National Health and Nutrition Examination Survey. Am J Clin Nutr. 2003;78(6):1120-7.

24. Xie B, Gilliland FD, Li YF, *et al.* Effects of ethnicity, family income, and education on dietary intake among adolescents. Preventive Medicine. 2003;36(1):30-40.

25. Tur JA, Puig MS, Benito E, *et al.* Associations between sociodemographic and lifestyle factors and dietary quality among adolescents in Palma de Mallorca. Nutrition (Burbank, Los Angeles County, Calif). 2004;20(6):502-8.

26. Martini LA, Verly E, Marchioni DML, *et al.* Prevalence and correlates of calcium and vitamin D status adequacy in adolescents, adults, and elderly from the Health Survey-Sao Paulo. Nutrition (Burbank, Los Angeles County, Calif). 2013;29(6):845-50.

27. Cribb VL, Jones LR, Rogers IS, *et al.* Is maternal education level associated with diet in 10-year-old children? Public health nutrition. 2011;14(11):2037-48.

28. Navia B, Ortega RM, Requejo AM, *et al.* Influence of maternal education on food consumption and energy and nutrient intake in a group of pre-school children from Madrid. International journal for vitamin and nutrition research Internationale Zeitschrift fur Vitamin- und Ernahrungsforschung Journal international de vitaminologie et de nutrition. 2003;73(6):439-45.

29. Iglesia I, Mouratidou T, Gonzalez-Gross M, *et al.* Socioeconomic factors are associated with folate and vitamin B12 intakes and related biomarkers concentrations in European adolescents: the Healthy Lifestyle in Europe by Nutrition in Adolescence study. Nutrition research (New York, NY). 2014;34(3):199-209.

30. Golley RK, Hendrie GA, McNaughton SA. Scores on the dietary guideline index for children and adolescents are associated with nutrient intake and socio-economic position but not adiposity. J Nutr. 2011;141(7):1340-7.

31. Sawyer SM, Afifi RA, Bearinger LH, *et al.* Adolescence: a foundation for future health. Lancet. 2012;379(9826):1630-40.

32. Santos R, Moreira C, Abreu S, *et al.* Parental education level is associated with clustering of metabolic risk factors in adolescents independently of cardiorespiratory

fitness, adherence to the Mediterranean diet, or pubertal stage. Pediatric cardiology. 2014;35(6):959-64.

33. Mota J, Silva G. Adolescent's Physical Activity: Association with Socio-Economic Status and Parental Participation Among a Portuguese Sample. Sport, Education and Society. 1999;4(2):193-9.

34. WHO. Physical Status: The Use and Interpretation of Anthropometry: report of a WHO expert committee. Geneva: World Health Organization, 1995.

35. Martins I. Tabela da Composição de Alimentos. 1st ed. Jorge CdSAeN-INdSDR, editor: Editorial do Menistério da Educação; 2007.

36. Murphy SP, Poos MI. Dietary Reference Intakes: summary of applications in dietary assessment. Public health nutrition. 2002;5(6a):843-9.

37. Dietary Reference Intakes: The Essential Guide to Nutrient Requirements. Washington, DC: The National Academies Press; 2006. 560 p.

38. Dietary Reference Intakes for Calcium and Vitamin D. Washington, DC: The National Academies Press; 2011. 1132 p.

39. Eckel RH, Jakicic JM, Ard JD, *et al.* 2013 AHA/ACC Guideline on Lifestyle Management to Reduce Cardiovascular Risk: A Report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines. Circulation. 2013.

40. Murphy SP, Guenther PM, Kretsch MJ. Using the Dietary Reference Intakes to Assess Intakes of Groups: Pitfalls to Avoid. Journal of the American Dietetic Association. 2006;106(10):1550-3.

41. Goldberg GR, Black AE, Jebb SA, *et al.* Critical evaluation of energy intake data using fundamental principles of energy physiology: 1. Derivation of cut-off limits to identify under-recording. European journal of clinical nutrition. 1991;45(12):569-81.

42. Black AE. Critical evaluation of energy intake using the Goldberg cut-off for energy intake: basal metabolic rate. A practical guide to its calculation, use and limitations. International journal of obesity and related metabolic disorders : journal of the International Association for the Study of Obesity. 2000;24(9):1119-30.

43. Rowlands AV, Eston RG. The Measurement and Interpretation of Children's Physical Activity. Journal of Sports Science & Medicine. 2007;6(3):270-6.

44. Evenson KR, Catellier DJ, Gill K, *et al.* Calibration of two objective measures of physical activity for children. Journal of sports sciences. 2008;26(14):1557-65.

45. WHO. Global recommendations on physical activity for health. Switzerland: World Health Organization; 2010.

46. Valente H, Padez C, Mourao I, *et al.* [Prevalence of nutritional inadequacy among Portuguese children]. Acta Med Port. 2010;23(3):365-70.

47. FAO. Fats and fatty acids in human nutrition - Report of an expert consultation [Internet]. Rome: Food and Agriculture Organization of the United Nations; 2010. Podcast

48. Demory-Luce D, Morales M, Nicklas T, *et al.* Changes in food group consumption patterns from childhood to young adulthood: the Bogalusa Heart Study. Journal of the American Dietetic Association. 2004;104(11):1684-91.

49. Manios Y, Moschonis G, Grammatikaki E, *et al.* Food group and micronutrient intake adequacy among children, adults and elderly women in Greece. Nutrients. 2015;7(3):1841-58.

50. Barr SI, DiFrancesco L, Fulgoni VL, 3rd. Breakfast consumption is positively associated with nutrient adequacy in Canadian children and adolescents. The British journal of nutrition. 2014;112(8):1373-83.

51. Marrero NM, He FJ, Whincup P, *et al.* Salt intake of children and adolescents in South London: consumption levels and dietary sources. Hypertension. 2014;63(5):1026-32.

52. Campanozzi A, Avallone S, Barbato A, *et al.* High Sodium and Low Potassium Intake among Italian Children: Relationship with Age, Body Mass and Blood Pressure. PloS one. 2015;10(4):e0121183.

53. Moreno LA, Gottrand F, Huybrechts I, *et al.* Nutrition and lifestyle in european adolescents: the HELENA (Healthy Lifestyle in Europe by Nutrition in Adolescence) study. Advances in nutrition (Bethesda, Md). 2014;5(5):615s-23s.

54. WHO. Human Vitamin and Mineral Requirements - Report of a joint FAO/WHO expert consultation. Rome: Food and Agriculture Organization of the United Nations, 2001.

55. Misra M, Pacaud D, Petryk A, *et al.* Vitamin D deficiency in children and its management: review of current knowledge and recommendations. Pediatrics. 2008;122(2):398-417.

56. Celik N, Andiran N, Yilmaz AE. The relationship between serum magnesium levels with childhood obesity and insulin resistance: a review of the literature. J Pediatr Endocrinol Metab. 2011;24(9-10):675-8.

57. Dean SV, Lassi ZS, Imam AM, *et al.* Preconception care: nutritional risks and interventions. Reprod Health. 2014;11 Suppl 3:S3.

58. WHO. Guideline: sodium intake for adults and children. Geneva: World Health Organization, 2012.

59. Serra-Majem L, Ribas-Barba L, Perez-Rodrigo C, *et al.* Nutrient adequacy in Spanish children and adolescents. The British journal of nutrition. 2006;96 Suppl 1:S49-57.

60. Hulshof KF, Brussaard JH, Kruizinga AG, *et al.* Socio-economic status, dietary intake and 10 y trends: the Dutch National Food Consumption Survey. European journal of clinical nutrition. 2003;57(1):128-37.

61. Northstone K, Smith A, Cribb VL, *et al.* Dietary patterns in UK adolescents obtained from a dual-source FFQ and their associations with socio-economic position, nutrient intake and modes of eating. Public health nutrition. 2014;17(7):1476-85.

62. Stephens LD, McNaughton SA, Crawford D, *et al.* Correlates of dietary resilience among socioeconomically disadvantaged adolescents. European journal of clinical nutrition. 2011;65(11):1219-32.

63. Matthys C, De Henauw S, Maes L, *et al.* Adolescents' education and their diet recorded by 7-day food records. Soz Praventivmed. 2006;51(2):80-90.

64. Serra-Majem L, Ribas L, Perez-Rodrigo C, *et al.* Determinants of nutrient intake among children and adolescents: results from the enKid Study. Annals of nutrition & metabolism. 2002;46 Suppl 1:31-8.

65. McHale SM, Crouter AC, McGuire SA, *et al.* Congruence between mothers' and fathers' differential treatment of siblings: links with family relations and children's well-being. Child Dev. 1995;66(1):116-28.

66. Campbell KJ, Crawford DA, Salmon J, *et al.* Associations between the home food environment and obesity-promoting eating behaviors in adolescence. Obesity (Silver Spring, Md). 2007;15(3):719-30.

67. Johnson CM, Sharkey JR, Dean WR, *et al.* It's who I am and what we eat: Mothers' food-related identities in family food choice. Appetite. 2011;57(1):220-8.

68. Manios Y, Moschonis G, Mavrogianni C, *et al.* Micronutrient intakes among children and adults in Greece: the role of age, sex and socio-economic status. Nutrients. 2014;6(10):4073-92.

69. Lytle LA, Himes JH, Feldman H, *et al.* Nutrient intake over time in a multi-ethnic sample of youth. Public health nutrition. 2002;5(2):319-28.

70. Kourlaba G, Panagiotakos DB, Mihas K, *et al.* Dietary patterns in relation to socio-economic and lifestyle characteristics among Greek adolescents: a multivariate analysis. Public health nutrition. 2009;12(9):1366-72.

71. Mikkila V, Rasanen L, Raitakari OT, *et al.* Major dietary patterns and cardiovascular risk factors from childhood to adulthood. The Cardiovascular Risk in Young Finns Study. The British journal of nutrition. 2007;98(1):218-25.

72. Richter A, Heidemann C, Schulze MB, *et al.* Dietary patterns of adolescents in Germany--associations with nutrient intake and other health related lifestyle characteristics. BMC pediatrics. 2012;12:35.

73. Bibiloni Mdel M, Pich J, Cordova A, *et al.* Association between sedentary behaviour and socioeconomic factors, diet and lifestyle among the Balearic Islands adolescents. BMC public health. 2012;12:718.

74. Ottevaere C, Huybrechts I, Beghin L, *et al.* Relationship between self-reported dietary intake and physical activity levels among adolescents: the HELENA study. The international journal of behavioral nutrition and physical activity. 2011;8:8.

75. Knäuper B, Rabiau M, Cohen O, *et al.* Compensatory health beliefs: scale development and psychometric properties. Psychol Health. 2004;19(5):607-24.

76. Giles EL, Brennan M. Trading between healthy food, alcohol and physical activity behaviours. BMC public health. 2014;14:1231.

77. Shi L. Sociodemographic characteristics and individual health behaviors. Southern medical journal. 1998;91(10):933-41.

Paper II

Parental educational level and fruit and vegetable intake in Portuguese adolescents

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Submitted

Abstract

Aim's to study the relationship between adolescents' intake of fruit and vegetables (F&V) and parental educational level (EL).

Sociodemographic, anthropometric and dietary variables were collected. Logistic regression models were applied, adjusting for confounders.

None of the individuals achieved recommendations of F&V intake. Individuals who have both parents with high EL have higher chances of consuming more fruit than those with low-educated parents and adolescents whose mothers have high EL seem to have higher consumptions of vegetables than those whose mothers are low-educated, both independently of total energy intake.

Results suggest that EL, mainly mother's, positively influences children's intake of F&V.

Keywords

Fruit; vegetables; F&V; Adolescents; Parental educational level; Socioeconomic status

Introduction

The period between the ages of 10 and 19 years, commonly named adolescence (WHO 2014), is characterized by intense physical growth and mental development. Because of this, energy and nutrient needs are increased in this life stage and should be adequately satisfied (Mesias, Seiquer, and Navarro 2011). In that matter, healthy eating and exercise practices should be promoted for the younger populations in order to prevent the development of chronic diseases later in life (WHO 2003). Besides these biological aspects of adolescence, the setting and solidification of social and economic interactions (Viner, Ozer, Denny et al. 2012), development of own values and autonomy and alterations in the relationships with peers and family also occur (Steinberg 2005).

The importance of fruit and vegetable (F&V) consumption for a balanced and nutritious diet and a healthy life has been highlighted by international (Rodgers, P, Prentice et al. 2002) and national health organizations (Bordalo, Carvalho, Oliveira et al. 2015). These foods contribute to a diversified and nutritious diet as they provide a wide range of nutrients such as phytonutrients, vitamins, minerals and fibre and low amounts of energy (WHO 2003). The consumption of fruits and vegetables has been proven to be beneficial to overall health status, namely through the prevention of cardiovascular diseases (CVD) (Boeing, Bechthold, Bub et al. 2012; Asplund 2002; Agudo, Cabrera, Amiano et al. 2007; Kolte, Vijayaraghavan, Khera et al. 2014; Hunt and Cappuccio 2014; Zhan, Liu, Cai et al. 2015), some types of cancer (Wang, Ouyang, Liu et al. 2014; Zhan et al. 2015; Bradbury, Appleby, and Key 2014) and diabetes, particularly for green leafy vegetables (Wu, Zhang, Jiang et al. 2015), and weight control (Alinia, Hels, and Tetens 2009; Mytton, Nnoaham, Eyles et al. 2014).

Recommendations for F&V intake may vary between national and international organizations. The Portuguese Food Wheel (PFW) recommends the intake of 3 to 5 portion of each of those food groups daily (Rodrigues, Franchini, Graca et al. 2006), while the World Health Organization (WHO) points to the consumption of at least 400g of both F&V each day (WHO 2003).

However, fruit and vegetable intake among adolescents is a dietary issue of concern. Two European studies (Diethelm, Jankovic, Moreno et al. 2012; Lynch, Kristjansdottir, Te Velde et al. 2014), one of which included data from 11-year-old Portuguese children (Lynch et al. 2014), have shown that intake of both fruit and vegetables in young people are far below recommendations. Intake of F&V differs between girls and boys, with the female group consuming more fruits and less vegetables than males in Portugal (Lynch et al. 2014), however in other countries girls consume more of both fruit and vegetables than boys (Nilsen, Krokstad, Holmen et al. 2010; Diethelm et al. 2012; Vereecken, Pedersen, Ojala et al. 2015). Also of concern is the fact that F&V consumption tends to decrease from early to middle and from middle to late adolescence (Larson, Neumark-Sztainer, Hannan et al. 2007; Vereecken et al. 2015). Low F&V intake by adolescents doesn't seem to be improving in the past years as fruit consumption has decreased since 2002 to 2010 among Portuguese adolescents, while vegetable consumption didn't present important alterations (Vereecken et al. 2015).

Research indicates that parental educational level (EL) may be associated with adolescents' dietary intake. A study in Portuguese children showed that maternal EL and physical activity levels were positively associated with food patterns characterized by plant origin foods, which included fruits, vegetables and vegetable soup (Moreira, Santos, Padrao et al. 2010). In adolescents, it was seen that those who have high-educated parents tend to have a higher contribution of F&V to the intakes of carbohydrates and fiber and lower contributions of sweets and pastries to energy, carbohydrates and fats (Araujo, Severo, Lopes et al. 2011). Similar results of higher F&V intake in adolescents with high educated parents have been found in other countries (Bere, van Lenthe, Klepp et al. 2008; Nilsen et al. 2010; Finger, Varnaccia, Tylleskar et al. 2015; Northstone, Smith, Cribb et al. 2014).

Given this information, it seems that low SES adolescents are a target group for interventions that intend to pomote higher F&V consumption. The aim of the present study is to evaluate the consumption of F&V and its relation to parental EL in a group of Portuguese adolescents.

Methodology

The present study was conducted in a convenience sample of students from a basic an secondary school from the north of Portugal, included in the project Afina-te!. The initial sample of the present study included 302 (160 girls) students of a secondary school located on the north of Portugal, aged between 12 and 19 years and attending the 7th to the 12th grade. Individuals were classified in age categories (12 to 14 years and 15 to 19 years) according to the definition of early and late adolescence (Sawyer, Afifi, Bearinger et al. 2012).

A socioeconomic questionnaire that asked for age, sex, school grade, parents' EL and family monthly income was applied. Parental EL was classified according to a methodology already used in the Portuguese population (Santos, Moreira, Abreu et al. 2014; Mota and Silva 1999) in which the number of completed years of education is considered and individuals are located in one of three categories: low EL (up to the 9th grade); medium EL (from the 10th to the 12th grade); and high EL (above the 12th grade/university education).

Dietary information was collected by a 3 day food diary including 2 weekdays and 1 weekend day. Instructions were given to participants highlighting the importance of reporting everything they would be eating or drinking for 3 days with as much detail as possible. Individuals should quantify foods in household measures, individual portions, weight or units, without the assistance of any quantifying tool. Food data was then converted into nutrients according to the Portuguese Food Composition Table (Martins 2007) or nutritional labels when information was unavailable. Food intake was also assessed in grams and number of portions of the PFW groups (Rodrigues et al. 2006). These recommendations were also used for estimating the prevalence of adequate F&V intake. The volume of vegetables used also included those consumed as vegetable soup. Median value of fruit and vegetable intake was calculated for girls and boys individually. Goldberg cut-off method (Goldberg, Black, Jebb et al. 1991) adapted by Black (Black 2000) was used to identify misreporters.

Anthropometric measures were also assessed, namely height, with a SECA stadiometer (0.1 cm precision); and weight, through a TANITA BC-545 body analyser (100g

precision). Anthropometric measures were collected according to procedures recommended by the WHO (WHO 1995).These measures allowed the evaluation of body mass index (BMI) by dividing the weight (kg) by the height (m) squared, which was then categorized according to Cole (Cole and Lobstein 2012).

Physical activity (PA) was measured in order to be used as a confounding variable. Adolescents were asked to use Actigraph GT3X+ accelerometer for 7 consecutive days, according to what has been described (Rowlands and Eston 2007). Detailed instructions about accelerometer use were given to parents and students. Accelerometers were used since they woke up until they went to bed, with an elastic band in the waist line on their non-dominant side, excluding only water activities. Accelerometers were collected on the 8th day. Output data was analysed using Actilife (version 6.9, Actigraph, Florida) and to be considered valid a minimum of 8h/day of usage was required, with at least 4 days of evaluation necessary. Information was measured in min/day and classified in sedentary, light, moderate and vigorous activity according to level of intensity (Evenson, Catellier, Gill et al. 2008). The sum of moderate and vigorous activities was used to calculate total moderate to vigorous physical activity (MVPA). WHO recommends a minimum of 60 minutes of MVPA per day (WHO 2010).

Statistical analysis was conducted through SPSS 21.0 with the application of logistic regression models , being the intake of fruit and vegetables considered as the dependent variable and sociodemographic variables (sex, age group, BMI, MVPA compliance, father EL and mother EL) considered as independent. When these variables presented an association with consumption of fruit and vegetable in the crude model they were included in the adjusted models. Lowest groups of classification of sociodemographic variables were used as the reference groups. Total energy intake (TEI) was also included as a confounding variable in the adjusted models. Statistical significant was set as $p<0.05$.

The project “Afina-te!” was approved by the Research Centre in Physical Activity, Health and Leisure Scientific Committee from the Faculty of Sports of the University of Porto. A written informed consent was obtained from all participants and their parents.

Results

The study begun with a total of 302 adolescents, however this number decreased to 179 (100 girls) after exclusion of misreporters. Mean age was 15.36 years.

These adolescents weighted an average of 55.90±9.85 kg and had a mean height of 162.90±8.97 cm. Mean BMI was 20.98±2.78 kg/m^2 and individuals were classified according to Cole (Cole et al. 2012) in normal weighted (82.1%) and overweight or obese (17.9%).

In what concerns to parental EL, 45.5% of the individuals had mothers with high EL, 30.1% had mothers with low levels of education and 24.4% had mothers with medium EL. As for the fathers' level of education, 41.8% of the students had fathers with low EL, 34.5% had high-educated fathers and 23.7% had fathers with medium levels of education. Other sociodemographic characteristics are described in table 1.

Mean energy intake of the studied sample was 2300 Kcal distributed by macronutrients as follows: 97.1g (16.9%) of protein, 90.9g (35.6%) of total fat and 269.3g (46.8%) of carbohydrates.

Adolescents' F&V intake was much below recommendations of the PFW. Mean intake of fruit and vegetables according to sex is shown in tables 2 and 3, respectively. Girls' mean intake of vegetables was 49.05±46.90g (0.27 portions) and of fruit was 105.03±98.39g (0.66 portions) a day. Boys consumed an average of 58.14±62.44g of vegetables (0.32 portions) and 113.31±102.67g (0.71 portions) of fruit daily. Intake of fruit and vegetables was not significantly different between girls and boys.

None of the individuals has fulfilled the PFW recommendations for fruit and vegetable intake. When WHO recommendations of at least 400g of F&V intake daily are taken into consideration, only a very low percentage of individuals have an adequate intake of F&V (2.0% of girls and 6.3% of boys). In both groups, these individuals with F&V intake above recommendations have high-educated mothers.

Associations between different variables and fruit and vegetable intake were evaluated by a logistic regression model and are presented individually in tables 4 and 5, respectively.

The crude model refers to each studied variable separately and represents their association with fruit and vegetable intake without the effect of confounding variables. Model A shows an interaction term between two variables and model B includes those variables which presented significant results in the crude model. Both models are adjusted for total energy intake (TEI).

For fruit intake it seems that both high paternal and maternal EL seem to increase the chances of high fruit intake in about 2.5 times (p=0.009 and p=0.015, respectively). Once EL of both parents seems to influence adolescents' fruit intake, we decided to apply a logistic regression model with an interaction term between these two variables in order to deeply study relations between them. This analysis shows that when both the mother and the father have high EL there is an increase of 2.85 times in the chance of their children having higher fruit intake than children with low educated parents (p=0.005), independently of TEI. When one of the parents has medium EL and the other has high EL, there is also an increase in the odds of higher fruit intake, however this is not statistically significant. Interestingly, when both parents have medium EL, it is possible that their children have lower fruit intake than those adolescents with low educated parents, however with no significant effects.

Besides, lower chances of higher fruit intake are found among male, younger, heavier and more active individuals, however without significant results.

Analysing results for vegetable intake and when the crude model is applied, only mother EL seems to influence vegetable intake. A high mother EL increases the chances of high vegetable intake in 2.29 times (p=0.022). When the model is adjusted for TEI, trends and significant effects are similar for high mother EL (OR= 2.28; p=0.023), however medium mother EL seems now to decrease de chances of high vegetable intake but without statistical significance. Moreover, male, younger, normal weighted and more active adolescents are more susceptible to low vegetable intake. Once again, these results are not statistically significant.

Discussion

Fruit and vegetable intake was far below recommendations. In fact, none of the individuals achieved adequate intake for fruit and vegetables according to the PFW and only a very few percentage managed to fulfil WHO's recommendations of at least 400g of F&V daily. This is an issue of concern as low F&V intake seems to be related to worse overall health status and increased risk of developing several chronic diseases such as CVD, some types of cancer and T2DM (Boeing et al. 2012).

Studying the associations between some socio-demographic and lifestyle variables and F&V intake, some important conclusions can be drawn. First, for fruit intake it seems that both father and mother EL are individually associated with higher chances of fruit consumption. When interactions between EL of both parents are studied, it stands out that fruit intake increases only if both parents have high EL, independently of TEI, in contrast to both parents having low EL. Similar results have also been shown with significant associations between tertiary educated parents and higher fruit intake for boys and girls (Finger et al. 2015). The same has been shown in other papers (Bere et al. 2008; Nilsen et al. 2010; Finger et al. 2015; Lehto, Ray, te Velde et al. 2015).

High mother EL, but not that of the father, also seems to increase the chances of higher vegetable intake, independently of TEI. Effect of medium EL of the mother doesn't seem to significantly influence vegetable intake, comparing to low EL. Although father EL does not present significant results, the trend is that higher EL may positively influence adolescents' vegetable intake. Parental EL has been previously associated to higher vegetable intake (Bere et al. 2008; Lehto et al. 2015), even if differences between influence in boys and girls are not well defined, as while some authors defend influence of parental EL is more pronounced in boys (Finger et al. 2015), others say otherwise (Nilsen et al. 2010).

All other possibly influencing variables (sex, age group, BMI and MVPA compliance) do not present significant results for fruit or vegetable intake and have ORs really close to 1, so they cannot be generalized. Even so, the trends are that overweight or obese individuals

have higher chances of consuming less fruit and more vegetables than normal weighted. Besides, younger and more active individuals, as well as boys, are in risk of lower F&V intake.

Other authors have studied children and adolescents' food patterns according to parental education (Moreira et al. 2010; Northstone et al. 2014). A Portuguese study showed that maternal EL is associated to dietary patterns rich in plant origin food (vegetables, pulses, fruit, olive oil, vegetable soup, butter, starchy foods, and bread) in 5-10 year old children (Moreira et al. 2010). The adherence to a more traditional or health-conscious food pattern (including meat dishes, fish, eggs, rice, pasta, raw fruit, salad, peas, sweetcorn, green vegetables, root vegetables, pulses, potatoes, other bread than white, puddings and milk puddings/custard/mousse) was found between 13 year old girls whose mothers have high EL (Northstone et al. 2014). Even if this results can't be directly compared to ours as food patterns include food groups that were not our aim to study in the present paper, they seem to follow similar trends.

Various mechanisms by which well-educated parents positively influence their adolescent children's food intake have been proposed. Generally, parents with higher EL have better health and nutritional knowledge and are able to access and interpret health information more easily (Parmenter, Waller, and Wardle 2000; Hendrie, Coveney, and Cox 2008; Ball and Crawford 2006), which is proven by the fact that children with parents with high EL have better knowledge of the F&V recommendations (Lehto et al. 2015). Moreover, these parents attribute great importance to nutritional information and to transmitting it to their children (Zarnowiecki, Sinn, Petkov et al. 2012) besides privileging foods' effects on health instead of food price (Parmenter et al. 2000) and act as better role models for having healthy dietary habits (Ball et al. 2006).

Besides, the more pronounced role of the mother in the development of adequate food habits by their children is also comprehensible. The mother figure has more prominence in household care and availability of food, as well as its preparation (Campbell, Crawford, Salmon et al. 2007; Johnson, Sharkey, Dean et al. 2011), besides usually spending more time

with their children than the father. These results should now be further studied with bigger sample sizes and accounting for the influence of different variables.

The strengths of the present study should be highlighted. The relationship between parental EL and adolescents' intake of F&V has not been profoundly described in Portuguese populations, so it may introduce important insights on the topic for health and education campaigns and politics. The instrument used to measure food intake allows the collection of data on a wide range of days and the detailed description of foods and beverages consumed. The fact that possible confounders as well as misreporters were taken into account strengthens results.

Some limitations also stand out, mainly the fact that, being this a cross-sectional study, causality between variables cannot be inferred. Dietary information was self-reported, which may introduce some bias, even when misreporters are identified. Statistical analysis should have been conducted by sex, however the small sample would possibly have influenced results. Even so, sex was considered in the models as a possible confounder. The present study focused on parental EL, one of the variables included in the SES concept, however deeper investigation involving all the three main predictors of SES (parental educational level and occupational status and adjusted family monthly income) should be undertaken to verify individual effects of each one as well as interactions between them. This analysis was not performed in the present paper because of data constraints that didn't allow the adjustment of family income to the total number of individuals of the household.

Conclusions

The present investigation allows us to suggest that there are some differences in the association between parental EL and fruit and vegetable intake. High EL from both the mother and the father seems to be positively associated with adolescents' fruit intake while for vegetable intake a high mother EL by itself seems to increase the chances of high intake, independently of energy intake.

Table 1 – Sociodemographic characteristics by sex

		Girls (n=100)	Boys (n=79)	p
Age group	12-14 y	38 (38,0%)	27 (34,2%)	0,597
	15-19 y	62 (62,0%)	52 (65,8%)	
BMI	normal weight	82 (82,0%)	65 (82,3%)	0,961
	overweight/obesity	18 (18,0%)	14 (17,7%)	
MVPA	< 60 min/day	25 (78,1%)	12 (37,5%)	0,001*
	> 60 min/day	7 (21,9%)	20 (62,5%)	
Father EL	low	43 (43,4%)	31 (39,7%)	0,040*
	medium	29 (29,3%)	13 (16,7%)	
	high	27 (27,3%)	34 (43,6%)	
Mother EL	low	31 (31,3%)	22 (28,6%)	0,127
	medium	29 (29,3%)	14 (18,2%)	
	high	39 (39,4%)	41 (53,2%)	

BMI: Body Mass Index | MVPA: Moderate to Vigorous Physical Activity | EL: Educational Level | p values for qui-square test | *statistical significant differences

Table 2 - Distribution of fruit intake by different variables according to sex

Fruit (g)		Girls									Boys								
		Mean	SD	P50	Min.	Max.	P5	P25	P75	P95	Mean	SD	P50	Min.	Max.	P5	P25	P75	P95
Total		105,03	98,39	78,33	0,00	332,67	0,00	0,00	182,92	275,67	113,31	102,67	96,00	0,00	477,67	0,00	0,00	176,67	316,67
Age group	12-14 y	83,01	93,38	45,00	0,00	320,00	0,00	0,00	156,67	272,33	113,95	105,21	95,00	0,00	366,67	0,00	0,00	169,00	316,67
	15-19 y	118,53	99,68	96,67	0,00	332,67	0,00	35,00	201,67	279,00	112,98	102,36	107,17	0,00	477,67	0,00	0,00	177,83	289,80
BMI	normal weight	104,78	97,65	80,67	0,00	332,67	0,00	0,00	178,00	268,00	108,74	92,97	96,00	0,00	366,67	0,00	0,00	169,00	288,00
	overweight/obesity	106,19	104,62	60,33	0,00	320,00	0,00	35,00	201,67	320,00	134,56	141,76	97,50	0,00	477,67	0,00	0,00	226,67	477,67
MVPA	< 60 min/day	125,88	100,41	110,00	0,00	320,00	0,00	43,33	220,00	272,33	124,13	103,30	134,47	0,00	316,67	0,00	21,67	187,50	316,67
	≥ 60 min/day	101,67	89,70	90,00	0,00	245,00	0,00	0,00	156,67	245,00	86,85	129,60	39,17	0,00	477,67	0,00	0,00	103,00	422,17
Father EL	low	99,93	102,89	67,33	0,00	332,67	0,00	0,00	178,00	272,33	96,70	94,64	86,67	0,00	316,67	0,00	0,00	176,67	289,80
	medium	74,80	85,47	43,33	0,00	279,00	0,00	0,00	117,67	241,67	112,92	136,68	91,33	0,00	477,67	0,00	0,00	165,00	477,67
	high	140,42	93,69	156,67	0,00	320,00	0,00	75,00	201,67	308,27	131,94	94,73	128,63	0,00	366,67	0,00	46,67	194,67	323,67
Mother EL	low	100,84	99,30	78,33	0,00	303,33	0,00	0,00	178,00	268,00	73,73	87,63	39,17	0,00	289,80	0,00	0,00	118,33	255,00
	medium	72,57	84,86	43,33	0,00	279,00	0,00	13,33	93,33	266,53	87,55	64,40	92,33	0,00	176,67	0,00	0,00	140,00	176,67
	high	130,02	102,10	118,00	0,00	332,67	0,00	35,00	215,00	320,00	144,85	112,58	138,33	0,00	477,67	0,00	43,33	207,67	323,67

SD: standard deviation | BMI: Body Mass Index | MVPA: Moderate to Vigorous Physical Activity | EL: Educational Level

Table 3 - Distribution of vegetable intake by different variables according to sex

Vegetables (g)		Girls									Boys								
		Mean	SD	P50	Min.	Max.	P5	P25	P75	P95	Mean	SD	P50	Min.	Max.	P5	P25	P75	P95
Total		49,05	46,90	40,71	0,00	295,17	0,00	20,00	66,76	134,69	58,14	62,44	36,67	0,00	251,36	0,00	13,89	80,00	213,33
Age group	12-14 y	43,03	38,45	38,93	0,00	148,81	0,00	10,71	60,00	121,67	33,17	39,65	20,00	0,00	160,00	0,00	0,00	54,29	106,67
	15-19 y	52,74	51,34	41,67	0,00	295,17	0,00	20,00	68,57	136,05	71,10	68,26	46,67	0,00	251,36	0,00	20,00	98,33	227,14
BMI	normal weight	48,50	46,35	40,71	0,00	295,17	0,00	20,00	66,67	121,67	59,11	65,28	34,29	0,00	251,36	0,00	13,89	80,00	213,33
	overweight/obesity	51,53	50,64	40,60	0,00	168,00	0,00	10,71	73,67	168,00	53,59	48,83	40,89	0,00	150,00	0,00	20,00	86,67	150,00
MVPA	< 60 min/day	50,99	43,45	41,43	0,00	148,81	0,00	20,00	72,38	121,67	48,64	48,75	47,83	0,00	144,67	0,00	0,00	80,00	144,67
	≥ 60 min/day	22,93	28,24	10,00	0,00	68,57	0,00	0,00	53,33	68,57	28,51	25,98	23,33	0,00	80,00	0,00	1,18	48,81	73,57
Father EL	low	39,46	35,63	39,05	0,00	168,00	0,00	10,00	57,60	103,33	54,51	62,09	20,00	0,00	238,10	0,00	0,00	86,67	185,00
	medium	44,72	43,82	40,00	0,00	148,81	0,00	6,67	65,07	145,00	34,75	30,70	40,00	0,00	90,00	0,00	2,33	54,29	90,00
	high	68,25	60,70	53,33	0,00	295,17	0,00	31,67	96,67	136,05	72,09	69,54	40,00	0,00	251,36	0,00	20,00	106,67	227,14
Mother EL	low	31,05	26,58	26,67	0,00	88,10	0,00	0,00	57,14	73,67	44,55	50,37	20,00	0,00	185,00	0,00	0,00	80,00	150,00
	medium	52,99	44,68	40,00	0,00	168,00	0,00	20,00	73,33	148,81	34,12	37,89	23,33	0,00	126,67	0,00	0,00	50,00	126,67
	high	58,61	56,57	48,10	0,00	295,17	0,00	20,00	80,00	145,00	74,51	71,61	57,60	0,00	251,36	0,00	20,00	106,67	227,14

SD: standard deviation | BMI: Body Mass Index | MVPA: Moderate to Vigorous Physical Activity | EL: Educational Level

Table 4 - Variables associated with fruit intake

		N (% total)	Fruit intake		p†	Crude			Model A		
			<P50	>P50		OR	95% CI	p‡	OR	95% CI	p‡
Sex	Girls	100 (55,9%)	49 (55,7%)	51 (56,0%)	0,961	1,00					
	Boys	79 (44,1%)	39 (44,3%)	40 (44,0%)		0,99	0,546-1,778	0,961			
Age group	12 - 14 y	65 (36,3%)	38 (43,2%)	27 (29,7%)	0,060	1,00					
	15 - 19 y	114 (63,7%)	50 (56,8%)	64 (70,3%)		1,80	0,972-3,338	0,061			
BMI	Normal weight	147 (82,1%)	71 (80,7%)	76 (83,5%)	0,621	1,00					
	Overweight/obesity	32 (17,9%)	17 (19,3%)	15 (16,5%)		0,82	0,383-1,773	0,621			
MVPA	< 60 min/day	37 (20,7%)	15 (46,9%)	22 (68,8%)	0,076	1,00					
	> 60 min/day	27 (15,1%)	17 (53,1%)	10 (31,3%)		0,40	0,145-1,112	0,079			
Father EL	Low	74 (41,3%)	41 (47,1%)	33 (36,7%)		1,00					
	Medium	42 (23,5%)	26 (29,9%)	16 (17,8%)	0,005*	0,77	0,353-1,657	0,496			
	High	61 (34,1%)	20 (23,0%)	41 (45,6%)		2,55*	1,260-5,150	0,009			
p for trend								0,024			
Mother EL	Low	53 (29,6%)	30 (34,5%)	23 (25,8%)		1,00					
	Medium	43 (24,0%)	29 (33,3%)	14 (15,7%)	0,001*	0,63	0,272-1,455	0,279			
	High	80 (44,7%)	28 (32,2%)	52 (58,4%)		2,42*	1,189-4,934	0,015			
p for trend								0,018			
Mother EL*Father EL	Low*low	41 (22,9%)	23 (76,7%)	18 (81,8%)					1,00		
	Medium*medium	16 (8,9%)	12 (41,4%)	4 (28,6%)					0,46	0,135-1,574	0,217
	Medium*high	5 (2,8%)	2 (6,9%)	3 (21,4%)					2,00	0,313-12,752	0,464
	High*medium	16 (8,9%)	8 (28,6%)	8 (15,4%)					1,65	0,548-4,956	0,374
	High*High	53 (29,6%)	17 (60,7%)	36 (69,2%)					2,85*	1,371-5,919	0,005
p for trend											0,005

Model A: interaction term for mother EL and father EL, adjusted for total energy intake (continuous) | CI: Confidence Interval | BMI: Body Mass Index | EL: Educational Level | MVPA: Moderate to Vigorous Physical Activity | † p values for qui-square test | ‡ p values for logistic regression analysis | *Statistical significant differences

Table 5 - Variables associated with vegetable intake

		N (% total)	Vegetable intake		p†	Crude			Model B		
			<P50	≥P50		OR	95% CI	p‡	OR	95% CI	p‡
Sex	Girls	100 (55,9%)	50 (55,6%)	50 (56,2%)	0,933	1,00					
	Boys	79 (44,1%)	40 (44,4%)	39 (43,8%)		0,80	0,540-1,759	0,933			
Age group	12 - 14 y	65 (36,3%)	38 (42,2%)	27 (30,3%)	0,098	1,00					
	15 - 19 y	114 (63,7%)	52 (57,8%)	62 (69,7%)		1,68	0,907-3,106	0,099			
BMI	Normal weight	147 (82,1%)	75 (83,3%)	72 (80,9%)	0,671	1,00					
	Overweight/obesity	32 (17,9%)	15 (16,7%)	17 (19,1%)		1,18	0,549-2,539	0,671			
MVPA	< 60 min/day	37 (20,7%)	18 (50,0%)	19 (67,9%)	0,151	1,00					
	≥ 60 min/day	27 (15,1%)	18 (50,0%)	9 (32,1%)		0,47	0,170-1,324	0,154			
Father EL	Low	74 (41,3%)	40 (44,9%)	34 (38,6%)		1,00					
	Medium	42 (23,5%)	23 (25,8%)	19 (21,6%)	0,335	0,97	0,454-2,079	0,941			
	High	61 (34,1%)	26 (29,2%)	35 (39,8%)		1,58	0,800-3,136	0,187			
p for trend								0,232			
Mother EL	Low	53 (29,6%)	32 (36,0%)	21 (24,1%)		1,00			1,00		
	Medium	43 (24,0%)	25 (28,1%)	18 (20,7%)	0,037*	1,10	0,484-2,487	0,824	1,11	0,488-2,519	0,805
	High	80 (44,7%)	32 (36,0%)	48 (55,2%)		2,29	1,125-4,646	0,022	2,28	1,120-4,641	0,023
p for trend								0,024			0,024

Model B: includes mother EL, adjusted for total energy intake (continuous) | CI: Confidence Interval | BMI: Body Mass Index | EL: Educational Level | MVPA: Moderate to Vigorous Physical Activity | † p values for qui-square test | ‡ p values for logistic regression analysis | *Statistical significant differences

References

Agudo, A., L. Cabrera, P. Amiano, E. Ardanaz, A. Barricarte, T. Berenguer, M. D. Chirlaque, et al. 2007. Fruit and vegetable intakes, dietary antioxidant nutrients, and total mortality in Spanish adults: findings from the Spanish cohort of the European Prospective Investigation into Cancer and Nutrition (EPIC-Spain). *Am J Clin Nutr* 85 (6):1634-42.

Alinia, S., O. Hels, and I. Tetens. 2009. The potential association between fruit intake and body weight – a review. *Obesity Reviews* 10 (6):639-647.

Araujo, J., M. Severo, C. Lopes, and E. Ramos. 2011. Food sources of nutrients among 13-year-old Portuguese adolescents. *Public Health Nutr* 14 (11):1970-8.

Asplund, K. 2002. Antioxidant vitamins in the prevention of cardiovascular disease: a systematic review. *J Intern Med* 251 (5):372-92.

Ball, K., and D. Crawford. 2006. Socio-economic factors in obesity: a case of slim chance in a fat world? *Asia Pac J Clin Nutr* 15 Suppl:15-20.

Bere, E., F. van Lenthe, K. I. Klepp, and J. Brug. 2008. Why do parents' education level and income affect the amount of fruits and vegetables adolescents eat? *Eur J Public Health* 18 (6):611-5.

Black, A. E. 2000. Critical evaluation of energy intake using the Goldberg cut-off for energy intake: basal metabolic rate. A practical guide to its calculation, use and limitations. *Int J Obes Relat Metab Disord* 24 (9):1119-30.

Boeing, H., A. Bechthold, A. Bub, S. Ellinger, D. Haller, A. Kroke, E. Leschik-Bonnet, et al. 2012. Critical review: vegetables and fruit in the prevention of chronic diseases. *Eur J Nutr* 51 (6):637-63.

Bordalo, A., Á. A. d. Carvalho, A. L. Oliveira, A. P. Soares, A. Pedroso, A. Diniz, C. S. Farinha, et al. 2015. A Saúde dos Portugueses. Perspetiva 2015. edited by D.-G. d. Saúde. Lisboa: Direção-Geral da Saúde.

Bradbury, K. E., P. N. Appleby, and T. J. Key. 2014. Fruit, vegetable, and fiber intake in relation to cancer risk: findings from the European Prospective Investigation into Cancer and Nutrition (EPIC). *Am J Clin Nutr* 100 Suppl 1:394s-8s.

Campbell, K. J., D. A. Crawford, J. Salmon, A. Carver, S. P. Garnett, and L. A. Baur. 2007. Associations between the home food environment and obesity-promoting eating behaviors in adolescence. *Obesity (Silver Spring)* 15 (3):719-30.

Cole, T. J., and T. Lobstein. 2012. Extended international (IOTF) body mass index cut-offs for thinness, overweight and obesity. *Pediatric Obesity* 7 (4):284-294.

Diethelm, K., N. Jankovic, L. A. Moreno, I. Huybrechts, S. De Henauw, T. De Vriendt, M. Gonzalez-Gross, et al. 2012. Food intake of European adolescents in the light of different food-based dietary guidelines: results of the HELENA (Healthy Lifestyle in Europe by Nutrition in Adolescence) Study. *Public Health Nutr* 15 (3):386-98.

Evenson, K. R., D. J. Catellier, K. Gill, K. S. Ondrak, and R. G. McMurray. 2008. Calibration of two objective measures of physical activity for children. *J Sports Sci* 26 (14):1557-65.

Finger, J. D., G. Varnaccia, T. Tylleskar, T. Lampert, and G. B. Mensink. 2015. Dietary behaviour and parental socioeconomic position among adolescents: the German Health Interview and Examination Survey for Children and Adolescents 2003-2006 (KiGGS). *BMC Public Health* 15:498.

Goldberg, G. R., A. E. Black, S. A. Jebb, T. J. Cole, P. R. Murgatroyd, W. A. Coward, and A. M. Prentice. 1991. Critical evaluation of energy intake data using fundamental principles of energy physiology: 1. Derivation of cut-off limits to identify under-recording. *Eur J Clin Nutr* 45 (12):569-81.

Hendrie, G. A., J. Coveney, and D. Cox. 2008. Exploring nutrition knowledge and the demographic variation in knowledge levels in an Australian community sample. *Public Health Nutr* 11 (12):1365-71.

Hunt, B. D., and F. P. Cappuccio. 2014. Potassium Intake and Stroke Risk: A Review of the Evidence and Practical Considerations for Achieving a Minimum Target. *Stroke* 45 (5):1519-1522.

Johnson, C. M., J. R. Sharkey, W. R. Dean, W. A. McIntosh, and K. S. Kubena. 2011. It's who I am and what we eat: Mothers' food-related identities in family food choice. *Appetite* 57 (1):220-228.

Kolte, D., K. Vijayaraghavan, S. Khera, D. A. Sica, and W. H. Frishman. 2014. Role of magnesium in cardiovascular diseases. *Cardiol Rev* 22 (4):182-92.

Larson, N. I., D. Neumark-Sztainer, P. J. Hannan, and M. Story. 2007. Trends in adolescent fruit and vegetable consumption, 1999-2004: project EAT. *Am J Prev Med* 32 (2):147-50.

Lehto, E., C. Ray, S. te Velde, S. Petrova, V. Duleva, M. Krawinkel, I. Behrendt, et al. 2015. Mediation of parental educational level on fruit and vegetable intake among schoolchildren in ten European countries. *Public Health Nutrition* 18 (1):89-99.

Lynch, C., A. G. Kristjansdottir, S. J. Te Velde, N. Lien, E. Roos, I. Thorsdottir, M. Krawinkel, et al. 2014. Fruit and vegetable consumption in a sample of 11-year-old children in ten European countries--the PRO GREENS cross-sectional survey. *Public Health Nutr* 17 (11):2436-44.

Martins, I. 2007. *Tabela da Composição de Alimentos*. Edited by C. d. S. A. e. N.-I. N. d. S. D. R. Jorge. 1st ed: Editorial do Menistério da Educação.

Mesias, M., I. Seiquer, and M. P. Navarro. 2011. Calcium nutrition in adolescence. *Crit Rev Food Sci Nutr* 51 (3):195-209.

Moreira, P., S. Santos, P. Padrao, T. Cordeiro, M. Bessa, H. Valente, R. Barros, et al. 2010. Food patterns according to sociodemographics, physical activity, sleeping and obesity in Portuguese children. *Int J Environ Res Public Health* 7 (3):1121-38.

Mota, J., and G. Silva. 1999. Adolescent's Physical Activity: Association with Socio-Economic Status and Parental Participation Among a Portuguese Sample. *Sport, Education and Society* 4 (2):193-199.

Mytton, O. T., K. Nnoaham, H. Eyles, P. Scarborough, and C. Ni Mhurchu. 2014. Systematic review and meta-analysis of the effect of increased vegetable and fruit consumption on body weight and energy intake. *BMC Public Health* 14:886.

Nilsen, S. M., S. Krokstad, T. L. Holmen, and S. Westin. 2010. Adolescents' health-related dietary patterns by parental socio-economic position, the Nord-Trondelag Health Study (HUNT). *Eur J Public Health* 20 (3):299-305.

Northstone, K., A. Smith, V. L. Cribb, and P. M. Emmett. 2014. Dietary patterns in UK adolescents obtained from a dual-source FFQ and their associations with socio-economic position, nutrient intake and modes of eating. *Public Health Nutrition* 17 (7):1476-1485.

Parmenter, K., J. Waller, and J. Wardle. 2000. Demographic variation in nutrition knowledge in England. *Health Educ Res* 15 (2):163-74.

Rodgers, A., V. P, T. Prentice, T. T. Edejer, D. Evans, and J. Lowe. 2002. The World Health Report 2002 - Reduzing Risks, Promoting Healthy Life. Geneva: WHO.

Rodrigues, S. S., B. Franchini, P. Graca, and M. D. de Almeida. 2006. A new food guide for the Portuguese population: development and technical considerations. *J Nutr Educ Behav* 38 (3):189-95.

Rowlands, A. V., and R. G. Eston. 2007. The Measurement and Interpretation of Children's Physical Activity. *Journal of Sports Science & Medicine* 6 (3):270-276.

Santos, R., C. Moreira, S. Abreu, L. Lopes, J. R. Ruiz, P. Moreira, P. Silva, and J. Mota. 2014. Parental education level is associated with clustering of metabolic risk factors in adolescents independently of cardiorespiratory fitness, adherence to the Mediterranean diet, or pubertal stage. *Pediatr Cardiol* 35 (6):959-64.

Sawyer, S. M., R. A. Afifi, L. H. Bearinger, S. J. Blakemore, B. Dick, A. C. Ezeh, and G. C. Patton. 2012. Adolescence: a foundation for future health. *Lancet* 379 (9826):1630-40.

Steinberg, L. 2005. Cognitive and affective development in adolescence. *Trends Cogn Sci* 9 (2):69-74.

Vereecken, C., T. P. Pedersen, K. Ojala, R. Krolner, A. Dzielska, N. Ahluwalia, M. Giacchi, and C. Kelly. 2015. Fruit and vegetable consumption trends among adolescents from 2002 to 2010 in 33 countries. *Eur J Public Health* 25 Suppl 2:16-9.

Viner, R. M., E. M. Ozer, S. Denny, M. Marmot, M. Resnick, A. Fatusi, and C. Currie. 2012. Adolescence and the social determinants of health. *The Lancet* 379 (9826):1641-1652.

Wang, X., Y. Ouyang, J. Liu, M. Zhu, G. Zhao, W. Bao, and F. B. Hu. 2014. Fruit and vegetable consumption and mortality from all causes, cardiovascular disease, and cancer: systematic review and dose-response meta-analysis of prospective cohort studies. *Bmj* 349:g4490.

WHO. 1995. Physical Status: The Use and Interpretation of Anthropometry: report of a WHO expert committee. Geneva: World Health Organization.

Repeated Author. 2003. Diet, nutrition and the prevention of chronic diseases: report of a joint WHO/FAO expert consultation. In *World Health Organ Tech Rep Ser*: World Health Organiztion.

Repeated Author. 2010. Global recommendations on physical activity for health. Switzerland: World Health Organization.

Repeated Author. *Adolescent health*. World Health Organization 2014 [cited 27.11.2014. Available from http://www.who.int/topics/adolescent_health/en/.

Wu, Y., D. Zhang, X. Jiang, and W. Jiang. 2015. Fruit and vegetable consumption and risk of type 2 diabetes mellitus: a dose-response meta-analysis of prospective cohort studies. *Nutr Metab Cardiovasc Dis* 25 (2):140-7.

Zarnowiecki, D., N. Sinn, J. Petkov, and J. Dollman. 2012. Parental nutrition knowledge and attitudes as predictors of 5-6-year-old children's healthy food knowledge. *Public Health Nutr* 15 (7):1284-90.

Zhan, J., Y. J. Liu, L. B. Cai, F. R. Xu, T. Xie, and Q. Q. He. 2015. Fruit and Vegetable Consumption and Risk of Cardiovascular Disease: a Meta-analysis of Prospective Cohort Studies. *Crit Rev Food Sci Nutr*:0.

Overall discussion

Food habits and consequent nutrient intake is an issue of concern among children and adolescents, mainly those from low socioeconomic backgrounds.

Both papers included in this dissertation show that food and nutrient intake among adolescents are generally inadequate and that those with better educated parents seem to benefit from more adequate dietary habits. These results meet those previously drawn by other authors.

Paper I studied adolescents' diets nutritional adequacy and their relationships with parental EL. NAS was generally low among adolescents, mainly due to high intakes of total and saturated fat as well as sodium and low intakes of vitamin A, vitamin D, vitamin E, folate, calcium and magnesium. Similar results were found in Portuguese children, although with lower rates of inadequacy (Who, 2012b), fact that can be explained by the decrease in diet quality with increased age (Demory-Luce, D. *et al.*, 2004). Our results show that mother EL, and not the father's, positively relates to adolescents' nutritional adequacy, independently of age group and TEI but not MVPA compliance. Analogous results have been shown by other authors (Beghin, L. *et al.*, 2014; Golley, R.K. *et al.*, 2011; Hulshof, K.F. *et al.*, 2003; Northstone, K. *et al.*, 2014; Stephens, L.D. *et al.*, 2011).

In what concerns to paper II, this was directed to evaluating adolescents' intake of F&V and its relationship with parental EL. Prevalence of adequate intake of F&V was low among adolescents, with not a single individual achieving the recommended intake for both food groups presented by the PFW and only a very small amount fulfilling WHO's recommendations. Fruit intake seems to be positively influenced by parental EL when both parents present high levels of education, independently of TEI. Similar results have been already described (Bere, E. *et al.*, 2008; Finger, J.D. *et al.*, 2015; Lehto, E. *et al.*, 2015; Nilsen, S.M. *et al.*, 2010). Vegetable intake also seems to be influenced by parental EL, but only that of the mother. In fact our results shown that high mother EL increases the odds of higher vegetable intake among adolescents, independently of TEI. Approximate results have been previously shown (Bere, E. *et al.*, 2008; Lehto, E. *et al.*, 2015; Nilsen, S.M. *et al.*, 2010).

Besides the association of individual intake of F&V, also the association of parental EL with adolescents' eating patterns has been studied. Literature shows that generally children with high-educated parents have healthier eating patterns characterized by the intake of plant based foods (Moreira, P. *et al.*, 2010; Northstone, K. *et al.*, 2014).

Parental EL has been shown to be a consistent predictor of a family's SES (Turrell, G. *et al.*, 2003), even if a complete construct should also include parental occupational

status and family monthly income per capita (Berkman, L.F. and Macintyre, S., 1997; Liberatos, P. *et al.*, 1988). Nonetheless, it keeps being important to study SES indicators individually in order to understand which of those deserves more attention in designing interventions and campaigns.

Importance of parental EL to adequate nutrition of their children holds up to the fact that usually people with higher EL usually have more knowledge of nutrition recommendations, give more importance to a foods' effect in health to the detriment of its price, making better food choices and consequently improving the quality of the food available at home (Ball, K. and Crawford, D., 2006; Parmenter, K. *et al.*, 2000). Besides, these parents also seem to be more engaged in explaining nutrition concepts to their children. The more prominent role of the mother is also understandable as usually the female figure is more engaged in children rearing and in choosing and preparing food (Campbell, K.J. *et al.*, 2007; Johnson, C.M. *et al.*, 2011; Mchale, S.M. *et al.*, 1995).

In a national context these findings gain additional importance. Even if the average EL of Portuguese adults aged 25 to 44 years, the potential parents of nowadays children and adolescents, has been increasing since 1991 it is still positioned in the lowest limit of the high EL group (10.4 school years attended) (Canelas, A. *et al.*, 2014). On the other hand, a positive fact may also be highlighted as females presented in 2011 higher EL than males (10.9 and 9.9 school years, respectively) (Canelas, A. *et al.*, 2014). Knowing that the mother has a dominant effect on children's dietary habits, it is positive to know that females' EL has been increasing, making the mothers more capable of teaching their children.

Both papers seem to point in the same direction. In fact, the low nutritional adequacy showed in paper I may possibly be explain by low F&V consumption as these food groups supply a great amount of vitamins and minerals included in the NAS. Other food groups should also be studied to understand which contributes the most to nutritional inadequacy and to better direct interventions to improve food habits. Moreover, the influence of parental EL in the consumption of each one of the PFW groups is also an interesting study to be developed. A study assessing the relationships between parental EL and individual nutrients' intake by adolescents should also be conducted so that nutrients and foods deserving more attention might be identified.

Nonetheless, adolescents with high-educated parents should also be a target for nutrition education campaigns as, even having lower prevalence of inadequate nutrient intake and F&V consumption, they also fail to meet the recommendations.

The results presented in this dissertation show that involvement of parents in nutrition education campaigns and school interventions programs is important in order to increase

their knowledge of nutritional recommendations and ways to apply them to the family's daily routine and habits. This is also important because nutritional education campaigns started in school should be translated to the home environment to keep being effective. Knowledge and skills transmitted to students in school will not be applied at home if parents do not provide adequate tools and motivation. Increasing nutritional knowledge of adolescents and their parents should be a concern in future projects, interventions and policies.

Conclusion

The work developed through this dissertation brings new insights in adolescents' dietary habits, suggesting that both food and nutrient intakes are influenced by parental EL.

The adolescents participating in the present study have high prevalence of inadequate intake of several nutrients. Besides, nutritional adequacy of adolescents' diets seems to be positively influenced by maternal EL as high educated mothers seem to have children with more adequate nutrient intake, comparing to those less educated.

None of the individuals included in this study managed to achieve the recommendations of F&V of the PFW. Nevertheless, consumption of both fruits and vegetables seems to be influenced by parental EL. For fruit intake, when both parents are high-educated their children seem to have higher intake of fruit compared to those with low-educated parents. When vegetable consumption is considered, mother EL seems to positively influence adolescents' vegetable intake.

Nutrition education interventions and policies developed in order to improve adolescents' dietary habits should take into account the effect of parental EL and settle a personalized action plan so that better results can be achieved, particularly for those adolescents with low educated parents.

References

Agudo, A., Cabrera, L., Amiano, P., Ardanaz, E., Barricarte, A., Berenguer, T., Chirlaque, M.D., Dorronsoro, M., Jakszyn, P., Larranaga, N., Martinez, C., Navarro, C., Quiros, J.R., Sanchez, M.J., Tormo, M.J. e Gonzalez, C.A. (2007). Fruit and vegetable intakes, dietary antioxidant nutrients, and total mortality in Spanish adults: findings from the Spanish cohort of the European Prospective Investigation into Cancer and Nutrition (EPIC-Spain). *Am J Clin Nutr,* **85**(6): 1634-1642.

Alberga, A.S., Sigal, R.J., Goldfield, G., Prud'homme, D. e Kenny, G.P. (2012). Overweight and obese teenagers: why is adolescence a critical period? *Pediatr Obes,* **7**(4): 261-273. doi: 10.1111/j.2047-6310.2011.00046.x

Alinia, S., Hels, O. e Tetens, I. (2009). The potential association between fruit intake and body weight – a review. *Obesity Reviews,* **10**(6): 639-647. doi: 10.1111/j.1467-789X.2009.00582.x

Ambrosini, G.L., Oddy, W.H., Robinson, M., O'sullivan, T.A., Hands, B.P., De Klerk, N.H., Silburn, S.R., Zubrick, S.R., Kendall, G.E., Stanley, F.J. e Beilin, L.J. (2009). Adolescent dietary patterns are associated with lifestyle and family psycho-social factors. *Public Health Nutr,* **12**(10): 1807-1815. doi: 10.1017/s1368980008004618

Apa. (2015). Socioeconomic status. Retrieved 02/01/2015, 2015, from http://www.apa.org/topics/socioeconomic-status/

Aranceta, J., Perez-Rodrigo, C., Ribas, L. e Serra-Majem, L. (2003). Sociodemographic and lifestyle determinants of food patterns in Spanish children and adolescents: the enKid study. *Eur J Clin Nutr,* **57 Suppl 1**: S40-44. doi: 10.1038/sj.ejcn.1601813

Araujo, J., Severo, M., Lopes, C. e Ramos, E. (2011). Food sources of nutrients among 13-year-old Portuguese adolescents. *Public Health Nutr,* **14**(11): 1970-1978. doi: 10.1017/s1368980011001224

Asplund, K. (2002). Antioxidant vitamins in the prevention of cardiovascular disease: a systematic review. *J Intern Med,* **251**(5): 372-392.

Attorp, A., Scott, J.E., Yew, A.C., Rhodes, R.E., Barr, S.I. e Naylor, P.J. (2014). Associations between socioeconomic, parental and home environment factors and fruit and vegetable consumption of children in grades five and six in British Columbia, Canada. *BMC Public Health,* **14**: 9. doi: 10.1186/1471-2458-14-150

Ball, K. e Crawford, D. (2006). Socio-economic factors in obesity: a case of slim chance in a fat world? *Asia Pac J Clin Nutr,* **15 Suppl**: 15-20.

Ball, K., Macfarlane, A., Crawford, D., Savige, G., Andrianopoulos, N. e Worsley, A. (2009). Can social cognitive theory constructs explain socio-economic variations in adolescent eating behaviours? A mediation analysis. *Health Educ Res,* **24**(3): 496-506. doi: 10.1093/her/cyn048

Barr, S.I., Difrancesco, L. e Fulgoni, V.L. (2014). Breakfast consumption is positively associated with nutrient adequacy in Canadian children and adolescents - CORRIGENDUM. *Br J Nutr*: 1. doi: 10.1017/s0007114514003961

Beghin, L., Dauchet, L., De Vriendt, T., Cuenca-Garcia, M., Manios, Y., Toti, E., Plada, M., Widhalm, K., Repasy, J., Huybrechts, I., Kersting, M., Moreno,

L.A. e Dallongeville, J. (2014). Influence of parental socio-economic status on diet quality of European adolescents: results from the HELENA study. *Br J Nutr,* **111**(7): 1303-1312. doi: 10.1017/s0007114513003796

Bere, E., Van Lenthe, F., Klepp, K.I. e Brug, J. (2008). Why do parents' education level and income affect the amount of fruits and vegetables adolescents eat? *Eur J Public Health,* **18**(6): 611-615. doi: 10.1093/eurpub/ckn081

Berkman, L.F. e Macintyre, S. (1997). The measurement of social class in health studies: old measures and new formulations. *IARC Sci Publ*(138): 51-64.

Boeing, H., Bechthold, A., Bub, A., Ellinger, S., Haller, D., Kroke, A., Leschik-Bonnet, E., Muller, M.J., Oberritter, H., Schulze, M., Stehle, P. e Watzl, B. (2012). Critical review: vegetables and fruit in the prevention of chronic diseases. *Eur J Nutr,* **51**(6): 637-663. doi: 10.1007/s00394-012-0380-y

Boffetta, P., Couto, E., Wichmann, J., Ferrari, P., Trichopoulos, D., Bueno-De-Mesquita, H.B., Van Duijnhoven, F.J., Buchner, F.L., Key, T., Boeing, H., Nothlings, U., Linseisen, J., Gonzalez, C.A., Overvad, K., Nielsen, M.R., Tjonneland, A., Olsen, A., Clavel-Chapelon, F., Boutron-Ruault, M.C., Morois, S., Lagiou, P., Naska, A., Benetou, V., Kaaks, R., Rohrmann, S., Panico, S., Sieri, S., Vineis, P., Palli, D., Van Gils, C.H., Peeters, P.H., Lund, E., Brustad, M., Engeset, D., Huerta, J.M., Rodriguez, L., Sanchez, M.J., Dorronsoro, M., Barricarte, A., Hallmans, G., Johansson, I., Manjer, J., Sonestedt, E., Allen, N.E., Bingham, S., Khaw, K.T., Slimani, N., Jenab, M., Mouw, T., Norat, T., Riboli, E. e Trichopoulou, A. (2010). Fruit and vegetable intake and overall cancer risk in the European Prospective Investigation into Cancer and Nutrition (EPIC). *J Natl Cancer Inst,* **102**(8): 529-537. doi: 10.1093/jnci/djq072

Bordalo, A., Carvalho, Á.a.D., Oliveira, A.L., Soares, A.P., Pedroso, A., Diniz, A., Farinha, C.S., Santos, C.S., Sena, C., Pinto, C.S., Bárbara, C., Mota, E., Nunes, E., Calé, E., Falcão, E., Sabino, F., George, F., Freitas, G., Bettencourt, J., Valente, J., Paiva, J.A., Boavida, J.M., Martins, J., Luís, L., Vicente, L., Serra, L., Cardoso, M., Ferreira, M.C., Alves, M.I., Ramos, M., Rosa, M.V., Arriaga, M.T.D., Miranda, N., Henriques, P., Valente, P., Vasconcelos, P., Vicêncio, P., Vitória, P., Nogueira, P., Graça, P., Duarte, R., Ferreira, R.C., Mendanha, T., Fernandes, T. e Prazeres, V. (2015). *A Saúde dos Portugueses. Perspetiva 2015*. Lisboa: Direção-Geral da Saúde.

Bradbury, K.E., Appleby, P.N. e Key, T.J. (2014). Fruit, vegetable, and fiber intake in relation to cancer risk: findings from the European Prospective Investigation into Cancer and Nutrition (EPIC). *Am J Clin Nutr,* **100 Suppl 1**: 394s-398s. doi: 10.3945/ajcn.113.071357

Cameron, A.J., Ball, K., Pearson, N., Lioret, S., Crawford, D.A., Campbell, K., Hesketh, K. e Mcnaughton, S.A. (2012). Socioeconomic variation in diet and activity-related behaviours of Australian children and adolescents aged 2-16 years. *Pediatr Obes,* **7**(4): 329-342. doi: 10.1111/j.2047-6310.2012.00060.x

Campbell, K.J., Crawford, D.A., Salmon, J., Carver, A., Garnett, S.P. e Baur, L.A. (2007). Associations between the home food environment and obesity-promoting eating behaviors in adolescence. *Obesity (Silver Spring),* **15**(3): 719-730. doi: 10.1038/oby.2007.553

Canelas, A., Ferreira, A.L., Gregório, C., Reis, C., Faria, E., Ramos, F., Rodrigues, I., Peliz, M., Perdigão, R., Casas-Novas, T., Gaspar, T., Félix, P. e Ferreira, S. (2014). Estado da Educação 2013. Lisboa: Conselho Nacional de Educação.

Carlson, A. e Frazão, E. (2012). *Are Healthy Foods Really More Expensive? It Depends on How You Measure the Price*. (Economic Information Bulletin Number 96).

Celik, N., Andiran, N. e Yilmaz, A.E. (2011). The relationship between serum magnesium levels with childhood obesity and insulin resistance: a review of the literature. *J Pediatr Endocrinol Metab,* **24**(9-10): 675-678.

Cole, T.J. e Lobstein, T. (2012). Extended international (IOTF) body mass index cut-offs for thinness, overweight and obesity. *Pediatr Obes,* **7**(4): 284-294. doi: 10.1111/j.2047-6310.2012.00064.x

Collins, J.F. e Klevay, L.M. (2011). Copper. *Adv Nutr,* **2**(6): 520-522. doi: 10.3945/an.111.001222

Contento, I.R. (2007). *Nutrition Education: Linking Theory, Research, and Practice*. Jones & Bartlett. Sudbury, MA.

Contento, I.R. (2008). Nutrition education: linking research, theory, and practice. *Asia Pac J Clin Nutr,* **17 Suppl 1**: 176-179.

Coombs, N., Shelton, N., Rowlands, A. e Stamatakis, E. (2013). Children's and adolescents' sedentary behaviour in relation to socioeconomic position. *J Epidemiol Community Health,* **67**(10): 868-874. doi: 10.1136/jech-2013-202609

Cooper, A.J., Forouhi, N.G., Ye, Z., Buijsse, B., Arriola, L., Balkau, B., Barricarte, A., Beulens, J.W.J., Boeing, H., Buchner, F.L., Dahm, C.C., De Lauzon-Guillain, B., Fagherazzi, G., Franks, P.W., Gonzalez, C., Grioni, S., Kaaks, R., Key, T.J., Masala, G., Navarro, C., Nilsson, P., Overvad, K., Panico, S., Ramon Quiros, J., Rolandsson, O., Roswall, N., Sacerdote, C., Sanchez, M.J., Slimani, N., Sluijs, I., Spijkerman, A.M.W., Teucher, B., Tjonneland, A., Tumino, R., Sharp, S.J., Langenberg, C., Feskens, E.J.M., Riboli, E. e Wareham, N.J. (2012). Fruit and vegetable intake and type 2 diabetes: EPIC-InterAct prospective study and meta-analysis. *Eur J Clin Nutr,* **66**(10): 1082-1092.

Cowan, C.D., Hausser, R.M., Kominski, R.A., Levin, H.M., Lucas, S.R., Morgan, S.L., Spencer, M.B. e Chapman, S. (2012). Improving the Measurement of Socioeconomic Status for the National Assessment of Educational Progress: A Theoretical Foundation: U.S. Department of Education Institute of Education Sciences National Center for Education Statistics.

Craig, L.C., Mcneill, G., Macdiarmid, J.I., Masson, L.F. e Holmes, B.A. (2010). Dietary patterns of school-age children in Scotland: association with socio-economic indicators, physical activity and obesity. *Br J Nutr,* **103**(3): 319-334. doi: 10.1017/s0007114509991942

Cribb, V.L., Jones, L.R., Rogers, I.S., Ness, A.R. e Emmett, P.M. (2011). Is maternal education level associated with diet in 10-year-old children? *Public Health Nutr,* **14**(11): 2037-2048. doi: 10.1017/s136898001100036x

Currie, C., Molcho, M., Boyce, W., Holstein, B., Torsheim, T. e Richter, M. (2008). Researching health inequalities in adolescents: the development of the Health Behaviour in School-Aged Children (HBSC) family affluence scale. *Soc Sci Med,* **66**(6): 1429-1436. doi: 10.1016/j.socscimed.2007.11.024

Currie, C.E., Elton, R.A., Todd, J. e Platt, S. (1997). Indicators of socioeconomic status for adolescents: the WHO Health Behaviour in School-aged Children Survey. *Health Educ Res,* **12**(3): 385-397. doi: 10.1093/her/12.3.385

Darmon, N., Briend, A. e Drewnowski, A. (2004). Energy-dense diets are associated with lower diet costs: a community study of French adults. *Public Health Nutr,* **7**(1): 21-27.

Darmon, N. e Drewnowski, A. (2008). Does social class predict diet quality? *The American Journal of Clinical Nutrition,* **87**(5): 1107-1117.

Dean, S.V., Lassi, Z.S., Imam, A.M. e Bhutta, Z.A. (2014). Preconception care: nutritional risks and interventions. *Reprod Health,* **11 Suppl 3**: S3. doi: 10.1186/1742-4755-11-s3-s3

Demory-Luce, D., Morales, M., Nicklas, T., Baranowski, T., Zakeri, I. e Berenson, G. (2004). Changes in food group consumption patterns from childhood to young adulthood: the Bogalusa Heart Study. *J Am Diet Assoc,* **104**(11): 1684-1691. doi: 10.1016/j.jada.2004.07.026

Diethelm, K., Huybrechts, I., Moreno, L., De Henauw, S., Manios, Y., Beghin, L., Gonzalez-Gross, M., Le Donne, C., Cuenca-Garcia, M., Castillo, M.J., Widhalm, K., Patterson, E. e Kersting, M. (2014). Nutrient intake of European adolescents: results of the HELENA (Healthy Lifestyle in Europe by Nutrition in Adolescence) Study. *Public Health Nutr,* **17**(3): 486-497. doi: 10.1017/s1368980013000463

Diethelm, K., Jankovic, N., Moreno, L.A., Huybrechts, I., De Henauw, S., De Vriendt, T., Gonzalez-Gross, M., Leclercq, C., Gottrand, F., Gilbert, C.C., Dallongeville, J., Cuenca-Garcia, M., Manios, Y., Kafatos, A., Plada, M. e Kersting, M. (2012). Food intake of European adolescents in the light of different food-based dietary guidelines: results of the HELENA (Healthy Lifestyle in Europe by Nutrition in Adolescence) Study. *Public Health Nutr,* **15**(3): 386-398. doi: 10.1017/s1368980011001935

Drewnowski, A. (2009). Obesity, diets, and social inequalities. *Nutr Rev,* **67 Suppl 1**: S36-39. doi: 10.1111/j.1753-4887.2009.00157.x

Drewnowski, A., Darmon, N. e Briend, A. (2004). Replacing fats and sweets with vegetables and fruits--a question of cost. *Am J Public Health,* **94**(9): 1555-1559.

Engler-Stringer, R., Le, H., Gerrard, A. e Muhajarine, N. (2014). The community and consumer food environment and children's diet: a systematic review. *BMC Public Health,* **14**: 522. doi: 10.1186/1471-2458-14-522

(2010). *Fats and fatty acids in human nutrition - Report of an expert consultation* [

Finger, J.D., Varnaccia, G., Tylleskar, T., Lampert, T. e Mensink, G.B. (2015). Dietary behaviour and parental socioeconomic position among adolescents: the German Health Interview and Examination Survey for Children and Adolescents 2003-2006 (KiGGS). *BMC Public Health,* **15**: 498. doi: 10.1186/s12889-015-1830-2

Fismen, A.S., Smith, O., Torsheim, T. e Samdal, O. (2014). A school based study of time trends in food habits and their relation to socio-economic status among Norwegian adolescents, 2001 inverted question mark2009. *Int J Behav Nutr Phys Act,* **11**(1): 115. doi: 10.1186/s12966-014-0115-y

Fulton, S.L., Mckinley, M.C., Young, I.S., Cardwell, C.R. e Woodside, J.V. (2014). The effect of increasing fruit and vegetable consumption on overall diet: a

systematic review and meta-analysis. *Crit Rev Food Sci Nutr*. doi: 10.1080/10408398.2012.727917

Galobardes, B., Morabia, A. e Bernstein, M.S. (2001). Diet and socioeconomic position: does the use of different indicators matter? *International Journal of Epidemiology,* **30**(2): 334-340. doi: 10.1093/ije/30.2.334

Ganzeboom, H.B.G., De Graaf, P.M. e Treiman, D.J. (1992). A standard international socio-economic index of occupational status. *Social Science Research,* **21**(1): 1-56. doi: http://dx.doi.org/10.1016/0049-089X(92)90017-B

Golley, R.K., Hendrie, G.A. e Mcnaughton, S.A. (2011). Scores on the dietary guideline index for children and adolescents are associated with nutrient intake and socio-economic position but not adiposity. *J Nutr,* **141**(7): 1340-1347. doi: 10.3945/jn.110.136879

Grosso, G., Marventano, S., Buscemi, S., Scuderi, A., Matalone, M., Platania, A., Giorgianni, G., Rametta, S., Nolfo, F., Galvano, F. e Mistretta, A. (2013). Factors associated with adherence to the Mediterranean diet among adolescents living in Sicily, Southern Italy. *Nutrients,* **5**(12): 4908-4923. doi: 10.3390/nu5124908

Gururaj e Maheshwaran. (2014). Kuppuswamy's Socio-Economic Status Scale - A Revision of Income Parameter For 2014. *International Journal of Recent Trends in Science And Technology,* **11**(1): 2.

Hendrie, G.A., Coveney, J. e Cox, D. (2008). Exploring nutrition knowledge and the demographic variation in knowledge levels in an Australian community sample. *Public Health Nutr,* **11**(12): 1365-1371. doi: 10.1017/s1368980008003042

Hoppu, U., Lehtisalo, J., Tapanainen, H. e Pietinen, P. (2010). Dietary habits and nutrient intake of Finnish adolescents. *Public Health Nutr,* **13**(6a): 965-972. doi: 10.1017/s1368980010001175

Hulshof, K.F., Brussaard, J.H., Kruizinga, A.G., Telman, J. e Lowik, M.R. (2003). Socio-economic status, dietary intake and 10 y trends: the Dutch National Food Consumption Survey. *Eur J Clin Nutr,* **57**(1): 128-137. doi: 10.1038/sj.ejcn.1601503

Hunt, B.D. e Cappuccio, F.P. (2014). Potassium Intake and Stroke Risk: A Review of the Evidence and Practical Considerations for Achieving a Minimum Target. *Stroke,* **45**(5): 1519-1522. doi: 10.1161/strokeaha.113.004282

Iglesia, I., Mouratidou, T., Gonzalez-Gross, M., Novakovic, R., Breidenassel, C., Jimenez-Pavon, D., Huybrechts, I., De Henauw, S., Geelen, A., Gottrand, F., Kafatos, A., Mistura, L., De Heredia, F.P., Widhalm, K., Manios, Y., Molnar, D., Stehle, P., Gurinovic, M., Cavelaars, A.E., Van't Veer, P. e Moreno, L.A. (2014). Socioeconomic factors are associated with folate and vitamin B12 intakes and related biomarkers concentrations in European adolescents: the Healthy Lifestyle in Europe by Nutrition in Adolescence study. *Nutr Res,* **34**(3): 199-209. doi: 10.1016/j.nutres.2014.01.006

Ilo. (2004). International Standard Classification of Occupations - ISCO-88. Retrieved 03/01/2015, 2015, from http://www.ilo.org/public/english/bureau/stat/isco/isco88/index.htm

John, J.H., Ziebland, S., Yudkin, P., Roe, L.S. e Neil, H.A. (2002). Effects of fruit and vegetable consumption on plasma antioxidant concentrations and

blood pressure: a randomised controlled trial. *Lancet,* **359**(9322): 1969-1974.

Johnson, C.M., Sharkey, J.R., Dean, W.R., Mcintosh, W.A. e Kubena, K.S. (2011). It's who I am and what we eat: Mothers' food-related identities in family food choice. *Appetite,* **57**(1): 220-228. doi: 10.1016/j.appet.2011.04.025

Kolte, D., Vijayaraghavan, K., Khera, S., Sica, D.A. e Frishman, W.H. (2014). Role of magnesium in cardiovascular diseases. *Cardiol Rev,* **22**(4): 182-192. doi: 10.1097/crd.0000000000000003

Kranz, S., Brauchla, M., Slavin, J.L. e Miller, K.B. (2012). What do we know about dietary fiber intake in children and health? The effects of fiber intake on constipation, obesity, and diabetes in children. *Adv Nutr,* **3**(1): 47-53. doi: 10.3945/an.111.001362

Kushi, L.H., Doyle, C., Mccullough, M., Rock, C.L., Demark-Wahnefried, W., Bandera, E.V., Gapstur, S., Patel, A.V., Andrews, K. e Gansler, T. (2012). American Cancer Society Guidelines on nutrition and physical activity for cancer prevention: reducing the risk of cancer with healthy food choices and physical activity. *CA Cancer J Clin,* **62**(1): 30-67. doi: 10.3322/caac.20140

Larson, N.I., Neumark-Sztainer, D., Hannan, P.J. e Story, M. (2007). Trends in adolescent fruit and vegetable consumption, 1999-2004: project EAT. *Am J Prev Med,* **32**(2): 147-150. doi: 10.1016/j.amepre.2006.10.011

Lee, H., Harris, K.M. e Lee, J. (2013). Multiple levels of social disadvantage and links to obesity in adolescence and young adulthood. *J Sch Health,* **83**(3): 139-149. doi: 10.1111/josh.12009

Lee, P.A. (1980). Normal ages of pubertal events among American males and females. *J Adolesc Health Care,* **1**(1): 26-29.

Lehto, E., Ray, C., Te Velde, S., Petrova, S., Duleva, V., Krawinkel, M., Behrendt, I., Papadaki, A., Kristjansdottir, A., Thorsdottir, I., Yngve, A., Lien, N., Lynch, C., Ehrenblad, B., De Almeida, M.D.V., Ribic, C.H., Simcic, I. e Roos, E. (2015). Mediation of parental educational level on fruit and vegetable intake among schoolchildren in ten European countries. *Public Health Nutr,* **18**(1): 89-99. doi: 10.1017/s136898001300339x

Liberatos, P., Link, B.G. e Kelsey, J.L. (1988). The measurement of social class in epidemiology. *Epidemiol Rev,* **10**: 87-121.

Libuda, L., Alexy, U., Buyken, A.E., Sichert-Hellert, W., Stehle, P. e Kersting, M. (2009). Consumption of sugar-sweetened beverages and its association with nutrient intakes and diet quality in German children and adolescents. *Br J Nutr,* **101**(10): 1549-1557. doi: 10.1017/s0007114508094671

Lien, N., Lytle, L.A. e Klepp, K.I. (2001). Stability in consumption of fruit, vegetables, and sugary foods in a cohort from age 14 to age 21. *Prev Med,* **33**(3): 217-226. doi: 10.1006/pmed.2001.0874

Lim, P. e Gemici, S. (2011). *Measuring the socioeconomic status of Australian youth*. Australia: National Centre for Vocational Education Research.

Loring, B. e Robertson, A. (2014). *Obesity and inequities*. World Health Organization. Copenhagen.

Lynch, C., Kristjansdottir, A.G., Te Velde, S.J., Lien, N., Roos, E., Thorsdottir, I., Krawinkel, M., De Almeida, M.D., Papadaki, A., Hlastan Ribic, C., Petrova, S., Ehrenblad, B., Halldorsson, T.I., Poortvliet, E. e Yngve, A. (2014). Fruit and vegetable consumption in a sample of 11-year-old children in ten

European countries--the PRO GREENS cross-sectional survey. *Public Health Nutr,* **17**(11): 2436-2444. doi: 10.1017/s1368980014001347

Martini, L.A., Verly, E., Marchioni, D.M.L. e Fisberg, R.M. (2013). Prevalence and correlates of calcium and vitamin D status adequacy in adolescents, adults, and elderly from the Health Survey-Sao Paulo. *Nutrition,* **29**(6): 845-850. doi: 10.1016/j.nut.2012.12.009

Matthys, C., De Henauw, S., Maes, L., De Bacquer, D., Verbeke, W. e De Backer, G. (2006). Adolescents' education and their diet recorded by 7-day food records. *Soz Praventivmed,* **51**(2): 80-90.

Mazur, R.E., Marquis, G.S. e Jensen, H.H. (2003). Diet and food insufficiency among Hispanic youths: acculturation and socioeconomic factors in the third National Health and Nutrition Examination Survey. *Am J Clin Nutr,* **78**(6): 1120-1127.

Mchale, S.M., Crouter, A.C., Mcguire, S.A. e Updegraff, K.A. (1995). Congruence between mothers' and fathers' differential treatment of siblings: links with family relations and children's well-being. *Child Dev,* **66**(1): 116-128.

Mesias, M., Seiquer, I. e Navarro, M.P. (2011). Calcium nutrition in adolescence. *Crit Rev Food Sci Nutr,* **51**(3): 195-209. doi: 10.1080/10408390903502872

Mesias, M., Seiquer, I. e Navarro, M.P. (2013). Iron nutrition in adolescence. *Crit Rev Food Sci Nutr,* **53**(11): 1226-1237. doi: 10.1080/10408398.2011.564333

Misra, M., Pacaud, D., Petryk, A., Collett-Solberg, P.F. e Kappy, M. (2008). Vitamin D deficiency in children and its management: review of current knowledge and recommendations. *Pediatrics,* **122**(2): 398-417. doi: 10.1542/peds.2007-1894

Moreira, P., Santos, S., Padrao, P., Cordeiro, T., Bessa, M., Valente, H., Barros, R., Teixeira, V., Mitchell, V., Lopes, C. e Moreira, A. (2010). Food patterns according to sociodemographics, physical activity, sleeping and obesity in Portuguese children. *Int J Environ Res Public Health,* **7**(3): 1121-1138. doi: 10.3390/ijerph7031121

Moreira, P.A. e Padrao, P.D. (2004). Educational and economic determinants of food intake in Portuguese adults: a cross-sectional survey. *BMC Public Health,* **4**: 58. doi: 10.1186/1471-2458-4-58

Mytton, O.T., Nnoaham, K., Eyles, H., Scarborough, P. e Ni Mhurchu, C. (2014). Systematic review and meta-analysis of the effect of increased vegetable and fruit consumption on body weight and energy intake. *BMC Public Health,* **14**: 886. doi: 10.1186/1471-2458-14-886

Navia, B., Ortega, R.M., Requejo, A.M., Perea, J.M., Lopez-Sobaler, A.M. e Faci, M. (2003). Influence of maternal education on food consumption and energy and nutrient intake in a group of pre-school children from Madrid. *Int J Vitam Nutr Res,* **73**(6): 439-445.

Nicholson, J.M., Lucas, N., Berthelsen, D. e Wake, M. (2012). Socioeconomic inequality profiles in physical and developmental health from 0–7 years: Australian National Study. *J Epidemiol Community Health,* **66**(1): 81-87. doi: 10.1136/jech.2009.103291

Nilsen, S.M., Krokstad, S., Holmen, T.L. e Westin, S. (2010). Adolescents' health-related dietary patterns by parental socio-economic position, the Nord-Trondelag Health Study (HUNT). *Eur J Public Health,* **20**(3): 299-305. doi: 10.1093/eurpub/ckp137

Northstone, K., Smith, A., Cribb, V.L. e Emmett, P.M. (2014). Dietary patterns in UK adolescents obtained from a dual-source FFQ and their associations with socio-economic position, nutrient intake and modes of eating. *Public Health Nutr,* **17**(7): 1476-1485. doi: 10.1017/s1368980013001547

Novakovic, R., Cavelaars, A., Geelen, A., Nikolic, M., Altaba, Ii, Vinas, B.R., Ngo, J., Golsorkhi, M., Medina, M.W., Brzozowska, A., Szczecinska, A., De Cock, D., Vansant, G., Renkema, M., Majem, L.S., Moreno, L.A., Glibetic, M., Gurinovic, M., Van't Veer, P. e Lisette, C.D.G. (2014). Review Article Socio-economic determinants of micronutrient intake and status in Europe: a systematic review. *Public Health Nutr,* **17**(5): 1031-1045. doi: 10.1017/s1368980013001341

Otten, J.J., Hellwig, J.P., Meyers, L.D. e Editors. (2006). *Dietary Reference Intakes: The Essential Guide to Nutrient Requirements*. The National Academies Press. Washington, DC.

Parmenter, K., Waller, J. e Wardle, J. (2000). Demographic variation in nutrition knowledge in England. *Health Educ Res,* **15**(2): 163-174.

Parrott, M.D., Shatenstein, B., Ferland, G., Payette, H., Morais, J.A., Belleville, S., Kergoat, M.-J., Gaudreau, P. e Greenwood, C.E. (2013). Relationship between Diet Quality and Cognition Depends on Socioeconomic Position in Healthy Older Adults. *The Journal of Nutrition,* **143**(11): 1767-1773. doi: 10.3945/jn.113.181115

Pietrobelli, A., Boner, A.L. e Tato, L. (2005). Adipose tissue and metabolic effects: new insight into measurements. *Int J Obes (Lond),* **29 Suppl 2**: S97-100.

Rasmussen, M., Krolner, R., Klepp, K.I., Lytle, L., Brug, J., Bere, E. e Due, P. (2006). Determinants of fruit and vegetable consumption among children and adolescents: a review of the literature. Part I: Quantitative studies. *Int J Behav Nutr Phys Act,* **3**: 22. doi: 10.1186/1479-5868-3-22

Rodgers, A., P, V., Prentice, T., Edejer, T.T., Evans, D. e Lowe, J. (2002). *The World Health Report 2002 - Reduzing Risks, Promoting Healthy Life*

Rodrigues, S.S., Franchini, B., Graca, P. e De Almeida, M.D. (2006). A new food guide for the Portuguese population: development and technical considerations. *J Nutr Educ Behav,* **38**(3): 189-195. doi: 10.1016/j.jneb.2006.01.011

Rogol, A.D., Roemmich, J.N. e Clark, P.A. (2002). Growth at puberty. *J Adolesc Health,* **31**(6 Suppl): 192-200.

Sawyer, S.M., Afifi, R.A., Bearinger, L.H., Blakemore, S.J., Dick, B., Ezeh, A.C. e Patton, G.C. (2012). Adolescence: a foundation for future health. *Lancet,* **379**(9826): 1630-1640. doi: 10.1016/s0140-6736(12)60072-5

Schulze, M.B., Schulz, M., Heidemann, C., Schienkiewitz, A., Hoffmann, K. e Boeing, H. (2007). Fiber and magnesium intake and incidence of type 2 diabetes: a prospective study and meta-analysis. *Arch Intern Med,* **167**(9): 956-965. doi: 10.1001/archinte.167.9.956

Serra-Majem, L., Ribas, L., Perez-Rodrigo, C., Garcia-Closas, R., Pena-Quintana, L. e Aranceta, J. (2002). Determinants of nutrient intake among children and adolescents: results from the enKid Study. *Ann Nutr Metab,* **46 Suppl 1**: 31-38. doi: 66398

Sinn, N., Milte, C. e Howe, P.R. (2010). Oiling the brain: a review of randomized controlled trials of omega-3 fatty acids in psychopathology across the lifespan. *Nutrients,* **2**(2): 128-170. doi: 10.3390/nu2020128

Smithers, G., Gregory, J.R., Bates, C.J., Prentice, A., Jackson, L.V. e Wenlock, R. (2000). The National Diet and Nutrition Survey: young people aged 4–18 years. *Nutrition Bulletin,* **25**(2): 105-111. doi: 10.1046/j.1467-3010.2000.00027.x

Steinberg, L. (2005). Cognitive and affective development in adolescence. *Trends Cogn Sci,* **9**(2): 69-74. doi: 10.1016/j.tics.2004.12.005

Steinberg, L. (2007). Risk Taking in Adolescence: New Perspectives From Brain and Behavioral Science. *Current Directions in Psychological Science,* **16**(2): 55-59. doi: 10.1111/j.1467-8721.2007.00475.x

Stephens, L.D., Mcnaughton, S.A., Crawford, D., Macfarlane, A. e Ball, K. (2011). Correlates of dietary resilience among socioeconomically disadvantaged adolescents. *Eur J Clin Nutr,* **65**(11): 1219-1232. doi: 10.1038/ejcn.2011.107

Sweeting, H. e West, P. (2005). Dietary habits and children's family lives. *J Hum Nutr Diet,* **18**(2): 93-97. doi: 10.1111/j.1365-277X.2005.00592.x

Thompson, T.G. e Veneman, A.M. (2005). *Dietary Guidelines for Americans 2005*. Washington, DC: U.S. Government Printing Office.

Tsang, S.K.M., Hui, E.K.P. e Law, B.C.M. (2012). Positive identity as a positive youth development construct: a conceptual review. *The Scientific World Journal,* **8**. doi: 10.1100/2012/529691

Tur, J.A., Puig, M.S., Benito, E. e Pons, A. (2004). Associations between sociodemographic and lifestyle factors and dietary quality among adolescents in Palma de Mallorca. *Nutrition,* **20**(6): 502-508. doi: 10.1016/j.nut.2004.03.009

Turrell, G., Hewitt, B., Patterson, C. e Oldenburg, B. (2003). Measuring socio-economic position in dietary research: is choice of socio-economic indicator important? *Public Health Nutr,* **6**(2): 191-200. doi: 10.1079/phn2002416

Uauy, R. e Dangour, A.D. (2009). Fat and Fatty Acid Requirements and Recommendations for Infants of 0–2 Years and Children of 2–18 Years. *Annals of Nutrition and Metabolism,* **55**(1-3): 76-96.

Unesco. (2012). *International Standard Classification of Education ISCED 2011*. Canada: United Nations Educational, Scientific and Cultural Organization.

Valente, H., Padez, C., Mourao, I., Rosado, V. e Moreira, P. (2010). [Prevalence of nutritional inadequacy among Portuguese children]. *Acta Med Port,* **23**(3): 365-370.

Valente, T.W., Fujimoto, K., Chou, C.P. e Spruijt-Metz, D. (2009). Adolescent affiliations and adiposity: a social network analysis of friendships and obesity. *J Adolesc Health,* **45**(2): 202-204. doi: 10.1016/j.jadohealth.2009.01.007

Van Der Horst, K., Oenema, A., Ferreira, I., Wendel-Vos, W., Giskes, K., Van Lenthe, F. e Brug, J. (2007). A systematic review of environmental correlates of obesity-related dietary behaviors in youth. *Health Educ Res,* **22**(2): 203-226. doi: 10.1093/her/cyl069

Van Duyn, M.A. e Pivonka, E. (2000). Overview of the health benefits of fruit and vegetable consumption for the dietetics professional: selected literature. *J Am Diet Assoc,* **100**(12): 1511-1521. doi: 10.1016/s0002-8223(00)00420-x

Vereecken, C., Pedersen, T.P., Ojala, K., Krolner, R., Dzielska, A., Ahluwalia, N., Giacchi, M. e Kelly, C. (2015). Fruit and vegetable consumption trends

among adolescents from 2002 to 2010 in 33 countries. *Eur J Public Health,* **25 Suppl 2**: 16-19. doi: 10.1093/eurpub/ckv012

Viner, R.M., Ozer, E.M., Denny, S., Marmot, M., Resnick, M., Fatusi, A. e Currie, C. (2012). Adolescence and the social determinants of health. *The Lancet,* **379**(9826): 1641-1652.

Wang, X., Ouyang, Y., Liu, J., Zhu, M., Zhao, G., Bao, W. e Hu, F.B. (2014). Fruit and vegetable consumption and mortality from all causes, cardiovascular disease, and cancer: systematic review and dose-response meta-analysis of prospective cohort studies. *Bmj,* **349**: g4490. doi: 10.1136/bmj.g4490

Weyers, S., Dragano, N., Mobus, S., Beck, E.M., Stang, A., Mohlenkamp, S., Jockel, K.H., Erbel, R. e Siegrist, J. (2010). Poor social relations and adverse health behaviour: stronger associations in low socioeconomic groups? *Int J Public Health,* **55**(1): 17-23. doi: 10.1007/s00038-009-0070-6

Who. (2001a). Human energy requirements - Report of a Joint FAO/WHO/UNU Expert Consultation. Rome: FAO - Food and Nutrition Technical Report Series.

Who. (2001b). Human Vitamin and Mineral Requirements - Report of a joint FAO/WHO expert consultation. Rome: Food and Agriculture Organization of the United Nations.

Who. (2002). Protein and amino acid requirements in human nutrition : report of a joint FAO/WHO/UNU expert consultation. Geneva, Switzerland.

Who. (2003). Diet, nutrition and the prevention of chronic diseases: report of a joint WHO/FAO expert consultation *World Health Organ Tech Rep Ser* (2003/05/29 ed., Vol. 916, pp. i-viii, 1-149, backcover): World Health Organiztion.

Who. (2012a). Guideline: sodium intake for adults and children. Geneva: World Health Organization.

Who. (2012b). Social determinants of health and well-being among young people : Health Behaviour in School-Aged Children (HBSC) study : international report from the 2009/2010 survey World Health Organization.

Who. (2014). Adolescent health. Retrieved 27.11.2014, from http://www.who.int/topics/adolescent_health/en/

Who. (2015). Guideline: sugars intake for adults and children. Geneva: World Health Organization.

Willoughby, J.L. e Bowen, C.N. (2014). Zinc deficiency and toxicity in pediatric practice. *Curr Opin Pediatr,* **26**(5): 579-584. doi: 10.1097/mop.0000000000000132

Wu, Y., Zhang, D., Jiang, X. e Jiang, W. (2015). Fruit and vegetable consumption and risk of type 2 diabetes mellitus: a dose-response meta-analysis of prospective cohort studies. *Nutr Metab Cardiovasc Dis,* **25**(2): 140-147. doi: 10.1016/j.numecd.2014.10.004

Xie, B., Gilliland, F.D., Li, Y.F. e Rockett, H.R.H. (2003). Effects of ethnicity, family income, and education on dietary intake among adolescents. *Preventive Medicine,* **36**(1): 30-40. doi: 10.1006/pmed.2002.1131

Zarnowiecki, D., Ball, K., Parletta, N. e Dollman, J. (2014). Describing socioeconomic gradients in children's diets - does the socioeconomic indicator used matter? *International Journal of Behavioral Nutrition and Physical Activity,* **11**: 12. doi: 10.1186/1479-868-11-44

Zarnowiecki, D., Sinn, N., Petkov, J. e Dollman, J. (2012). Parental nutrition knowledge and attitudes as predictors of 5-6-year-old children's healthy food knowledge. *Public Health Nutr,* **15**(7): 1284-1290. doi: 10.1017/s1368980011003259

Zhan, J., Liu, Y.J., Cai, L.B., Xu, F.R., Xie, T. e He, Q.Q. (2015). Fruit and Vegetable Consumption and Risk of Cardiovascular Disease: a Meta-analysis of Prospective Cohort Studies. *Crit Rev Food Sci Nutr*: 0. doi: 10.1080/10408398.2015.1008980

Zofkova, I., Nemcikova, P. e Matucha, P. (2013). Trace elements and bone health. *Clin Chem Lab Med,* **51**(8): 1555-1561. doi: 10.1515/cclm-2012-0868

Appendices

Appendix I

Questionnaire of Physical Activity Knowledge

QCAF

No âmbito do projecto AFINA-te, estamos a avaliar o que os adolescentes sabem sobre actividade física e o que acham confuso.

Isto é um questionário, não é um teste. Não serás avaliado.

As tuas respostas não serão divulgadas em nenhum momento.

Por favor sê honesto, responde sozinho a todas as questões.
Se não souberes alguma resposta, escolhe "Não tenho a certeza", não tentes adivinhar.

Muito Obrigado pela tua ajuda e colaboração!

1. Qual a tua data de nascimento?

DD MM AAAA

Dia/Mês/Ano ____ / ____ / ____

2. Qual a tua idade?

Anos

3. Género

- ◯ Feminino
- ◯ Masculino

4. Qual o nome da tua escola?

5. Qual o teu ano, turma e número?

Ano

Número

Turma

6. Valores antropométricos

Peso (Kg)

Altura (m)

7. Habitualmente como vais para a escola?

- ◯ Carro/ Autocarro
- ◯ Bicicleta
- ◯ A pé
- ◯ Outro, como?

8. Como preferes passar os teus tempos livres?

- [ ] Jogos de bola (futebol, voleibol...)
- [ ] Correr ou andar de bicicleta
- [ ] Ecrã (TV, computador, playstation...)
- [ ] Ler ou escrever
- [ ] Passear
- [ ] Outro, o quê?

9. Como podemos entrar em contacto contigo?

Telemóvel

E-mail

Outro

10. Com quem vives?

Escolhe a(s) opção(s) que se aplica(m) a ti!

- [ ] Pai
- [ ] Mãe
- [ ] Irmão(s)
- [ ] Avó(s)
- [ ] Tio(s)
- [ ] Primo(s)
- [ ] Outro, com quem?

11. Qual a escolaridade do teu pai?

- ◯ Até ao 4º ano
- ◯ Entre o 5º e o 9º ano
- ◯ Entre o 10º e o 12º ano
- ◯ Mais do que 12º ano

12. Qual a escolaridade da tua mãe?

- ◯ Até ao 4º ano
- ◯ Entre o 5º e o 9º ano
- ◯ Entre o 10º e o 12º ano
- ◯ Mais do que 12º ano

13. Qual o rendimento mensal dos teus pais (os dois em conjunto)?

- ◯ Até 1000€ por mês
- ◯ De 1001€ a 2000€ por mês
- ◯ De 2001€ a 3000€ por mês
- ◯ De 3001€ a 4000€ por mês
- ◯ Mais de 4001€ por mês

14. O teu pai incentiva-te a praticares exercício físico?

- ◯ Muito
- ◯ Mais ou menos
- ◯ Pouco
- ◯ Não

15. A tua mãe incentiva-te a praticares exercício físico?

- ◯ Muito
- ◯ Pouco
- ◯ Mais ou menos
- ◯ Não

16. Os teus amigos incentivam-te a praticares exercício físico?

- ◯ Muito
- ◯ Pouco
- ◯ Mais ou menos
- ◯ Não

17. O teu pai pratica exercício físico?

- ◯ Muito
- ◯ Pouco
- ◯ Mais ou menos
- ◯ Não

18. A tua mãe pratica exercício físico?

- ◯ Muito
- ◯ Pouco
- ◯ Mais ou menos
- ◯ Não

19. Os teus amigos praticam exercício físico?

- ◯ Muito
- ◯ Pouco
- ◯ Mais ou menos
- ◯ Não

20. O teu pai incentiva-te a fazeres uma alimentação saudável?

- ◯ Muito
- ◯ Pouco
- ◯ Mais ou menos
- ◯ Não

21. A tua mãe incentiva-te a fazeres uma alimentação saudável?

- ◯ Muito
- ◯ Pouco
- ◯ Mais ou menos
- ◯ Não

22. Os teus amigos incentivam-te a fazeres uma alimentação saudável?

- ◯ Muito
- ◯ Pouco
- ◯ Mais ou menos
- ◯ Não

23. O teu pai faz uma alimentação saudável?

- ◯ Sempre
- ◯ Quase nunca
- ◯ Quase sempre
- ◯ Nunca

24. A tua mãe faz uma alimentação saudável?

- ◯ Sempre
- ◯ Quase nunca
- ◯ Quase sempre
- ◯ Nunca

25. Os teus amigos fazem uma alimentação saudável?

- ◯ Sempre
- ◯ Quase sempre
- ◯ Quase nunca
- ◯ Nunca

Por favor, assinala se concordas, discordas ou não tens a certeza relativamente às frases que se seguem.

26. Praticar actividade física traz benefícios fundamentais para a saúde das crianças e dos jovens.

- ◯ Concordo
- ◯ Discordo
- ◯ Não tenho a certeza

27. Praticar actividade física contribui para melhorar a saúde cardiovascular.

- ◯ Concordo
- ◯ Discordo
- ◯ Não tenho a certeza

28. Quem deseja perder gordura corporal deve aumentar a prática de actividade física.

- ◯ Concordo
- ◯ Discordo
- ◯ Não tenho a certeza

29. Praticar actividade física não está relacionado com a saúde dos ossos.

- ◯ Concordo
- ◯ Discordo
- ◯ Não tenho a certeza

30. Os sintomas de depressão não reduzem quando se aumenta a prática de actividade física.

- ◯ Concordo
- ◯ Discordo
- ◯ Não tenho a certeza

31. Praticar mais actividade física do que o recomendado tem vantagens adicionais para a saúde das crianças e jovens.

- ◯ Concordo
- ◯ Discordo
- ◯ Não tenho a certeza

32. Não vale a pena praticar actividade física se não cumprir o tempo mínimo recomendado.

- ◯ Concordo
- ◯ Discordo
- ◯ Não tenho a certeza

Nas questões que se seguem escolhe a opção correcta.

33. Durante quanto tempo, por dia, as crianças e os jovens devem praticar actividade física?

- ◯ 30 minutos
- ◯ 45 minutos
- ◯ 60 minutos
- ◯ Não tenho a certeza

34. Quantos dias por semana, no mínimo, as crianças e os jovens devem praticar exercício físico para reforçar os músculos?

- ◯ Nenhum dia
- ◯ 3 dias
- ◯ 5 dias
- ◯ Não tenho a certeza

35. Que actividades são consideradas actividade física?

- ◯ Aulas de educação física ou treinos, com professor ou treinador
- ◯ Jogar "à bola" com os amigos
- ◯ Ir a pé de um sítio para o outro
- ◯ Todas as anteriores

MUITO OBRIGADO PELA TUA COLABORAÇÃO.

36. Se há algum comentário que gostarias de fazer relativamente a este questionário ou ao Projecto AFINA-te, por favor fá-lo aqui!

Appendix II

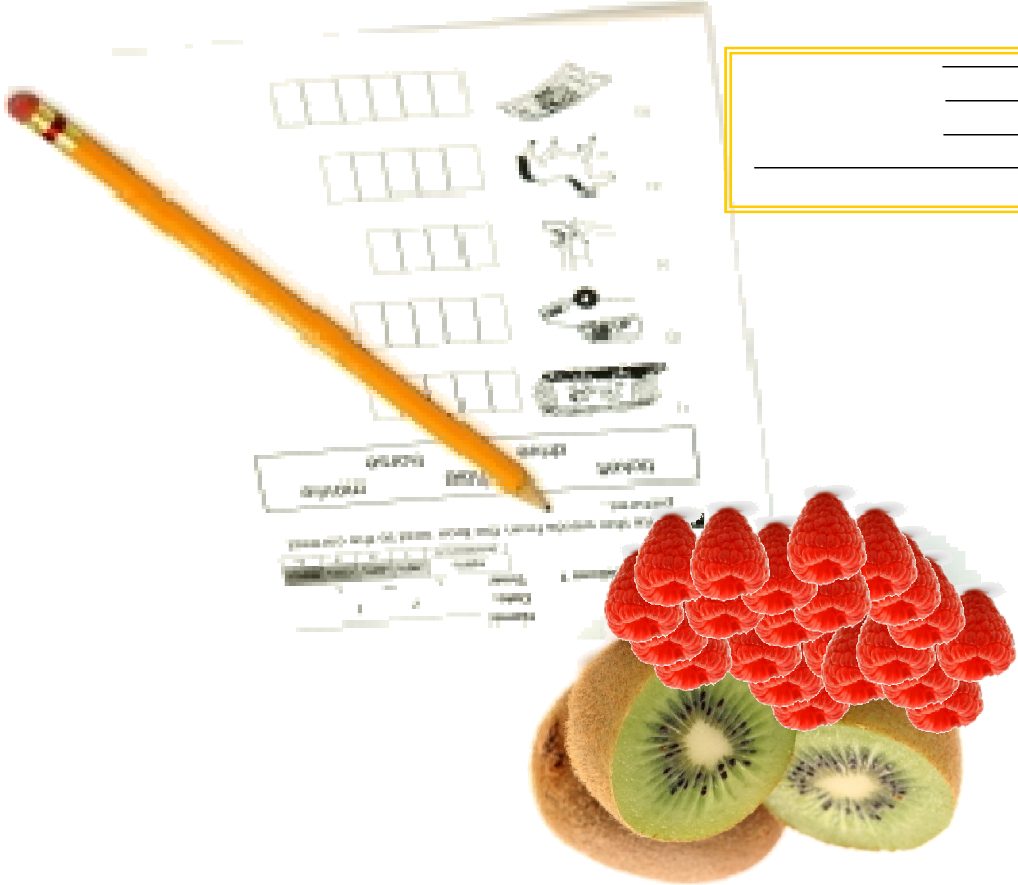
Food Diary

Escola: ____________________

Ano: ____________________

Turma: ____________________

Número: ____________________



O meu diário alimentar

No âmbito do Projecto AFINA-te estamos a estudar os Hábitos Alimentares dos Adolescentes. A tua ajuda é fundamental para que seja possível fazer este trabalho. Muito Obrigado!

Se tiveres dúvidas ou quiseres fazer algum comentário, contacta-me:

Vera Ferro Lebres
vferrolebres@gmail.com
939461125

Bolsa FCT: SFRH/PROTEC/49529/2009

CIAFEL

U.PORTO FACULDADE DE DESPORTO UNIVERSIDADE DO PORTO

Diário Alimentar

Fim de semana

Data: ___/___/___

Refeição/ Hora	Local	Com quem	Alimento	Quantidade	Observações

Diário Alimentar

Como se preenche?

- Deves continuar a comer como de costume.
- O Diário Alimentar deve andar sempre contigo. Preenche-o logo depois de teres comido.
- Deves preencher durante 3 dias (2 durante a semana e 1 no fim de semana).
- Sê honesto! Escreve tudo o que comes e bebes, mesmo apenas uma bolacha ou um copo de sumo.
- Começa cada dia numa nova página.

Qual o alimento que comeste, tenta ser o mais claro e específico possível. Deves incluir todos os alimentos, até os que petiscas fora das refeições. .

Refere-te à quantidade que realmente comes e não à que colocaste no prato. Não é preciso pesares os alimentos, diz em medidas que conheças: colheres, copos, unidades, tamanho mão, ou outras.

Exemplo.

Data: 23 / 03 / 2010

Refeição/ Hora	Local	Com quem	Alimento	Quantidade	Observações
Peq.Alm/ 8h	casa	família	iogurte líquido	1	
Alm/ 12.30	cantina	amigos	sopa	1 tigela	
			arroz	1/ 2 prato	
			frango	provei	não gostei do frango
			tomate	4 rodelas	
			sumo	1 copo	
			pão	1/ 2 biju	
			maçã	1	
Lanche/ 16h	escola	amigos	pacote batata frita	1	dividi com amigos

Refeição a que te referes e a que horas comeste; deves incluir todas as refeições mesmo os petiscos.

Indica onde foi que fizeste a refeição.

Diz quem estava contigo quando comeste, ou se estavas sozinho.

Acrescenta tudo o que julgues importante.

Dia de semana

Diário Alimentar

Data:___/ ___/ ___

Refeição/ Hora	Local	Com quem	Alimento	Quantidade	Observações

Fim de semana

Diário Alimentar

Data:___/ ___/ ___

Refeição/ Hora	Local	Com quem	Alimento	Quantidade	Observações

Diário Alimentar

Data:___/ ___/ ___

Fim de semana

Refeição/ Hora	Local	Com quem	Alimento	Quantidade	Observações

Diário Alimentar

Dia de semana

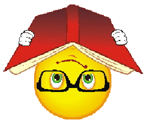
Data:___/ ___/ ___

Refeição/ Hora	Local	Com quem	Alimento	Quantidade	Observações

Observações	Quantidade	Alimento	Com quem	Local	Refeição/ Hora

Data:___/ ___/ ___

Dia de semana



Diário Alimentar

Diário Alimentar

Dia de semana

Data:___/ ___/ ___

Refeição/ Hora	Local	Com quem	Alimento	Quantidade	Observações

Diário Alimentar

Dia de semana

Data:___/ ___/ ___

Refeição/ Hora	Local	Com quem	Alimento	Quantidade	Observações

Diário Alimentar

Dia de semana

Data:___/ ___/ ___

Refeição/ Hora	Local	Com quem	Alimento	Quantidade	Observações